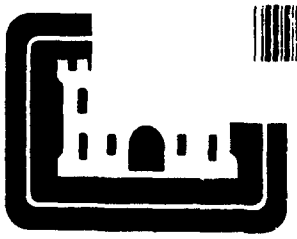
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Toxic and Hazardous Materials Agency

SIERRA ARMY DEPOT PHASE I REMEDIAL INVESTIGATION/ FEASIBILITY STUDY

LASSEN COUNTY, CALIFORNIA

FINAL REMEDIAL INVESTIGATION DAAA15-88-D-0006 TASK ORDER 3

OCTOBER 1991

JAMES M. MONTGOMERY CONSULTING ENGINEERS, INC.

AND

E.C. JORDAN

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PHASE I REMEDIAL INVESTIGATION/FEASIBILITY STUDY
SIERRA ARMY DEPOT

FINAL
REMEDIAL INVESTIGATION

CONTRACT DAAA15-88-D-0006
TASK ORDER 3

Prepared for:

UNITED STATES ARMY
TOXIC AND HAZARDOUS MATERIALS AGENCY
ABERDEEN PROVING GROUND, MARYLAND

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PHASE I REMEDIAL INVESTIGATION/FEASIBILITY STUDY
SIERRA ARMY DEPOT

Contract DAAA15-88-D-0006
Task Order 3

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SIERRA ARMY DEPOT

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REMEDIAL INVESTIGATION

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GLOSSARY OF ACRONYMS AND ABBREVIATIONS

APPENDICES

A - Environmental Assessment Data
B - Potential Location - Specific ARARs
C - Unexploded Ordnance Detection Data
D - Shallow Soil Gas Investigation
E - Surface Geophysical Survey
F - Drilling and Soil Boring Program
G - Geotechnical Sampling Analysis
H - Borehole Geophysical Survey
I - Groundwater Sampling Program
J - Land Survey Data
K - Basin-Wide Flow Model at Honey Lake Valley
L - Aquifer Test Results
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O - Contaminant Fate and Transport Model
P - Installation Restoration Data Management System (IRDMS) Tables
Q1 - Shower Inhalation Exposure Model
Q2 - Determination of Chemicals of Concern
Q3 - Public Health Assessment Evaluation - Toxicity Profiles
Q4 - Risk Characterization

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EXECUTIVE SUMMARY

A Phase I Remedial Investigation (RI) was conducted at five priority sites located at Sierra Army Depot (SIAD). The U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) has contracted with E.C. Jordan and James M. Montgomery, Consulting Engineers, Inc. (JMM), to perform this work in accordance with Clean and Abatement Order No. 6-88-107 issued by the California Regional Water Quality Control Board (RWQCB) - Lahanton Region on June 21, 1988, and a draft Remedial Action Order from the California Department of Health Services. The field investigations were accomplished by JMM under contract DAAA-15-88-D-0006.

Specific objectives of this RI included identification of the extent of contamination, analysis of the fate and transport of contaminants, and the development of a baseline risk assessment to evaluate the need for any further action at each specific site. The field investigations were conducted in January through June 1990 and focused on the confirmation of contamination presence or absence, as well an evaluation of the contamination nature and extent.

Five sites were investigated: the Abandoned Landfill; Construction Debris Landfill; Chemical Burial Site; DRMO Trench Area; and TNT Leaching Beds Site. Investigations included sampling Herlong potable supply wells and installing either soil borings, monitoring wells, or both, depending on the historical disposal practices at the site, geophysical and soil gas surveys, explosive ordinance detection (EOD) screening, test pit excavation, collection of continuous core from six 250-foot-deep soil borings, and aquifer testing.

During the course of this RI, four potable supply wells and 14 existing monitoring wells were sampled. In addition, 30 soil borings were drilled to the water table, six soil borings were drilled to 250 feet, and 18 monitoring wells were installed and sampled. Samples were also collected from eight surface soil and 11 test pit locations. Analytical parameters at each site varied with the expected contaminants based on past disposal practices. Depending on the site, soil samples were analyzed for dioxin/furans, asbestos, phenols, cyanide, priority pollutant and TTLC metals, VOCs, BNAs, pesticides, PCBs, and explosives. Water samples

were analyzed for priority pollutant metals, cyanide, phenols, VOCs, BNAs, pesticides, PCBs, and explosives. In addition, water quality parameters were also analyzed.

For contaminants present in the soils at the TNT Leaching Beds Subsite, a transport model was used to estimate contaminant migration to the groundwater. 1,3,5-TNB, the most frequently detected explosive compound, was modeled. A groundwater contaminant transport model was used to estimate migration of contaminants in the groundwater at the TNT Leaching Beds Area. 1,3,5-TNB and TCE were modeled because they were the most frequently observed compounds in groundwater at this site.

The following is a brief summary of the RI findings:

- TCE was detected above its Maximum Contamination Level (MCL) in a monitoring well at the Abandoned Landfill and in a well downgradient of the Abandoned Landfill at the Chemical Burial Site/Construction Debris Landfill. The TCE source is suspected to be in the northwest portion of the Abandoned Landfill.

- As determined by a geophysical survey and test pit excavations, Abandoned Landfill material is comprised of widely scattered surface metal debris, isolated areas of 2- to 6-inch-thick ash layers, and several 4- to 9-feet-deep trenches that have been filled. Low levels of heptachlor and TCE in the near surface soils were associated with these trenches and they are not considered a likely source of groundwater contamination.

- The Chemical Burial Site was identified by means of geophysics and test pit excavation. No buried drums were found and no significant soil contamination was detected. This site is not considered a likely source of groundwater contamination.

- The buried trench reported to exist at the DRMO Trench Area was not located by means of a geophysical survey, test pit excavations, or a review of aerial photographs. A 2- to 4-inch-thick burn and metal debris area was discovered about 120 feet southwest of the open trench. This area may be a contaminant source, however, it was not sampled.

- DRMO Trench Area soil contamination is primarily restricted to the immediate area of the open trench. Detected soil contaminants included pesticides and VOCs detected in a sample collected approximately 5 feet below the bottom of the open trench. Traces of TCE were detected in soils near the water table, suggesting that TCE has migrated vertically at this site. TCE was

also detected in all three monitoring wells; two contained concentrations of TCE above its MCL (5.0 μg/L). The highest TCE concentration was detected in the southernmost well. TCE in the groundwater at this site could not be modeled due to a lack of data.

- Two distinct contaminant sources are present at the TNT Leaching Beds Area. Therefore, this site was divided into two subsites: the TNT Leaching Beds Subsite and the Vehicle Maintenance Area Subsite. Explosives compounds in soil and groundwater are associated with the TNT Leaching Beds Subsite. VOCs in groundwater are associated with the Vehicle Maintenance Area Subsite. Explosives compounds were detected at high levels in every surface soil sample and 98 percent of the subsurface soil samples from the TNT Leaching Beds Subsite. The majority of the contaminant mass are restricted to the 0- to 2.5-foot interval. A VOC source at the Vehicle Maintenance Area Subsite was not identified.

- 1,3,5-TNB was the most widely distributed explosive contaminant in both the soil and groundwater and was the subject of both vadose and saturated zone models. The vadose zone model predicts that the concentration of 1,3,5-TNB will increase from 3 μg/g to 6 μg/g between the years 1990 to 2000. Saturated zone modeling indicates that both the explosives and TCE plume are essentially immobile.

- Calculated cancer risks exceeded the 1E-06 benchmark for the casual visitor, construction worker, and future residents exposed to contaminated soil and groundwater at the Abandoned Landfill and TNT Leaching Beds Site.

- Calculated cancer risks exceeded the 1E-06 benchmark for the future resident exposed to groundwater at the DRMO Trench Area and for future residents at the Chemical Burial Site/Construction Debris Landfill.

Section 1

Introduction



1.0 INTRODUCTION

1.1 PURPOSE

The U.S. Department of Defense (DOD) has recognized the need to identify and remediate sites that have been affected by past hazardous waste practices on DOD property. To oversee this activity, the Installation Restoration Program (IRP) was developed. The goal of the IRP is to control the migration of hazardous contaminants and protect public health and the environment from potential threats associated with hazardous waste contamination.

Under Contract DAAA15-88-D-0006, Task Order 3, the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) has contracted with E.C. Jordan Company and James M. Montgomery, Consulting Engineers, Inc. (JMM) to conduct the Phase I IRP Remedial Investigation/Feasibility Study (RI/FS) for six sites at Sierra Army Depot (SIAD). This work is being performed in accordance with Clean Up and Abatement Order No. 6-88-107 issued by the California Regional Water Quality Control Board (RWQCB) - Lahontan Region on June 21, 1988, and a draft Remedial Action Order from the California Department of Health Services (DHS). Tasks performed for the RI/FS have been conducted in accordance with relevant U.S. Environmental Protection Agency (USEPA) and State of California DHS guidance.

1.2 SCOPE

Previous environmental investigations conducted at SIAD identified 22 potential hazardous waste sites (Benioff, et al., 1988). The Phase I RI/FS focuses on six high-priority hazardous waste sites from this group. These sites include:

- Abandoned Landfill
- Chemical Burial Site
- Construction Debris Landfill
- DRMO Trench Area

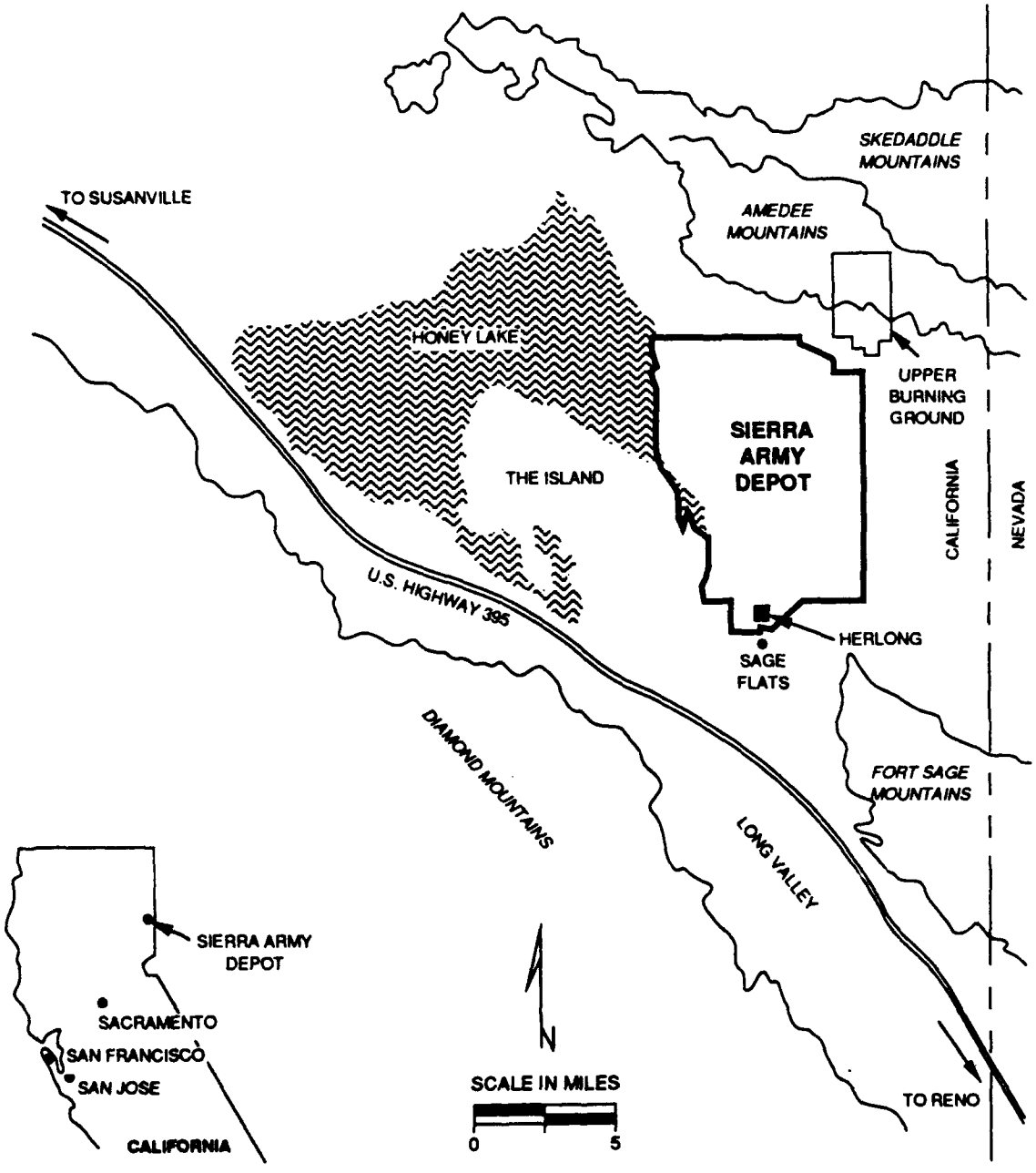
- TNT Leaching Beds Area (which includes the TNT Leaching Beds and Vehicle Maintenance Area Subsites)
- Honey Lake

This report presents the results of the SIAD Phase I RI. The goals of the RI are to define the horizontal and vertical extent of contamination, prepare a public health evaluation (baseline risk assessment) and environmental assessments, assure accurate groundwater modeling of contaminants where possible, and provide sufficient data for a complete Feasibility Study (FS) to be prepared for each of the sites. If these goals have not been attained, data necessary to complete these goals are identified. Tasks undertaken to accomplish the RI goals included field investigations, geologic and hydrogeologic assessments, chemical analyses of soil and groundwater, contamination assessments, Honey Lake Basin groundwater modeling, vadose zone and groundwater contaminant transport modeling, and a public health evaluation/environmental assessment.

1.3 LOCATION

SIAD is located in Honey Lake Valley of Lassen County in Northeast California, approximately 4 miles from the California-Nevada state border (Figure 1-1). The two largest communities near SIAD are Susanville, California (the Lassen county seat located 40 miles northwest of SIAD) and Reno, Nevada (located 55 miles southeast of SIAD). Other neighboring communities include Herlong and Sage Flats (located near the southern entrance to the main depot), and Doyle (located 8 miles south of SIAD).

The total area of SIAD is 37,060 acres and is comprised of two sites: the main depot (33,163 acres) and the upper burning grounds/demolition area (3,897 acres). The latter site is located one mile northwest of the main depot (Figure 1-1). The main depot borders the eastern side of Honey Lake. Mountain ranges that border SIAD are the Amedee and Skedaddle Mountains to the north, the Fort Sage Mountains to the south, and the Virginia



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LOCATION MAP

FIGURE 1-1

Mountains to the southeast. SIAD is located approximately 5 miles east of U.S. Highway 395.

1.4 SITE DESCRIPTIONS

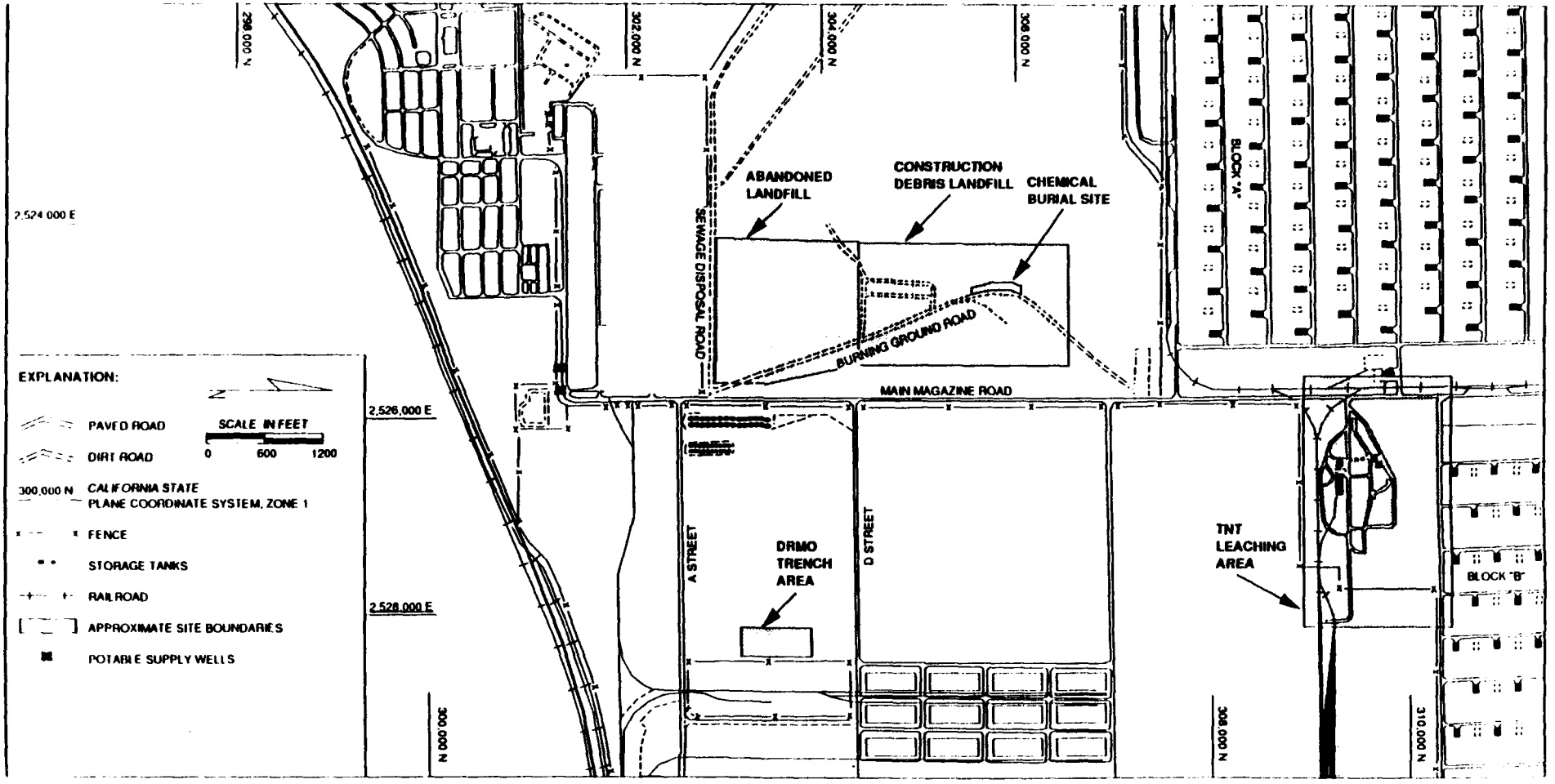
Six sites are included in the Phase I RI: the Abandoned Landfill, Chemical Burial Site, Construction Debris Landfill, DRMO Trench Area, TNT Leaching Beds Area (Figure 1-2), and Honey Lake (Figure 1-1).

The Abandoned Landfill is located at the intersection of Sewage Disposal Road and Main Magazine Road and is approximately 1,600 feet by 1,500 feet (Figure 1-3). The Chemical Burial Site is a covered trench approximately 100 feet by 600 feet located along the west side of the curve in Burning Ground Road (Figure 1-3). The site is approximately 1,000 feet north of the Abandoned Landfill.

The Construction Debris Landfill is nearly bisected by Burning Ground Road and is approximately 2,500 feet by 1,500 feet (Figure 1-3). The southern boundary of the Construction Debris Landfill overlaps the northern boundary of the Abandoned Landfill. The Chemical Burial Site is completely enclosed by the Construction Debris Landfill.

The DRMO Trench Area (Figure 1-4) is located between "A"and "D"Streets on the west side of the DRMO Property Disposal area, east of Main Magazine Road. The DRMO Trench Area consists of an open trench approximately 40 feet wide by 290 feet long by 10 feet deep. A covered trench was suspected to exist approximately 50 feet west of the open trench (Benioff, et al., 1988), but was not located during the Phase I RI field program. (The location and definition of the covered trench was the focus of various field investigations, including geophysical investigations and test pit excavations. See Section 6.2.4.2for a detailed discussion.)

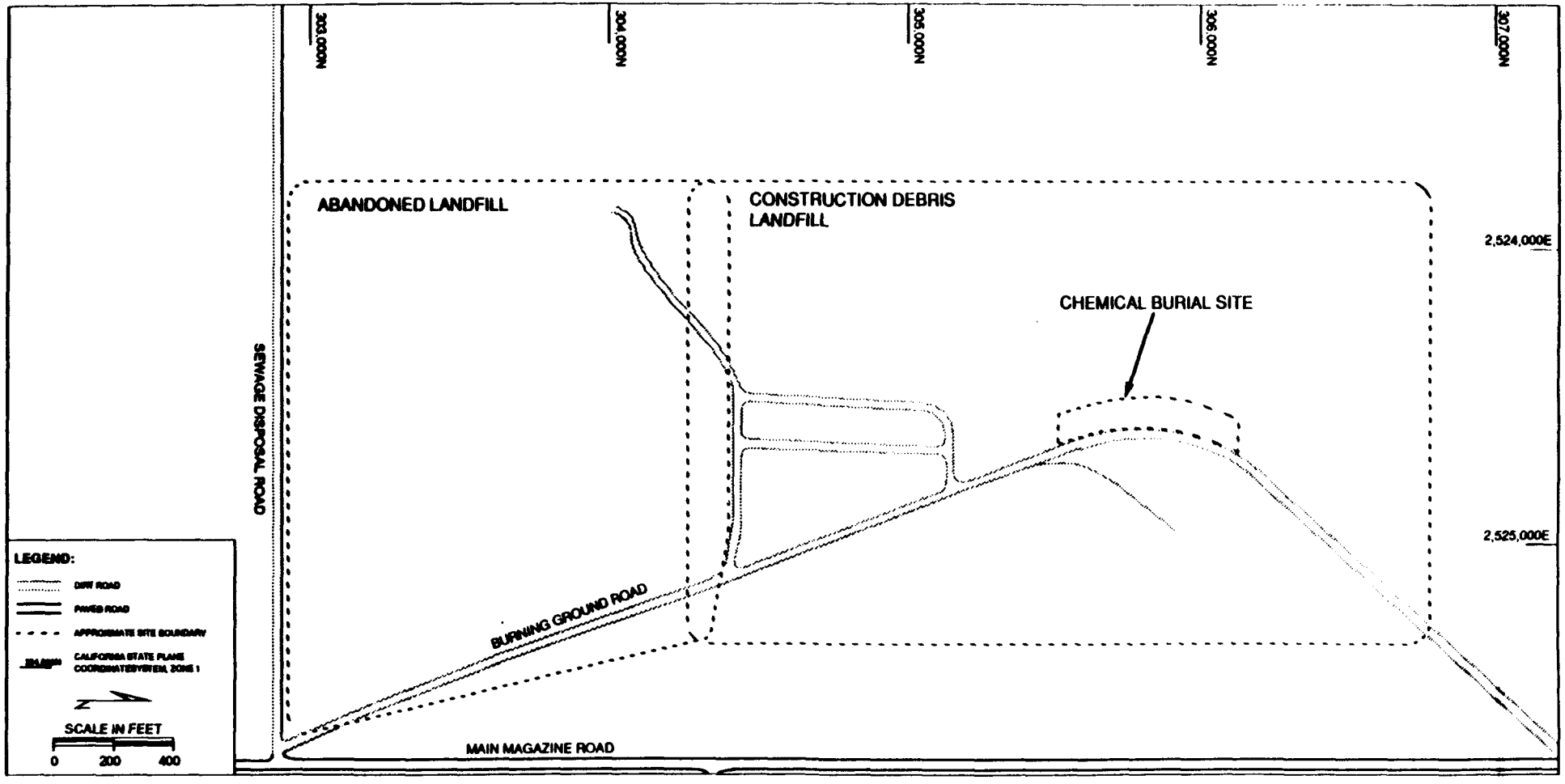
The TNT Leaching Beds Area is located on the east side of the Main Magazine Road along Workshop Road and is approximately 2,500 feet by 2,000 feet (Figure 1-5). The



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PHASE I RI SITE LOCATIONS

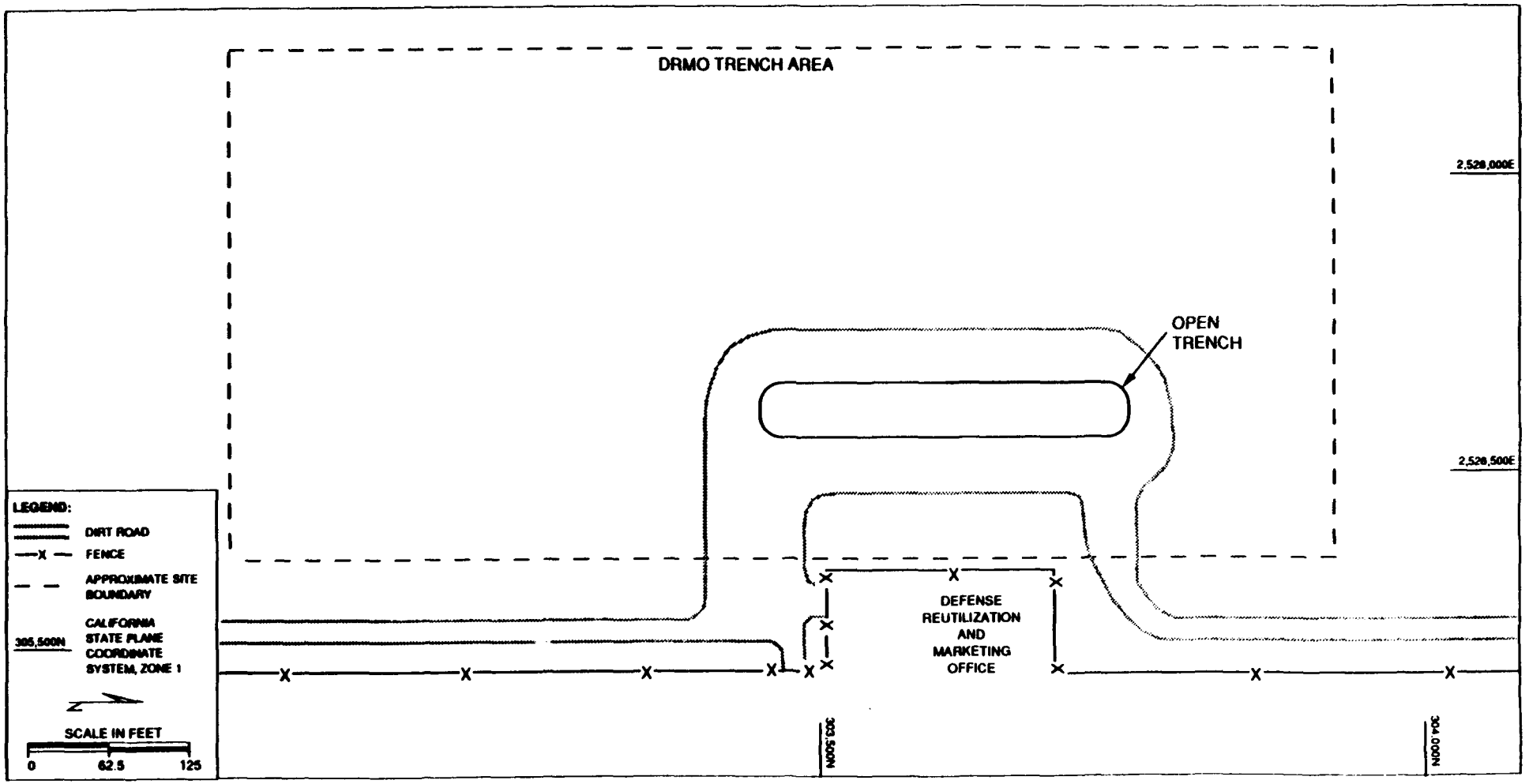
FIGURE 1-2



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SITE MAP:
ABANDONED LANDFILL/CHEMICAL BURIAL SITE/
CONSTRUCTION DEBRIS LANDFILL

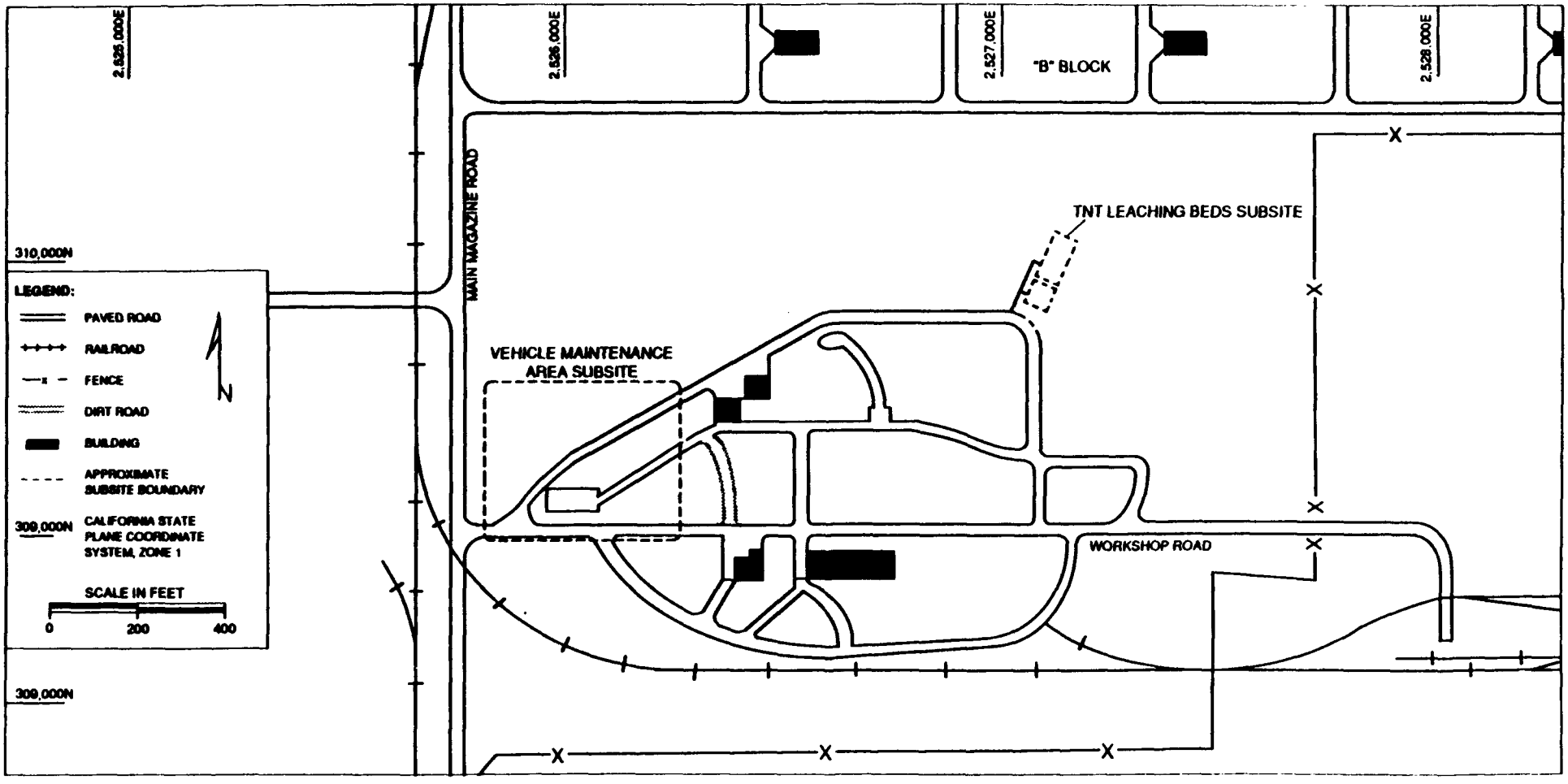
FIGURE 1-3



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SITE MAP: DRMO TRENCH AREA

FIGURE 1-4



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SITE MAP:

TNT LEACHING BEDS AREA

FIGURE 1-5

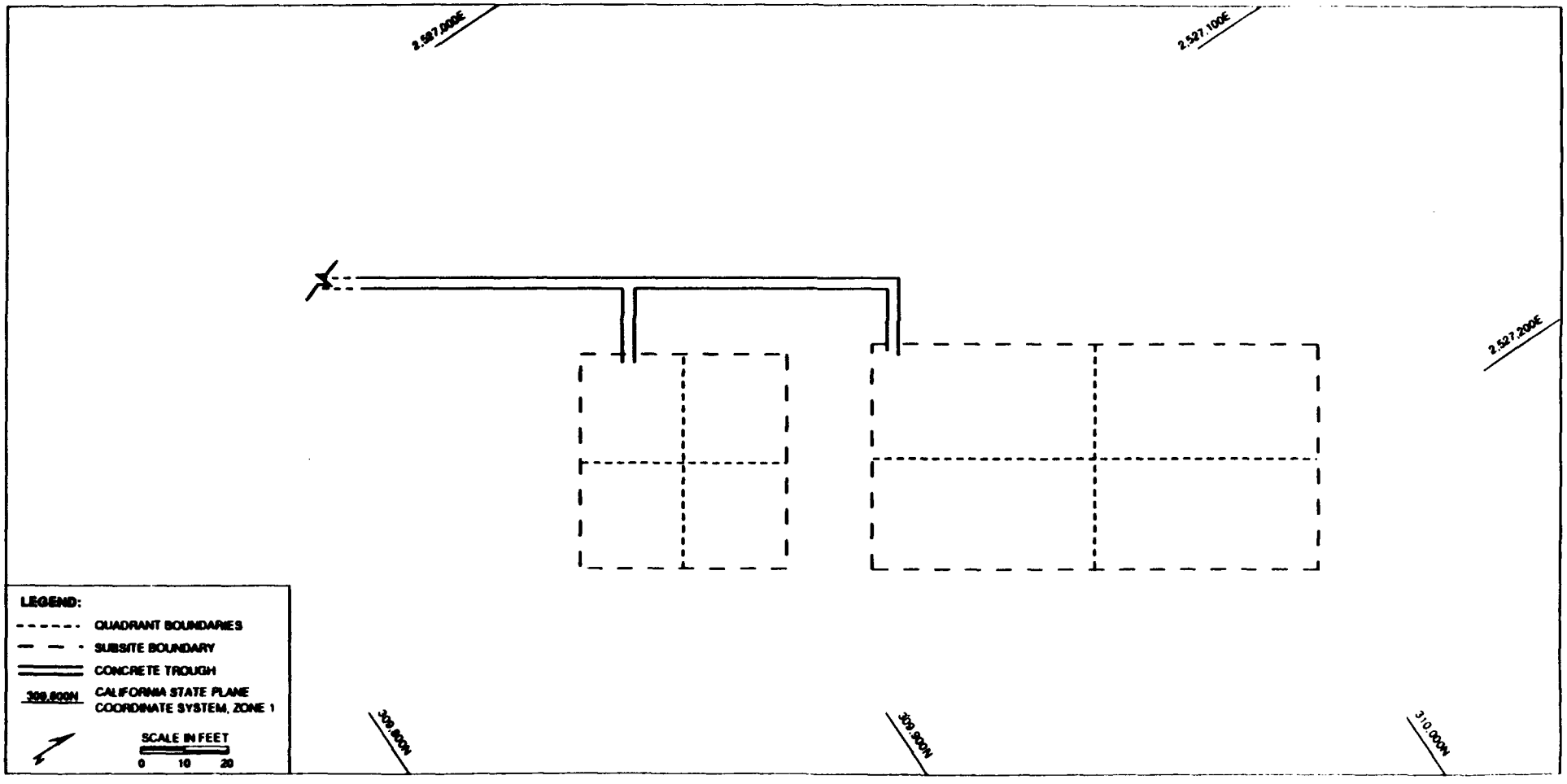
TNT Leaching Beds Area has been divided into two subsites (Figure 1-5), the TNT Leaching Beds Subsite (Figure 1-6) located in the northeastern quadrant, and the Vehicle Maintenance Area Subsite (Figure 1-7) located in the southwestern quadrant. The Vehicle Maintenance Area Subsite was also reported to house a paint shop. The TNT Leaching Beds Subsite consists of two beds. The southern bed is approximately 50 feet by 50 feet, and the northern bed is approximately 50 feet by 100 feet. Each bed is devoid of vegetation and has a sandy bottom. The bottom of each bed is approximately 4 to 5 feet below grade. The Vehicle Maintenance Area Subsite consists of the area surrounding a concrete pad that was formerly a Vehicle Maintenance Building. The concrete pad is approximately 3 feet high, 50 feet wide, and 120 feet long. A cement-lined trough extends eastward from the concrete pad towards a relatively low area about 140 feet east of the pad.

The Honey Lake Site consists of the eastern portion of Honey Lake, which is located on the western border of SIAD (see Figure 1-1). Honey Lake has an area of approximately 60,523 acres. In accordance with Task Order 3, RI sampling and health and safety plans were developed for the Honey Lake Site as part of the Phase I RI/FS but these plans were not implemented during the Phase I RI field program.

1.5 REMEDIAL INVESTIGATION REPORT ORGANIZATION

Subsequent sections of this SIAD Phase I RI Report include the following:

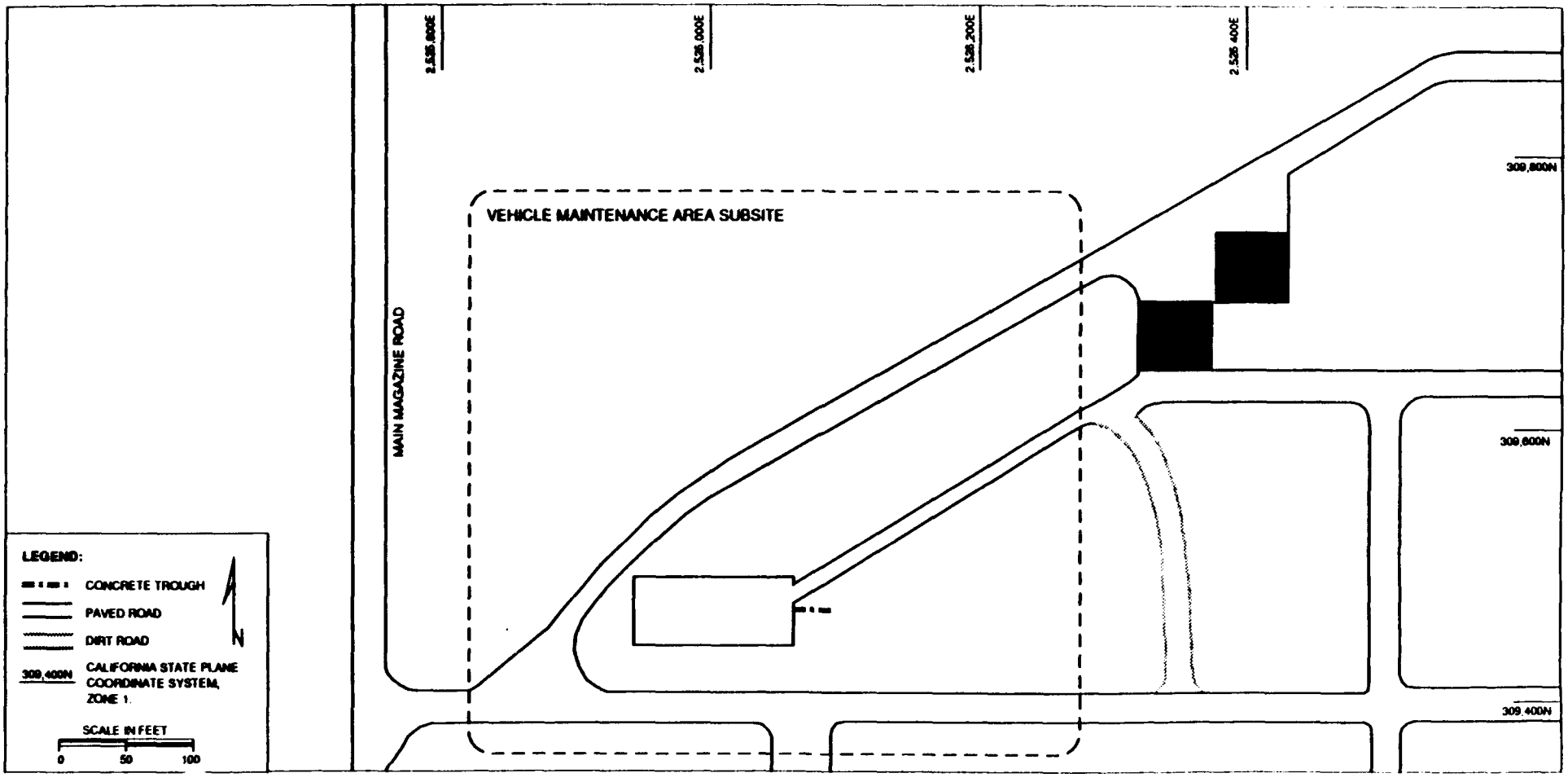
Section 2 - Background
Section 3 - Applicable or Relevant and Appropriate Requirements
Section 4 - Field Program Description and Rationale
Section 5 - Geology and Groundwater Characterization
Section 6 - Contamination Assessment
Section 7 - Public Health Evaluation
Section 8 - Environmental Assessment
Section 9 - Remedial Investigation Conclusions and Recommendations
References
Glossary of Acronyms and Abbreviations



SIERRA ARMY DEPOT

SITE MAP OF TNT LEACHING BEDS SUBSITE:
TNT LEACHING BEDS AREA

FIGURE 1-6



SIERRA ARMY DEPOT

SITE MAP OF VEHICLE MAINTENANCE AREA SUBSITE: TNT LEACHING BEDS AREA

FIGURE 1-7

Section 2 contains information describing the SIAD environmental setting, site history, and a summary of previous field investigations.

Section 3 addresses chemical- and location-specific applicable or relevant and appropriate requirements (ARARs) for contaminants detected at SIAD Phase I sites.

Section 4 presents the techniques and procedures used during the RI field program. Unexploded ordnance (UXO) screening, soil gas survey, geophysical survey, test pit excavation, soil boring and monitoring well installation, monitoring well development, logging and sampling techniques, and aquifer testing are specifically addressed in Section 4. All health and safety activities performed during the RI are also discussed in this section.

Section 5 includes descriptions of the geology and hydrogeology of the overall Honey Lake Basin and SIAD. In addition, the soils, geology, hydrogeology of unconsolidated sediments, and groundwater movement at each site is specifically addressed in this section.

Section 6 presents the Phase I RI contamination assessment data. Section 6.1 describes the laboratory program and data management system used for the RI. Section 6.2 presents the site contaminants and their concentrations in graphical and tabular form. For each site, vertical and horizontal contaminant distributions in specific environmental matrices are also presented. Section 6.2 also assesses the environmental fate (physical, chemical, and environmental degradation processes) and transport mechanisms (soil and groundwater) associated with site contaminants. The results o contaminant transport model of the TNT Leaching Beds Area are presented in this section.

Section 7 presents the public health evaluation for the Phase I sites. Included in the public health evaluation is an estimation of the risk to humans based on analytical modeling and a variety of exposure scenarios. A carcinogenic and noncarcinogenic risk characterization is presented for each of the RI sites based on both current and future land use scenarios.

Section 8 presents the impacts of SIAD Phase I RI contaminants on the environment.

Section 9 presents conclusions based on the information gathered during the RI and recommendations for any additional RI work at these sites.

References and the Glossary of Acronyms and Abbreviations follow Section 9.

The appendices accompanying this volume contain analytical results and data pertinent to the SIAD Phase I Remedial Investigation. They appear as follows:

Appendix	A	-	Environmental Assessment Data
Appendix	B	-	Potential Location-Specific ARARs
Appendix	C	-	Unexploded Ordnance Detection Data
Appendix	D	-	Shallow Soil Gas Investigation
Appendix	E	-	Surface Geophysical Survey
Appendix	F	-	Drilling and Soil Boring Program
Appendix	G	-	Geotechnical Sampling Analysis
Appendix	H	-	Borehole Geophysical Survey
Appendix	I	-	Groundwater Sampling Program
Appendix	J	-	Land Survey Data
Appendix	K	-	Basin-Wide Flow Model at Honey Lake Valley
Appendix	L	-	Aquifer Test Results
Appendix	M	-	Chemical Data Tables
Appendix	N	-	Quality Control Results
Appendix	O	-	Contaminant Fate and Transport Model
Appendix	P	-	Installation Restoration Data Management System (IRDMS) Tables
Appendix	Q1	-	Shower Inhalation Exposure Model
	Q2	-	Determination of Chemicals of Concern
	Q3	-	Public Health Assessment Evaluation - Toxicity Profiles
	Q4	-	Risk Characterization

Section 2

Background



2.0 BACKGROUND

2.1 ENVIRONMENTAL SETTING

2.1.1 Meteorology

The climate in the vicinity of SIAD is arid and is characterized by low relative humidity and low rainfall. The average summer temperature ranges between 64 degrees Farenheit (°F) and 100°F. Temperatures are commonly below freezing during the winter months (December through February). The record high and low temperatures are 104°F and -20°F, respectively. The average dates of the first and last killing frosts are October 22 and May 23, respectively (Benioff, et al., 1988). The most recent on-site temperature data for SIAD is shown in Table 2-1.

Average annual precipitation at SIAD is 5.6 inches, with about half of the total falling as snow. Very little rain falls between April and October. Prevailing daytime winds are from the west. At night, wind direction is variable and wind speed is low. The daytime wind pattern is the result of surface heating in the valley in which SIAD is located, causing dry air to sink from the adjacent mountain ranges. Daytime heat dissipates rapidly after nightfall (Benioff, et al., 1988). Table 2-2 lists the 1984-85 mean monthly precipitation for SIAD.

2.1.2 Physiography

SIAD is located in Honey Lake Valley, California, in the Basin and Range physiographic province. Honey Lake Valley lies along the California-Nevada state border, approximately 55 miles northwest of Reno, Nevada, and 40 miles southeast of Susanville, California. The valley is encompassed by the Fort Sage and Virginia Mountains on the southeast, the Diamond Mountains on the west, the Shaffer and Antelope Mountains on the north, and the Skedaddle and Amedee Mountains on the northeast. Honey Lake occupies the lower part of the valley (USATHAMA, 1979). SIAD is comprised of two sites, the main depot which occupies an area of 33,163 acres, and the upper burning grounds/demolition area, which occupies an area of 3,897 acres lying immediately northeast of the main depot.

TABLE 2-1

MONTHLY TEMPERATURE DATA FOR SIERRA ARMY DEPOT

Month	Temperature (°F)		
	Minimum	Maximum	Mean
January 1990	7.5	66.7	31.9
February 1990	-11.9	61.9	28.5
March 1990	16.7	70.2	44.9
April 1990	31.5	81.7	54.7
May 1990	32.9	86.2	55.3
June 1990	30.6	95.0	65.4
July 1987	36.7	100.4	69.3
August 1987	43.7	98.6	73.3
September 1987	34.0	94.6	65.7
October 1987	28.8	87.3	56.0
November 1987	15.3	63.9	42.9
December 1987	-4.9	86.5	34.4

Source: SIAD Display Tower

TABLE 2-2

1984-1985 MEAN MONTHLY PRECIPITATION FOR SIERRA ARMY DEPOT

Month	Rainfall (inches)
January	0.19
February	1.60
March	1.38
April	0.16
May	0.04
June	0.17
July	0.09
August	0.02
September	0.38
October	0.54
November	2.17
December	0.82

Source: SIAD Environmental Assessment, July 1990

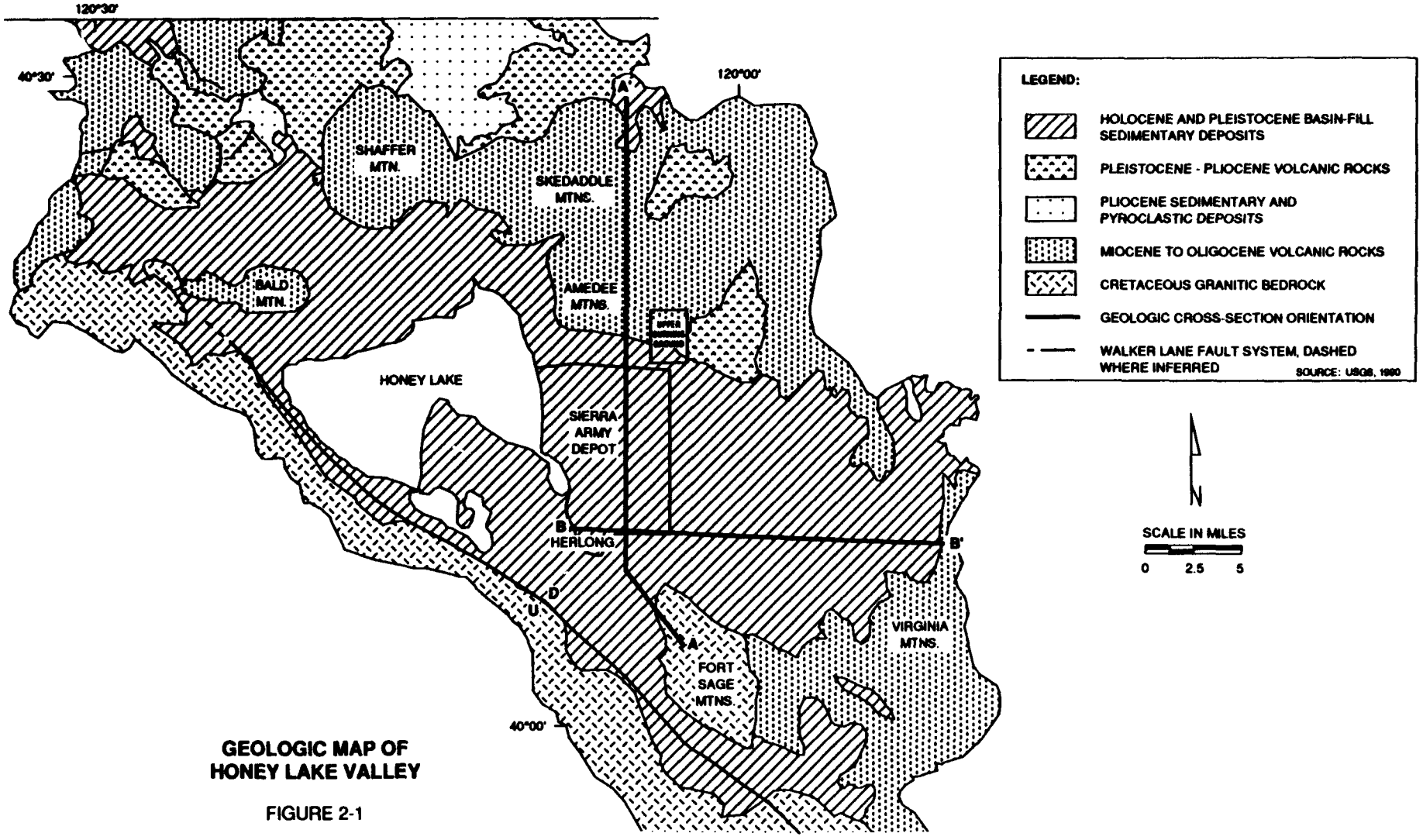
The topography of most of SIAD is relatively flat and ranges in elevation from 3,986 feet to approximately 4,134 feet above mean sea level (msl) at Herlong. The northern part of SIAD is on the lower lake elevations while the southern part is on a sandy terrace. The upper burning grounds/demolition area is a detached part of SIAD located on the edge of Amedee Mountain in ragged terrain and varies in elevation from 4,039 to 5,479 feet above msl (USATHAMA, 1979).

2.1.3 Geology of Honey Lake Basin

Honey Lake Valley lies at the junction of three geologic provinces: the western edge of the Basin and Range, the northeastern edge of the Sierra Nevada, and the southeastern edge of the Modoc Plateau. A northwest trending fault system, the Walker Lane, extends from Las Vegas to Honey Lake Valley. The topography of Honey Lake Valley is primarily a manifestation of horizontal and vertical movement along the several faults included in the Walker Lane fault system. Both right-lateral and vertical movements have been documented in the Walker Lane fault system (Handman, et al., 1990). Erosion, volcanism, and sedimentation in Honey Lake Valley also contributed to the topography of the basin.

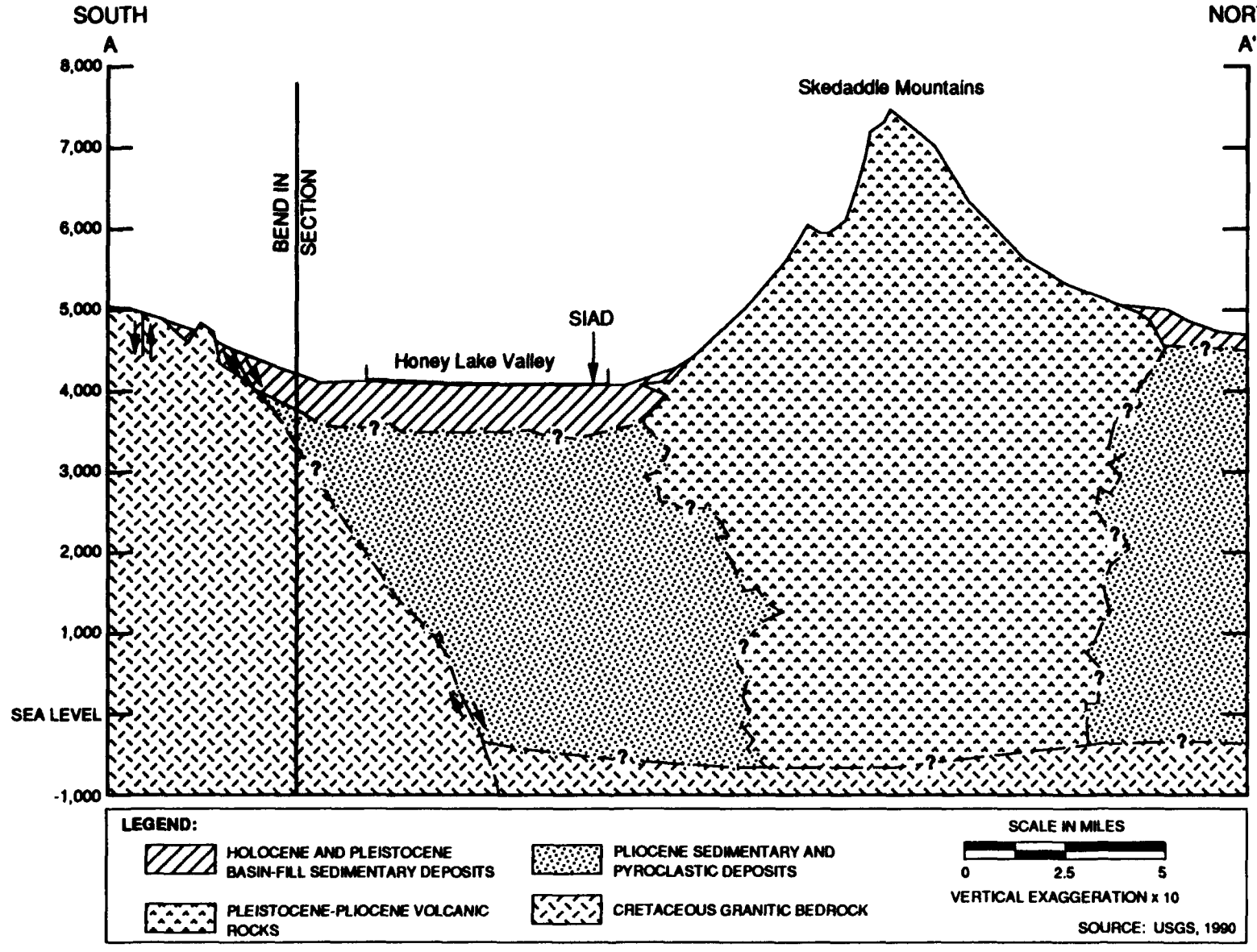
Honey Lake Valley is comprised of granitic bedrock, volcanic rocks, and unconsolidated to semi-consolidated sediments (Figures 2-1 through 2-3). Granitic bedrock forms the lower impermeable boundary to groundwater flow and is 5,000 to 6,000 feet below ground surface (Handman, et al., 1990). Volcanic rocks overlie granitic rocks in the Diamond Mountains to the west and Fort Sage Mountains to the south (Figure 2-1). These rocks range in age from approximately 12 million years (Miocene) to one million years (Pleistocene) (Handman, et al., 1990). Miocene age volcanic rocks are more than 5,000 feet thick in the Skedaddle Mountains to the north (Benioff, et al., 1988). These rocks are an important water source and provide a groundwater migration route along the entire north side of the basin.

Unconsolidated and semi-consolidated Pliocene and Holocene basin-fill deposits underlie, interfinger with, and overlie the consolidated volcanic rocks along the entire north and northeast margins of the basin. These semiconsolidated deposits consist of thick layers of volcanic tuff and ash that typically were deposited in shallow lakes along with lacustrine and



GEOLOGIC MAP OF HONEY LAKE VALLEY

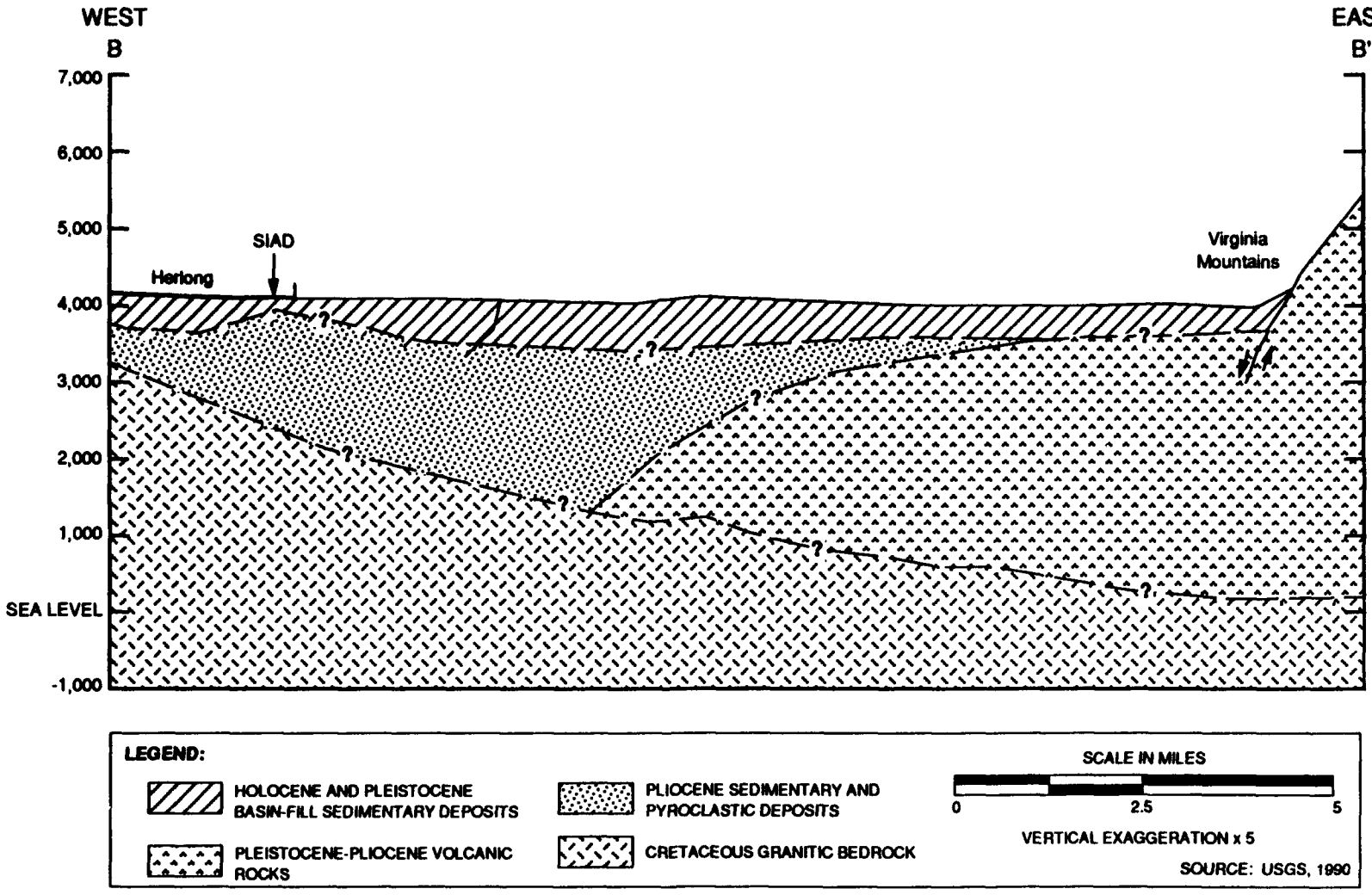
FIGURE 2-1



SIERRA ARMY DEPOT

GEOLOGIC CROSS SECTION A - A'

FIGURE 2-2



SIERRA ARMY DEPOT

GEOLOGIC CROSS SECTION B - B'

FIGURE 2-3

fluvial deposits of clay, silt, and minor amounts of sand. This unit has low permeability and is called a lake deposit by Lyndon and others (1960) and the California Department of Water Resources (1983), but is described as a volcanic tuff by Grose and others (1989) (Handman, et al., 1990). Most of the basin fill consists of this unit.

Honey Lake occupies part of an area previously covered by a much larger, prehistoric water body known as Lake Lahontan. Lake Lahontan water levels attained a maximum altitude of 4,365 feet above sea level, almost 400 feet above the present day level of Honey Lake. Quaternary age sediments deposited in Lake Lahontan are an important aquifer in the western portions of Honey Lake Valley where sands and gravels from Long Valley Creek are predominant. On the eastern side of the basin, the Quaternary age sediments consist mainly of fine-grained silts and clay that have low hydraulic conductivity.

Alluvial fans of Quaternary age consisting of poorly sorted deposits ranging in size from clay to boulders, have accumulated along the base of the mountain fronts. The distal portions of the fans interfinger with the predominantly fine-grained deposits toward the center of the basin. These alluvial sediments have moderate to high permeability and are an important aquifer at the western edge of the valley floor.

Surface Hydrology

More than 40 streams flow from the Diamond, Fort Sage, and Virginia Mountains and the northern volcanic uplands toward the center of the topographically closed basin. Most are intermittent and reach the valley floor only in the wet years. The largest streams in the basin are the Susan River and Baxter Creek which enter the valley from the northeast, and Long Valley Creek which enters the valley from the southeast. The most prominent surface water feature in the basin is Honey Lake, which fluctuates greatly in area and volume. On the average, it has a surface area of about 47,000 acres and contains about 120,000 acre-feet of water which is derived from a combination of lake-surface precipitation, stream inflow (mostly from the Susan River), and groundwater inflow. Water accumulates in Honey Lake during periods of rapid snow melt, but most stream flow is diverted for irrigation or seeps

into alluvial fan deposits before it reaches the valley floor and the lake (Handman, et al., 1990).

Hydrogeology

Groundwater in Honey Lake Valley mainly originates as precipitation in the basin and in the drainage areas of the Susan River, Baxter Creek, and Long Valley Creek. Precipitation infiltrates through unconsolidated deposits and seeps down faults and fractures in consolidated rocks to become groundwater. Groundwater flows downgradient from recharge areas in or near the mountains to discharge areas near the central axis of the basin (Handman, et al., 1990).

The median horizontal hydraulic conductivity of the basin-fill deposits and volcanic rocks was estimated to be about 8 ft./day on the basis of analyses of production tests and descriptions of geologic materials (Handman, et al., 1990). In general, the hydraulic conductivity of unconsolidated sediments decreases with decreasing elevation from a maximum on upper alluvial fans to a minimum in sediments underlying the playa on the valley floor. It also decreases with depth as the result of compaction. The greatest hydraulic conductivities are in fractured volcanic rocks in the southeastern part of the basin. The smallest are probably in massive granitic bedrock. A horizontal to vertical anisotropy of 100 to 1 is considered representative of sediments in basins similar to Honey Lake Valley (Handman, et al., 1990) and is reasonable for unconsolidated and volcanic aquifers in the basin. A specific yield of 15 percent has been used as the average for groundwater flow models of other valleys of the Great Basin and can be considered representative for primarily coarse-grained (upper-fan) deposits (Handman, et al., 1990). A specific yield of 10 percent is typical of mixed coarse- and fine-grained deposits and about 6 percent is typical for fine-grained deposits (Handman, et al., 1990). The former correspond to near-shore deposits in Honey Lake Valley and the latter correspond to offshore deposits beneath the central valley floor (Handman, et al., 1990).

Recharge to the groundwater system in Honey Lake Valley is from direct infiltration of precipitation and snowmelt into consolidated rock and unconsolidated basin fill deposits,

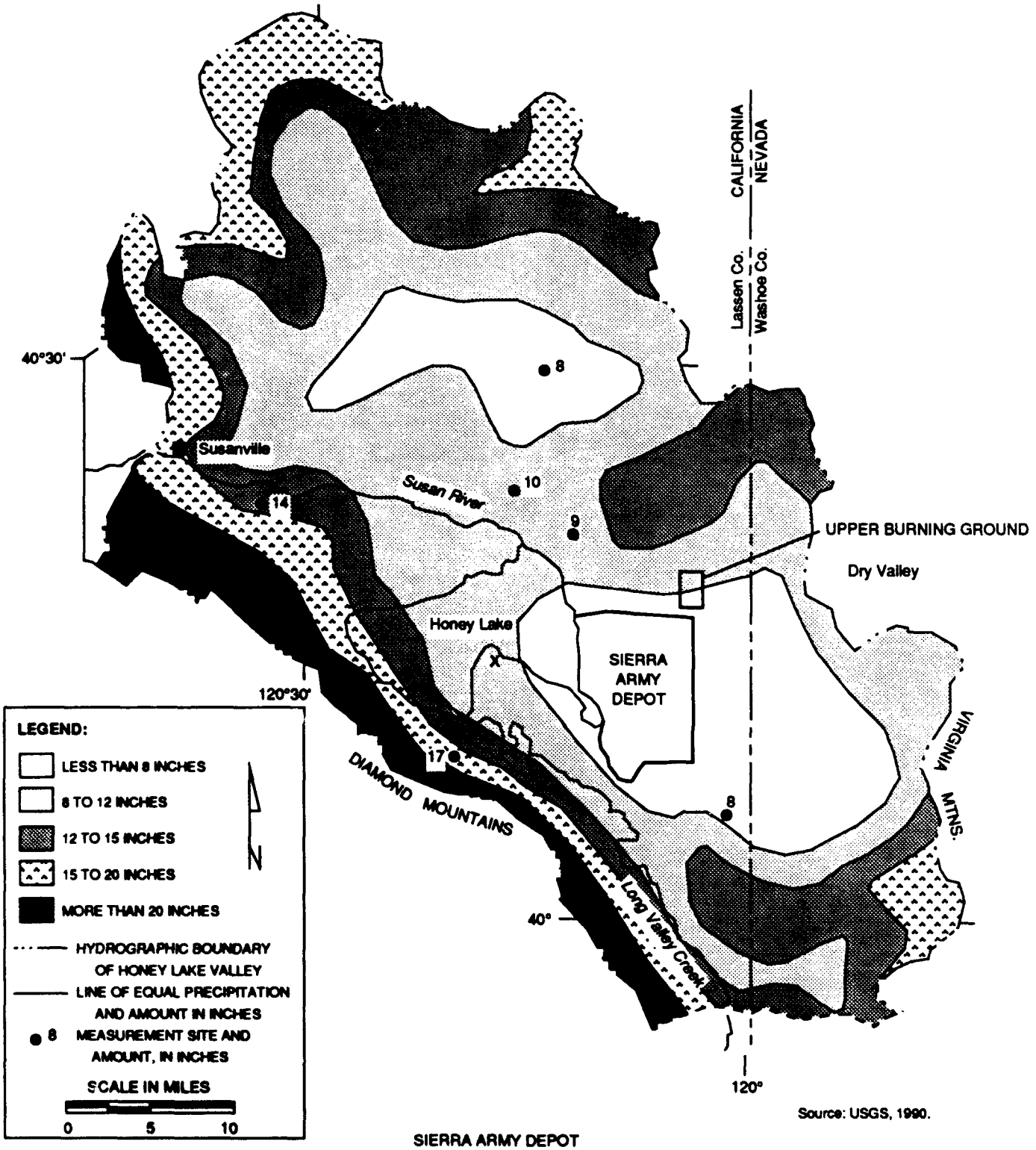
infiltration of water from streams, seepage of irrigation water, and subsurface inflow from adjacent areas. The major sources are direct infiltration of precipitation in upland areas and infiltration of streamflow in alluvial fan areas.

Most precipitation that falls on the basin evaporates or is transpired by vegetation before it infiltrates to the water table. The small amount that does infiltrate is the major source of groundwater recharge. Precipitation is much greater on the mountains than on the valley floor, ranging from more than 20 inches in the Diamond Mountains to less than 8 inches over large areas of the valley floor including most of SIAD (Figure 2-4). Mean annual precipitation over Honey Lake Valley is about 1.1 million acre-feet (Handman, et al., 1990).

Total mean annual streamflow in Honey Lake Valley is estimated to be 230,000 acre-feet (Handman, et al., 1990). Some streamflow evaporates or is transpired by vegetation along stream channels, some flows into Honey Lake, and some, approximately 40,000 acre-feet, infiltrates to become groundwater recharge. In the most arid parts of the basin, nearly all streamflows are lost to evaporation or infiltrate through permeable deposits and fractured rock to the groundwater system. However, larger streams, such as Long Valley Creek, may gain water after they reach the valley floor (Handman, et al., 1990).

Streamflow reaches Honey Lake during periods of snowmelt, occasional large storms, and as irrigation return flow during the growing season. Streams from the Diamond Mountains of the Sierra Nevada also discharge into the lake during parts of the year. Much of the water in Honey Lake is from these sources, although a small amount is probably from groundwater discharge into the lake by natural seepage through the lake bottom and by discharge of geothermal water. In addition, approximately 39,000 acre-feet is from precipitation directly onto the lake surface each year. Annual streamflow into the lake is estimated to be 130,000 acre-feet (Handman, et al., 1990).

The estimated average volume of surface water that is diverted from streams, flowing into the basin for irrigation each year is 54,000 acre-feet (Handman, et al., 1990). Assuming an average irrigation return of 25 percent in Honey Lake Valley, about 14,000 acre-feet of water



SIERRA ARMY DEPOT

MEAN ANNUAL PRECIPITATION, HONEY LAKE VALLEY, 1985-86

FIGURE 2-4

annually infiltrates to the groundwater flow system from surface water irrigation (Handman, et al., 1990).

2.1.4 Land Use

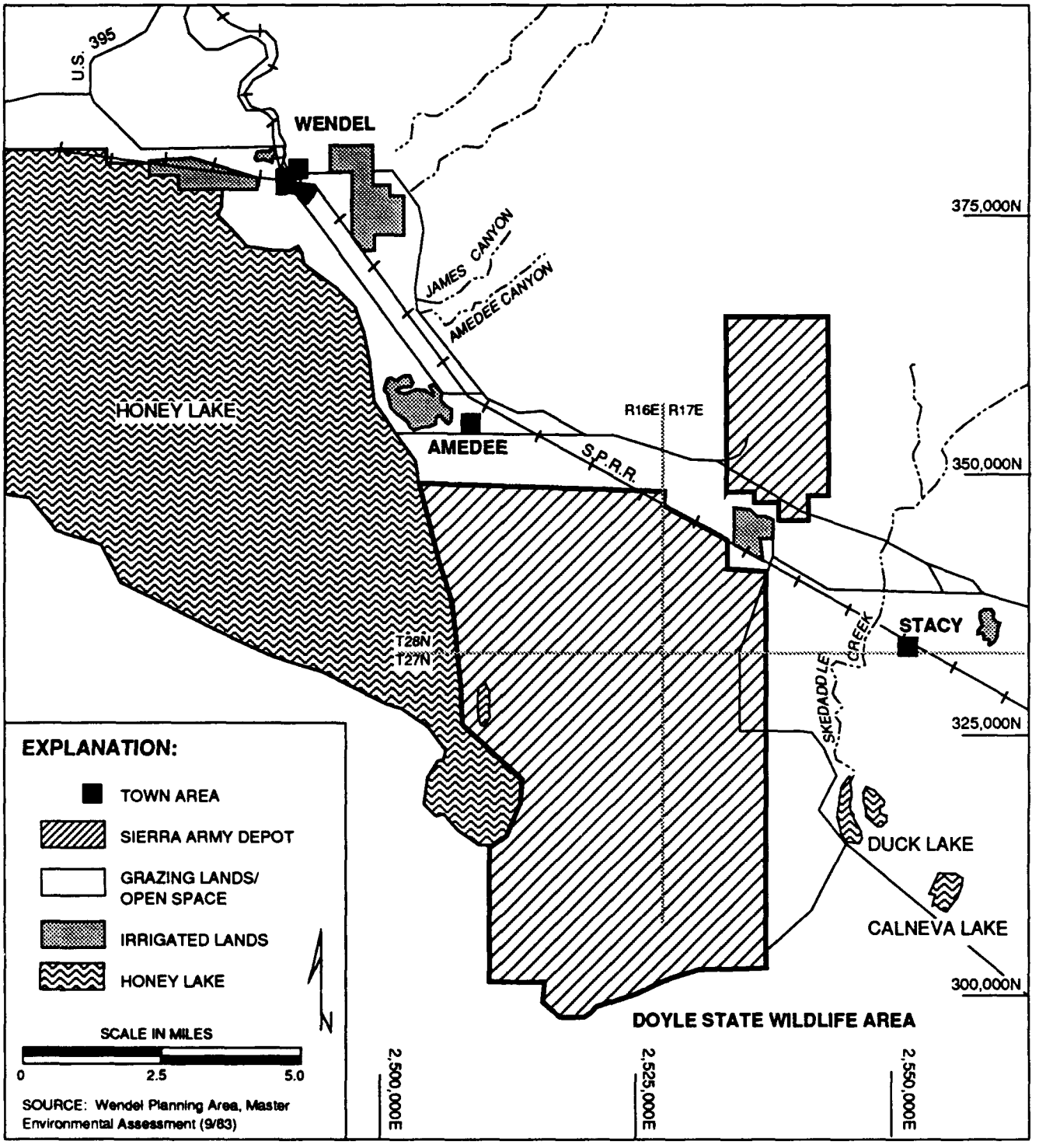
Lassen County has prepared a series of "area" plans covering selected portions of the county. SIAD is located within the Wendel Planning Area. Because of limited development and the sparse population, only four basic land use categories are found in this planning area: grazing lands/open space, Sierra Army Depot, irrigated lands, and town area, as shown in Figure 2-5.

The largest land use category is grazing lands/open space; most of the land is covered with native vegetation. Most of this land is in public ownership, with some private lands included. Approximately one-third of the total Wendel Planning Area consists of SIAD. A few isolated patches of irrigated fields are found in the planning area. These are mainly irrigated pastures of mixed grasses and native grasses. Some of these areas include residences associated with ranching. The fourth category is "towns" which consists of Wendel, Herlong, and Sage Flats located northwest of SIAD. Just south of SIAD is the Doyle State Wildlife area, a wintering habitat for mule deer. The communities of Herlong and Sage Flats reside near the southern entrance to the main depot.

2.1.5 Biota

2.1.5.1 Vegetation

SIAD encompasses approximately 37,060 acres of a dried salt lake bed and volcanic terrain located to the east of Honey Lake. The principal plant community at SIAD is greasewood-sagebrush, characteristic of the alkaline soils and semi-arid climate of the area. The most common shrubs are greasewood, sagebrush, rabbitbrush, spring hopsage, horsebrush, and shadscale. The principal grasses include Great Basin wild rye, saltgrass, squirrel tail, Mormon tea, and annual cheatgrass. Common forbs include poverty weed, pepperwood, and tansy mustard. Several tree species have been introduced on base, including Chinese elm,



SIERRA ARMY DEPOT

WENDEL PLANNING AREA
EXISTING LAND USE

FIGURE 2-5

Russian olive, Englemann spruce, Ponderosa pine, junipers and cottonwoods, in order to decrease erosion. No threatened or endangered species are known to occur on base. No in-depth survey of flora species has been conducted to date at SIAD. However, Appendix A, Environmental Assessment Data, lists the plants that can be found in the Bureau of Land Management's (BLM) Cal-Neva Planning Unit, the closest planning unit which would be representative of on-base vegetation.

2.1.5.2 Wildlife

A variety of wildlife species is found in the general area of SIAD. Included among the species inventoried for this area are four species of rabbits, 29 species of rodents, mountain lions, fox, mule-deer, various reptiles and amphibians and over 100 species of birds (Appendix A). From this diverse group, the Aleutian goose, mule deer, peregrine falcon, bald eagle and game bird species are the most significant from an ecological assessment viewpoint. Mule deer and game birds are recreationally important species, while peregrine falcons, bald eagles and Aleutian geese are rare, threatened or endangered species.

The animals expected to inhabit SIAD fall into two classes: (1) those organisms which utilize the site year-round, and (2) animals which only seasonally visit the site. The most likely animal species to be permanent residents include all rodents, other small mammals, lizards and snakes. These animals generally restrict their activities to early morning/evening and night. Desert rodents are primarily burrowers (Smith, 1974).

Temporary residents of the site would mostly include insect and bird species. The appearance of these organisms would be primarily limited by major influxes of water either in the form of rainfall or snowmelt. The presence of significant moisture (rainfall and snowmelt) in desert biomes results in germination of ephemeral plants. Desert insect species lifecycles are geared to the appearance of these plants. Subsequently, birds that utilize the ephemeral plants and/or insects as a food resource may become temporarily established at the site for breeding (Smith, 1974).

2.1.6 Demography

SIAD is located in a sparsely populated region. There are no major cities and few towns exist in the area. Approximately 1,000 people reside in Herlong and Sage Flats, which are located near the southern entrance to the main depot. The depot itself houses 535 military personnel. The town of Milford, located approximately 12 miles west of SIAD, has a population of 70, with an additional 300 people located in the surrounding area. In addition, several hamlets are scattered about the valley floor, each containing a handful of domestic dwellings (Jacobs, 1990).

2.1.7 Cultural Resources

An archaeological overview and management plan was prepared for SIAD in July 1987. According to this report there are no officially recorded archaeological resources at SIAD nor have any collections been identified. However, depot employees reported archaeological remains found at two sites; another 34 potentially significant historical resources were identified through archival research. The areas most likely to contain significant archaeological sites are the lakeshore zone within SIAD and the hillslopes of the demolition area. The flatland zones are considered to be less likely to contain significant archaeological sites. All of the RI sites are located in areas considered less likely to contain archaeological resources (WIRTH, 1987).

2.2 SITE HISTORY

2.2.1 Installation History

Prior to establishment of SIAD, Honey Lake was acquired by the Army in 1933 for use as a bombing range. Additional properties for the depot and demolition grounds were acquired in 1942, 1952, 1958, and 1959 (USATHAMA, 1979).

Construction of the Sierra Ordnance Depot was initiated in February 1942 and completed approximately one year later. Additional facilities including a hospital, chapel, elementary

school, Amedee Airstrip, and second housing tract of 600 units were constructed during World War II. Several buildings and barracks have been added to the depot subsequent to the World War II construction (USATHAMA, 1979).

SIAD began operations in 1942 involving the reserve storage of inert supplies and materials owned by the Treasury Department. After construction of the Igloo Storage Area at SIAD, the receipt, storage, and issue of explosives was assigned to the depot. In 1954, the additional missions of receipt, storage, and issue of guided missiles and propellant fuels were also assigned to SIAD. The present mission of SIAD is "the receipt, storage, surveillance, maintenance, and issue of munitions, strategic and critical materials, and obligated war reserve material" (Benioff, et al., 1988). SIAD also receives, ships, and stores packed or crated household goods (USATHAMA, 1979).

2.2.2 Types of Operations at SIAD

The current and past types of operations performed at SIAD that used or generated potentially hazardous materials were the maintenance of equipment and vehicles, maintenance and renovation of munitions, demilitarization of munitions, and disassembly and repair of weapons. The specific work practices involved with these operations have included: spray painting, welding and soldering, degreasing, lubricating, preserving with oils and waxes, removing rust and paint, explosive washout and destruction in popping furnaces, grinding and machining, abrasive-blasting, packaging items (including explosives), maintaining batteries, steam cleaning, heat-treating metal parts, and handling of asbestos and insecticides (USATHAMA, 1979). These operations have been performed in the Ammunition Maintenance Area since 1961. Painting and sandblasting of bombs was performed in the Ammunition Maintenance Area between 1957 and 1961.

2.2.3 Disposal Practices at SIAD

This section of the RI discusses the overall disposal practices at SIAD. Descriptions of chemical usage and disposal practices that have affected each of the Phase I RI sites addressed in this report are presented in subsequent sections.

Solid waste disposal practices at SIAD are described in USAEHA (1973). Based on the 1972 study, the installation generates an average of 64 tons/month of solid waste, primarily paper and plastics. Materials that could be sold to commercial firms for recycling or reused on the base for other purposes were salvaged. The housing and post solid wastes are disposed of in the sanitary landfill. Approximately 200 gallons/month of garbage and 80 gallons/month of grease were removed from SIAD by a disposal contractor (USAEHA, 1973). Classified special weapons materials, averaging approximately 0.40 tons/month, were disposed of in demilitarization operations. Classified documents are incinerated at SIAD (USAEHA, 1973).

SIAD operates a sanitary sewage system for wastewater treatment. Between 1941 and 1971, wastewater was treated at one of two sewage treatment plants consisting of an Imhoff tank and unlined polishing ponds. Two new treatment plants were constructed on the sites of the old treatment plants in 1971. Each new plant has two polyethylene-lined raw sewage stabilization ponds. Wastewater treatment consists solely of stabilization by biological action (USATHAMA, 1979). Prior to the 1970s, trichloroethylene and paint solids were occasionally discharged to the sanitary sewage system (USATHAMA, 1979). Sewage sludge is placed in windrows adjacent to oxidation ponds at the sewage treatment facility (USAEHA, 1973).

Waste oils and solvents are generated by several activities on the installation. Approximately 1,500 gallons/year of waste oil are generated at SIAD from equipment and vehicle maintenance. Small quantities of waste solvents (less than 50 gallons/year) are generated at SIAD (USAEHA, 1982). These wastes are currently managed as hazardous wastes by SIAD (USAEHA, 1982).

In the past, industrial liquid wastes, consisting of oil wastes and mixed solvents, have been disposed of in demilitarization operations and fire-fighting training at SIAD (USATHAMA, 1979). A solid waste disposal survey found that 415 gallons/month of oils and solvents were generated at SIAD (USAEHA, 1973). Vehicle waste oils were previously disposed of by spreading over roads and other areas for dust control, use as fuel to burn out projectiles in the ammunition maintenance area, ignition with dunnage during demilitarization operations,

and burning for fire-fighting training (USATHAMA, 1979). During the 1940s and 1950s, industrial wastes were also disposed of in the DRMO Trench Area.

2.2.4 Abandoned Landfill

The Abandoned Landfill was used as the main disposal area for SIAD domestic wastes (excluding those disposed of at the burning and demolition areas) from the early 1940s to 1965. The main method of disposal was waste burning followed by spreading and burying the resulting ash and residue. Because the site was used as the main SIAD disposal area for approximately 20 years, it was suspected that wastes like paint sludges, thinners, solvents, and cleaning fluids were disposed of at this site (ESE, 1983). A separate trench in the landfill area was reported to be used for the disposal of waste oil (Benioff, et al., 1988). However, the trench was not located during the Phase I RI field program.

The Abandoned Landfill is not an engineered landfill; therefore, it has no liner or leachate collection system. The landfill has been reported to be a trench type landfill; however, the area or areas that have been used for landfilling are poorly defined. The general dimensions of the Abandoned Landfill have been reported as approximately 1,600 by 1,500 feet (USAEHA, 1988b). The site boundary shown on Figure 1-3 is a broad area boundary and does not necessarily represent the exact boundaries of the areas used for landfilling. The depth and volume of fill, type of cover material, and thickness of cover material are also poorly defined.

2.2.5 Chemical Burial Site

The Chemical Burial Site is a 100- by 600-foot area within the Construction Debris Landfill (see Figure 1-3). The site was used from January 1971 to October 1972 for trench burial of retrograde drummed chemicals (Benioff, et al., 1988). In 1974, the drums were excavated and removed and the trench was backfilled (USATHAMA, 1979). Removal operations, conducted between March 4, 1974 and May 15, 1974, consisted of removing overburden using a dozer and scraper, excavating a trench to a depth of 12 feet, and removing the chemicals by hand (USAEHA, 1988b). The chemicals were repackaged, overpacked into

steel drums or containers, and transferred to the "K block" area. During excavation, all drums were observed to be intact (ESE, 1983). Based upon this observation, the chemicals were believed to be completely contained within the drums and the area was believed to be uncontaminated (ESE, 1983).

Buried chemicals included pesticides (1,000 L 0.5 percent diazinon and 4,500 kg chlordane dust), toluene (365 L), xylene (235 L), paint (3,800 L), 1,1,1-trichloroethane (28 kg), and mercuric oxide (3 kg) (Benioff, et al., 1988).

2.2.6 Construction Debris Landfill

The Construction Debris Landfill is a broad area that has been used for dumping of concrete, asphalt and construction rubble. The site was in operation from the early 1940s until closure in 1988 (USAEHA, 1988b). Some construction debris may have also been dumped within the Abandoned Landfill Area (Benioff, et al., 1988). The Chemical Burial Site is located within the central portion of the Construction Debris Landfill (see Figure 1-3).

The site has reportedly been used only for the disposal of inert construction materials (ESE, 1983; USAEHA, 1988b). The site was open to construction contractors working at SIAD for disposal of construction debris. Due to the uncontrolled nature of the site, there was the potential for disposal of hazardous materials. The site was used occasionally by base residents for disposal of household waste and appliances. The landfill operation generally consisted of shallow trenching, refuse placement, and backfilling with removed soils (Ryan, 1990).

2.2.7 DRMO Trench Area

The Defense Reutilization and Marketing Office (DRMO) Trench Area was used for the disposal of wood pallets, cardboard tubing, waste oil, sludge, and solvents (Benioff, et al., 1988). The site, previously referred to as the Defense Property Disposal Office (DPDO) Trenches was used extensively from 1942 to 1973 and in a limited capacity from 1973 to 1987 (ESE, 1983; USAEHA, 1988b). Between 1942 and 1973, approximately 90 liters per

day of waste oils, oil sludges, solvents, and cleaning fluids from vehicle maintenance activities in Buildings 208, 209, and 210 were disposed of and burned in the DRMO Trench Area (USATHAMA, 1979; ESE, 1983; USAEHA, 1988b). It was originally reported that cleaning solvents, gasoline and paint thinners from vehicle maintenance were disposed of in unlined ditches between Buildings 208, 209, and 210 (USATHAMA, 1979). However, interviews with long-term personnel familiar with the area indicated that the space between Buildings 208, 209, and 210 has been paved since construction in 1942 and that no ditches exist. The waste liquids from Buildings 208, 209, and 210 are believed to have been disposed of in the DRMO Trench Area (ESE, 1983).

The DRMO Trench Area consists of one open trench approximately 290 feet long by 40 feet wide by 10 feet deep (Figure 1-4). A second backfilled trench was reported to exist west of the open trench within an area devoid of vegetation (USATHAMA, 1979; ESE, 1983; USAEHA, 1987b; Benioff, et al., 1988). However, as discussed in Section 6.2.4.2, no evidence of a buried trench was observed during the Phase I RI field program.

2.2.8 TNT Leaching Beds Area

The TNT Leaching Beds Area has been divided into two subsites: the TNT Leaching Beds Subsite and the Vehicle Maintenance Area Subsite (Figure 1-5).

2.2.8.1 TNT Leaching Beds Subsite

Two TNT leaching beds were used for disposal of wastewater from a shell washout facility (Figure 1-6). The two leaching beds are unlined depressions approximately 50 feet by 50 feet and 50 feet by 100 feet in size, respectively. The shell washout facility, used to demilitarize TNT projectiles, was constructed in the 1940s and torn down in 1949 (ESE, 1983; USAEHA, 1988b). Flushed-out explosives were washed to a flaker-dryer to reclaim TNT; the remaining water was sluiced through a concrete trench to the TNT leaching beds (ESE, 1983). Within the leaching beds, water was allowed to evaporate and infiltrate into the soils. At maximum operation, the washout plant could process 800 105-mm shells per day.

During operation of the washout facility and leaching beds, the leaching beds were cleaned infrequently by shoveling out material that was readily reclaimable and disposing of it at the lower burning/demolition grounds. During a reassessment survey of SIAD, staining was observed within the leaching beds and also in surface soils up to a distance of 18 meters northeast of the leaching beds. The staining outside the leaching beds was presumed to be caused by wind action (ESE, 1983).

2.2.8.2 Vehicle Maintenance Area Subsite

The Vehicle Maintenance Area Subsite is approximately 1,100 feet southwest of the TNT Leaching Beds Subsite (see Figure 1-5). Vehicle maintenance was performed in a building near the center of the subsite from the 1940s until the site was deactivated in the mid-1950s (Ryan, 1990) (see Figure 1-7). The vehicle maintenance building was demolished and only the concrete foundation of the building remains.

Based on observation of the site, some liquid wastes typically used in vehicle maintenance such as fuels, solvents, oil, and grease may have been discharged to the soils in the immediate area. A concrete trough that extends eastward from the building foundation (Figure 1-7) may have carried liquid wastes to a low-lying area about 200 feet east of the concrete pad. Volumes of chemicals used, as well as disposal practices at the Vehicle Maintenance Subsite, are unknown.

2.2.9 Honey Lake

Honey Lake was acquired by the Army in 1933 for use as a bombing range. The following site history of Honey Lake is taken from Benioff, et al. (1988). From 1933 to 1940, Honey Lake (Figure 1-1) was used for aerial training with small-arms ammunition and possibly bombs. During the 1940s, the site was used as a surveillance test site and for demolition of munitions. From February through May 1946, a weekly shipment of about 265 tons of ammunition, mainly 105-mm shells, was detonated at the site using TNT. White phosphorous was also burned at the site in pits that are no longer visible. It was reported

that burned mine fuses were buried in the area during the late 1940s (USATHAMA, 1979; ESE, 1983).

Demolition of munitions is reported to have continued at the site during the 1950s. Aerial photographs taken in 1954 by the U.S. Department of Agriculture show areas of heavy cratering in the lake bed. The last report of any munitions detonations at the site refers to 1977, when an explosive ordnance demolition team detonated some UXO in a cleanup operation (USATHAMA, 1979; ESE, 1983).

Due to the demolition and training activities, UXO may be present at the site. It is reported that in 1976 the area was thought to be moderately contaminated with UXO from activities carried out prior to 1951. The possible presence of UXO beneath the lake sediments has also been noted. The contaminated areas presumably include both underwater and dry areas of the exposed lake bed and shore. The extent of each of these areas at any given time would depend on the lake level, which fluctuates with the seasons and years. During a ground tour of the area in July 1979, exploded ordnance debris was noted for a distance of 7.8 to 9.0 miles out into the lake bed (which was at a low level at the time). Metal debris was reported to be scattered out into the lake bed and to be concentrated in some areas (USATHAMA, 1979; ESE 1983).

In July 1951, the State of California asked that Honey Lake be returned to the state for annexation to a wildlife refuge. However, due to the possible presence of UXO, the state deferred acceptance of the entire area in 1978 (USATHAMA, 1979).

The existing Lahontan basin plan includes the following as present and intended beneficial uses of Honey Lake: nonwater contact recreation (fishing, beachcombing, etc.), warm- and cold-water habitats, wildlife habitat, and saline water habitat. Contact water recreation may be included in an update of the basin plan that is currently being prepared. Currently, the present or intended beneficial uses of Honey Lake are not restricted as a result of the possible presence of UXO in the eastern part of the lake (Benioff, et al., 1988).

2.3 SUMMARY OF PREVIOUS FIELD INVESTIGATIONS

The Phase I RI sites for which previous investigations have been conducted are the DRMO Trench Area, the TNT Leaching Beds Area, and Honey Lake (Table 2-3). Sampling methodology, locations and associated analytical results from previous field investigations are discussed in the following sections for each of the Phase I RI sites. No previous investigations were undertaken at the Abandoned Landfill or the Construction Debris Landfill. Removal of chemicals at the Chemical Burial Site was conducted in 1974. Recent and historical aerial photography of Honey Lake, the Abandoned Landfill, Chemical Burial Site, and Construction Debris Landfill, was presented by the Environmental Photographic Interpretation Center (EPIC) (Howard, 1989).

2.3.1 DRMO Trench Area

The DRMO Trench Area was investigated in 1984 by the U.S. Army Environmental Hygiene Agency (USAEHA, 1984). Five soil borings and two monitoring wells were placed and sampled to investigate potential soil and groundwater contamination due to disposal of liquid industrial wastes (USAEHA, 1984). Four of the soil borings were drilled at 50-foot intervals in the bottom of the open DRMO trench (Figure 2-6). The fifth soil boring (Boring 5) was drilled about 50 feet east of the DRMO Trench Area to obtain background data. Depths of the soil borings ranged from 20 to 40 feet (Table 2-4). As shown in Tables 2-4 and 2-5, soil samples from the borings were analyzed for volatile organic compounds (VOCs) and metals. Boring 2 was also analyzed for base-neutral and acid extractable organics (BNAs) (Table 2-6). Two monitoring wells were installed west and southwest of the DRMO Trench Area; however, these wells are considered unusable due to a lack of information on well construction methods (Benioff, et al., 1988; Whitten, 1989).

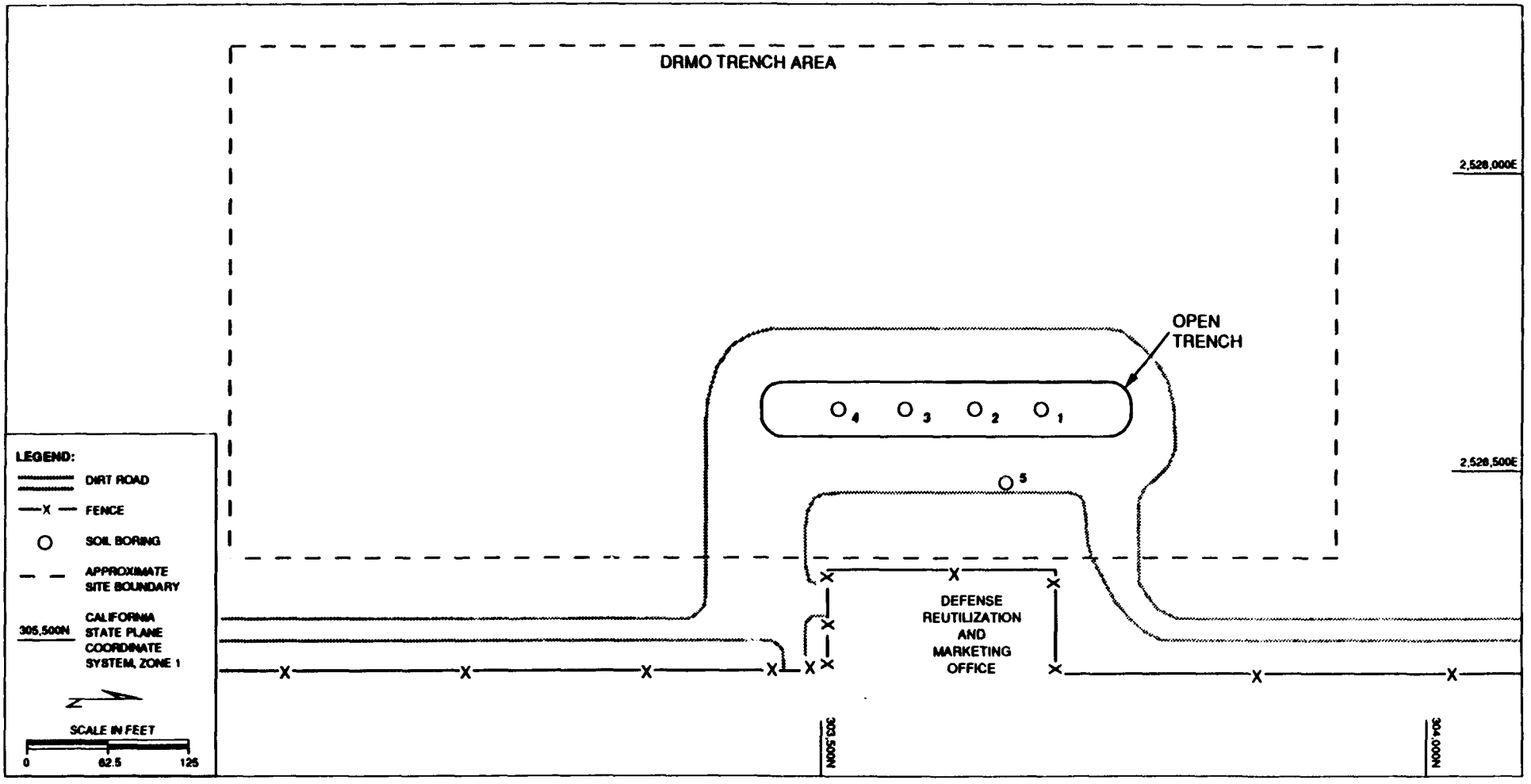
VOCs were detected in each of the four soil borings placed within the DRMO trench to depths of at least 15 feet below the bottom of the trench. Table 2-4 lists only those chemical parameters for which at least one soil sample contained detectable concentrations (USAEHA, 1984). The highest VOC concentrations were generally detected within the upper 10 feet.

TABLE 2-3

SUMMARY OF PREVIOUS FIELD INVESTIGATIONS
SIERRA ARMY DEPOT[a]

Site	Soil Borings	Monitoring Wells	Surface Soil Samples	Surface Water Samples	Findings
DRMO Trench Area	5	2[b]	NA	NA	VOCs, BNAs, and trace metals[c].
TNT Leaching Beds	6[d]	14	9	NA	Explosives, metals[e], VOCs and BNAs.
Honey Lake	NA	NA	NA	3 sets	Chemical parameters of Honey Lake defined[f].

[a] No previous data exist for the Abandoned Landfill, Chemical Burial Site, or the Construction Debris Site.
[b] Considered unusable because no information could be located concerning their construction method (Benioff, et al, 1988; Whitten, 1989).
[c] USAEHA (1984); USAEHA (1985).
[d] USAEHA (1984); USAEHA (1985).
[e] USAEHA (1988).
[f] Benioff, et al (1988).
NA Not Applicable



SIERRA ARMY DEPOT
SOIL BORING LOCATIONS FROM PREVIOUS FIELD INVESTIGATIONS:
DRMO TRENCH AREA

FIGURE 2-6

TABLE 2-4

CONCENTRATIONS OF VOCS IN SOILS IN THE DRMO TRENCH AREA
(mg/kg)[a]

Sample and Depth (ft)[b]	Aliphatics	Benzene	Bromodichloromethane	Chlorobenzene	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	1,2-Dichloroethane
1A, 0-2	5-15	<1	<1	<1	180	80	60	<1
1B, 3-5	ND	<1	<1	4	350	100	150	<1
1C, 8-10	ND	<1	<1	<1	30	3	<1	<1
1D, 13-15	ND	<1	<1	<1	8	<1	3	<1
1E, 18-20	ND	<1	<1	<1	9	3	3	<1
2A, 0-2	25-50	<1	2	<1	780	12	130	17
2B, 3-5	300-500	<1	<1	<1	2,500	130	290	<1
2C, 8-10	250-500	<1	<1	3	200	15	50	<1
2D, 13-15	NA	NA	NA	NA	1,400	130	280	<1
2E, 18-20	ND	<1	<1	<1	3	<1	<1	<1
2F, 28-30	ND	<1	<1	<1	<1	<1	<1	<1
2G, 38-40	ND	<1	<1	<1	<1	<1	<1	<1
3A, 0-2	25-50	<1	<1	<1	960	50	175	<1
3B, 3-5	500-1,500	<1	10	190	2,000	140	600	<1
3C, 8-10	200-300	2	10	50	280	50	180	<1
3D, 13-15	ND	<1	<1	<1	22	4	8	<1
3E, 18-20	ND	<1	<1	<1	<1	<1	<1	<1
4A, 0-2	30-50	<1	<1	<1	440	100	250	<1
4B, 3-5	200-400	<1	<1	25	840	150	270	<1
4C, 8-10	50-75	<1	<1	13	740	70	120	<1
4D, 13-15	2-10	<1	<1	<1	50	5	50	<1
4E, 18-20	ND	<1	<1	<1	27	4	24	<1
5A, 10-12	ND	<1	<1	<1	<1	<1	<1	<1
5B, 13-15	ND	<1	<1	<1	<1	<1	<1	<1
5C, 18-20	ND	<1	<1	<1	<1	<1	<1	<1
5D, 23-25	ND	<1	<1	<1	<1	<1	<1	<1
5E, 28-30	ND	<1	<1	<1	<1	<1	<1	<1

TABLE 2-4 (Continued)

CONCENTRATIONS OF VOCS IN SOILS IN THE DRMO TRENCH AREA
(mg/kg)[a]

Sample and Depth (ft)[b]	Ethyl-benzene	Ethyl Methyl Cyclo-hexane	Propyl Cyclo-hexane	Tetra-Chloro-ethylene	Tetramethyl and Ethyl Dimethyl Benzenes	Toluene	Trichloro-ethylene	Trimethyl and Ethyl Methyl Benzene
1A, 0-2	<1	2-10	5-15	<1	20-40	<10	<1	20-40
1B, 3-5	<1	ND	ND	<1	ND	80	3	ND
1C, 8-10	<1	ND	ND	<1	ND	<10	<1	ND
1D, 13-15	<1	ND	ND	<1	ND	<10	<1	ND
1E, 18-20	<1	ND	ND	<1	ND	<10	<1	ND
2A, 0-2	8	20-50	50-100	<1	200-400	<10	130	100-200
2B, 3-5	<1	300-400	100-200	<1	200-400	<10	125	200-400
2C, 8-10	2	5-10	20-40	<1	20-40	<10	90	100-200
2D, 13-15	NA	NA	NA	NA	NA	NA	NA	NA
2E, 18-20	<1	ND	ND	<1	ND	<10	<1	ND
2F, 28-30	<1	ND	ND	<1	ND	<10	<1	ND
2G, 38-40	<1	ND	ND	<1	ND	<10	<1	ND
3A, 0-2	<1	40-80	10-30	<1	100-300	<10	1	100-150
3B, 3-5	30	40-80	100-300	3	100-300	<10	710	1,000-3,000
3C, 8-10	10	40-80	50-150	3	300-500	<10	620	1,000-1,500
3D, 13-15	<1	ND	ND	<1	ND	<10	<1	ND
3E, 18-20	<1	ND	ND	<1	ND	<10	<1	ND
4A, 0-2	12	10-20	10-20	<1	50-100	<10	45	50-100
4B, 3-5	47	100-300	100-300	<1	50-150	<10	92	50-150
4C, 8-10	40	150-200	25-50	<1	300-500	<10	23	300-500
4D, 13-15	1	5-15	1-5	<1	10-25	<10	<1	10-25
4E, 18-20	<1	ND	ND	<1	ND	<10	<1	ND
5A, 10-12	<1	ND	ND	<1	ND	<10	<1	ND
5B, 13-15	<1	ND	ND	<1	ND	<10	<1	ND
5C, 18-20	<1	ND	ND	<1	ND	<10	<1	ND
5D, 23-25	<1	ND	ND	<1	ND	<10	<1	ND
5E, 28-30	<1	ND	ND	<1	ND	<10	<1	ND

[a] Values are given to two significant figures. The table lists only those VOCs (App. B) for which at least one detectable value was measured. NA indicates not analyzed and ND indicates not detected.

[b] See Figure 2-2 for borehole locations.

Source: USAEHA (1984).

A[redacted]l sa[redacted] wer[redacted]ecte[redacted]984.[redacted]

TABLE 2-5

SUMMARY OF PH AND TOTAL CONCENTRATIONS OF METALS
IN SOILS IN THE DRMO TRENCH AREA (mg/kg)[a]

Borehole and Sample[b] Designation	Sample Depth (ft)	Arsenic	Barium	Cadmium	Chromium	Copper	Lead	Mercury	Silver	pH
1A	0-2	<4.0	290	<4.0	9.9	34	56	<0.08	<9.9	7.9
1B	3-5	<3.4	<100	<3.4	<8.5	22	<34	<0.07	<8.5	9.0
1C	8-10	<3.1	<92	<3.1	<7.7	7.7	<31	<0.06	<7.7	8.7
1D	13-15	<3.4	<100	<3.4	<8.5	<8.5	<34	<0.07	<8.5	7.2
1E	18-20	<3.8	<110	<3.8	<9.5	<9.5	<38	<0.08	<9.5	7.8
2A	0-2	<3.4	100	<3.4	<8.4	41	91	<0.07	<8.4	8.3
2B	3-5	<3.5	110	<3.5	13	18	<35	<0.07	<8.7	8.4
2C	8-10	<3.8	<110	<4.0	<9.5	<9.5	<38	<0.08	<9.5	8.1
2D	13-15	<4.0	<120	<4.0	10	<10	<40	<0.07	<10	8.9
2E	18-20	<3.4	<100	<3.4	12	<8.5	<34	<0.08	<8.5	8.3
2F	28-30	<3.9	180	<3.9	10	<10	<39	<0.08	<9.7	7.6
2G	38-40	<4.1	<120	<4.0	<10	<10	<41	<0.08	<10	6.6
3A	0-2	<4.0	130	<5.4	18	11	63	<0.08	<10	8.1
3B	3-5	<3.0	<120	<4.1	19	11	<41	<0.08	<10	8.1
3C	8-10	<3.0	94	<3.1	<7.8	<7.8	<31	<0.06	<7.8	8.4
3D	13-15	<3.0	140	<3.4	9.9	15	<34	<0.07	<8.6	8.3
3E	18-20	<3.0	<89	<3.0	<7.5	<7.5	<30	<0.06	<7.5	7.9
4A	0-2	<3.7	130	7.4	56	16	<37	<0.07	<9.2	8.4
4B	3-5	<3.0	100	5.0	29	15	47	<0.06	<7.8	6.8
4C	8-10	<4.0	<120	<4.1	13	12	54	<0.08	<10	8.9
4D	13-15	<4.0	<110	<3.6	9.4	9.4	<36	<0.07	<9.0	7.8
4E	18-20	<4.0	<110	<3.7	<9.4	<9.4	<37	<0.07	<9.4	8.2
5A	10-12	<3.0	96	5.6	<7.7	64	834	<0.06	<7.7	8.7
5B	13-15	<4.0	120	<3.5	<88	23	120	<0.07	<8.8	8.5
5C	18-20	<4.0	<120	<4.1	<10	<10	<41	<0.08	<10	8.4
5D	23-25	<3.0	<100	<3.4	<8.5	<8.5	<34	<0.07	<8.5	8.4
5E	28-30	<4.0	<120	<3.9	<9.7	<9.7	<39	<0.08	<9.7	8.5

[a] Values are given to two significant figures. Samples were also analyzed for selenium; none was detected at a detection limit of 2 ppm.

[b] See Figure 2-2 for borehole locations.

Source: USAEHA (1985).

All soil samples were collected in 1984.

TABLE 2-6

SUMMARY OF CONCENTRATIONS OF BNAs AT VARIOUS DEPTHS IN BORING 2 IN THE DRMO TRENCH AREA (mg/kg)[a]

Sample[b]	Sample Depth (ft)	p,p-DDT	o,p-DDT	Dimethyl Naphthalenes	Methyl Naphthalene	Naptha-lene
2A	0-2	12	<1	30-60	30-60	15
2B	3-5	5-10	5-30	100-300	100-200	30
2C	8-10	<1	<1	30-60	30-60	10
2D	13-15	16	5-30	70-150	70-150	40
2E	18-20	<1	<1	ND	ND	<10
2F	28-30	<1	<1	ND	1-3	< 1
2G	38-40	<1	<1	ND	ND	< 1

Sample[b]	Sample Depth (ft)	1,2,4-Trichloro-benzene	Trimethyl and Methyl Ethyl Benzenes	Hexane Dioic Acid, Dioctyl Ester	C_{10} to C_{16} Hydrocarbons
2A	0-2	16	200-500	30-50	150-300
2B	3-5	30	1,000-3,000	50-150	1,000-3,000
2C	8-10	10	150-400	ND	300-600
2D	13-15	40	500-1,000	50-150	2,000-4,000
2E	18-20	<10	ND	ND	50-200
2F	28-30	< 1	ND	ND	1-3
2G	38-40	< 1	ND	ND	1-3

[a] Values are given to two significant figures. All BNAs are listed for which one or more detectable values were measured.

[b] See Figure 2-6 for the borehole location.

ND = Not detected.

All soil samples were collected in 1984.
Source: USAEHA (1985).

Peak concentrations of 2,500 mg/kg and 2,000 mg/kg of 1,2-dichlorobenzene were detected in the 3- to 5-foot sample in Borings 2 and 3, respectively. In Boring 3, peak concentrations of 710 mg/kg of trichloroethylene and 1,000 to 3,000 mg/kg of trimethyl and ethyl methyl benzenes were detected at a depth of 3 to 5 feet. Contrary to VOC sample handling protocol, the samples were apparently not refrigerated until they were received at the USAEHAlaboratories in Maryland (USAEHA, 1984). Therefore, VOC concentrations are believed to be minimum values (Benioff, et al., 1988).

Chromium and copper were detected (within the upper 6 feet of the soil borings in the open DRMO Trench Area) at concentrations exceeding background levels (Table 2-5). Arsenic, barium, cadmium, silver, mercury, and selenium concentrations were similar in each sample collected and were close to the detection limit, indicating that these metals are at natural background concentrations and are not contaminants (Benioff, et al., 1988). Elevated concentrations of lead and copper were detected in Boring 5, located outside the DRMO Trench Area. The source of the lead and copper is unknown (Benioff, et al., 1988). USEPA Extraction Procedure (EP) toxicity testing of soil samples did not detect metals (Benioff, et al., 1988). The detection limits were set at 10 percent of the limits presented in Title 40 of Code Federal Regulations, Part 261-Identification and Listing of Hazardous Waste (40 CFR 261). Therefore, soils in the DRMO trench were not considered EP toxic according to USEPA test methods (Benioff, et al., 1988).

BNA analyses of Boring 2 samples indicated that isomers of the insecticide dichlorodiphenyltrichloroethane (DDT) (up to 30 mg/kg), naphthalenes (up to 300 mg/kg), and several other BNA compounds were present to depths of 13 to 15 feet (Table 2-6). The only BNAs found at depths of 18 feet or more were the C_{10} to C_{16} aliphatics and small amounts of methyl naphthalene (Benioff, et al., 1988). The deepest sample in Boring 2 was collected at a depth of 38 to 40 feet below the trench bottom and contained 1 to 3 mg/kg C_{10} to C_{16} aliphatic hydrocarbons.

2.3.2 TNT Leaching Beds Area

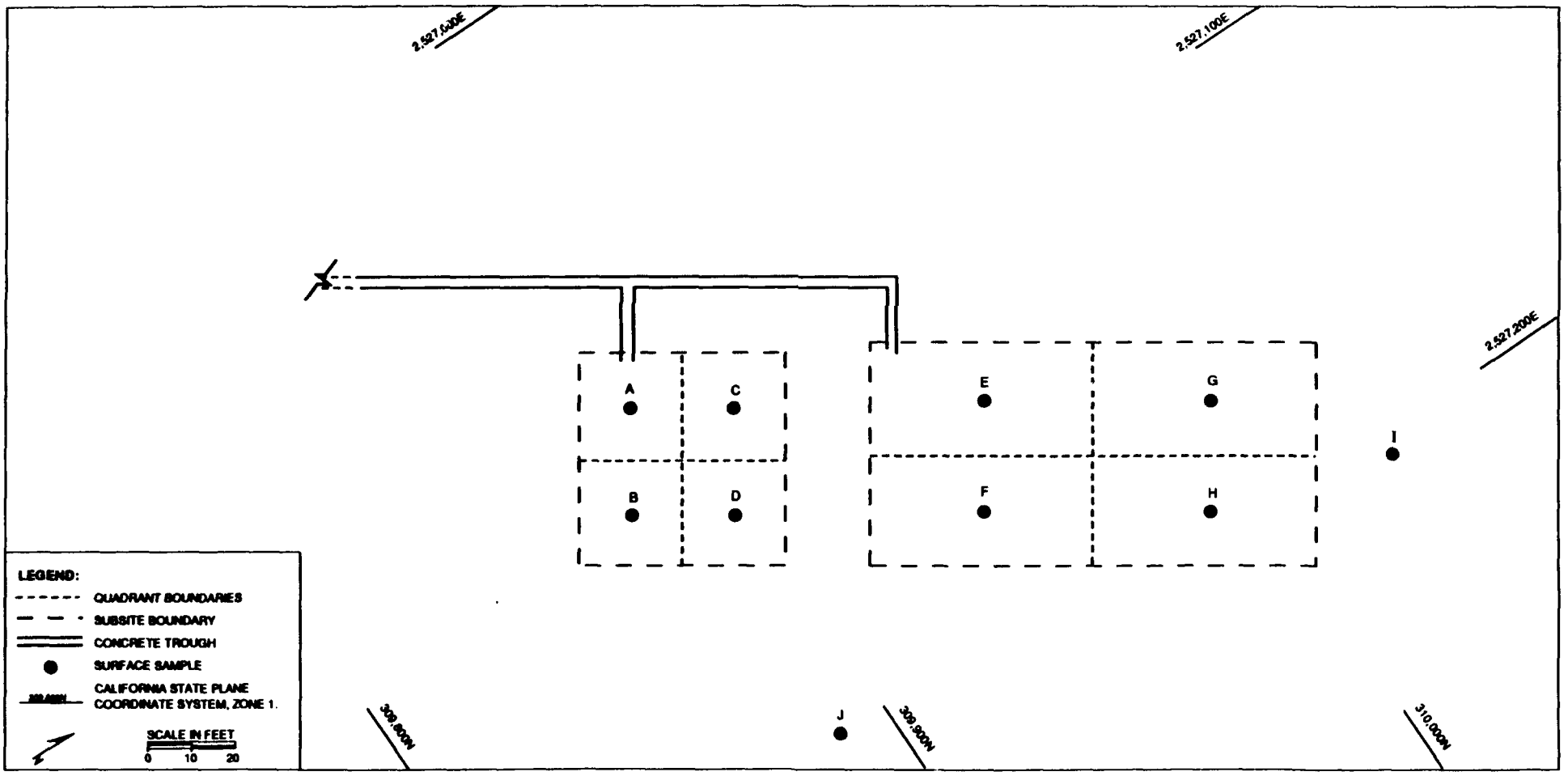
A hazardous waste study was conducted by USAEHA at the TNT Leaching Beds Area to investigate the potential for hazardous waste contamination (USAEHA, 1984). The study identified the inactive TNT leaching beds as a site with significant levels of contamination in the unsaturated zone. As a result, two monitoring wells were installed in August of 1985 (USAEHA, 1985), eight wells were installed in November 1986 (USAEHA, 1987b), and four wells were installed in April 1988 (USAEHA, 1988a).

Water table elevations measured in the 14 wells ranged from 52.0 to 60.7 feet below ground surface in June 1988. VOCs were detected in monitoring wells TNT-01-MWA, TNT-02-MWA, TNT-10-MWA, and TNT-11-MWA. The water table was shown to be relatively flat in this area and the source of any VOCs in these wells was expected to be in close proximity to these wells (USAEHA, 1988a).

2.3.2.1 Surface Soil Samples

Soil contamination in the TNT Leaching Beds Subsite was evaluated in 1984 by taking composite surface samples and by sampling the soils at various depths in six soil borings (Figure 2-7). In April 1984, four composite surface samples (upper 6 inches) were taken from each bed, one was taken for background about 60 feet east of the beds, and one was taken in an area north of the two beds (USAEHA, 1984). In October 1984, the eight quadrants in the leaching beds were resampled. One composite surface soil sample was collected from each quadrant for a total of eight samples (USAEHA, 1985).

Both the April and October 1984 surface samples were analyzed for the EP toxicity test metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) and copper. The only metals detected were chromium, lead, and barium. In all the October 1984 samples, low concentrations (ranging from 0.09 to 0.23 mg/kg) of total chromium were detected. Lead concentrations in the October 1984 surface samples ranged from 0.56 to 1.5 mg/kg. Barium was detected in only one sample in April 1984 at 150 mg/kg (Benioff, et al., 1988).



SIERRA ARMY DEPOT

SURFACE SOIL SAMPLE LOCATIONS FROM PREVIOUS FIELD INVESTIGATIONS: TNT LEACHING BEDS SUBSITE

FIGURE 2-7

Table 2-7 summarizes the results from the April and October 1984 analyses for explosives in the surface soil composite samples. High concentrations of 2,4,6-trinitrotoluene (2,4,6-TNT), up to 16,000 mg/kg (1.6 percent), were present in the surface soil of the leaching beds. Within each bed, the distribution of 2,4,6-TNT over the surface was uneven, especially in the southernmost bed, where concentrations between the different quadrants (samples A through D) varied by factors up to 1,000 or more. The surface samples also contained elevated concentrations of hexahydro-1,3,5-trinitro-1,3,4-triazine (RDX), up to 480 mg/kg, and 1,3,5-trinitrobenzene (1,3,5-TNB), up to 12 mg/kg. None of the samples contained detectable concentrations of cyclotetramethylene tetranitramine (HMX), 2,6-dinitrotoluene (2,6-DNT), tetryl, or 1,3-dinitrobenzene (1,3-DNB) (Benioff, et al., 1988).

2.3.2.2 Subsurface Soil Samples

Six soil borings were also drilled in the TNT Leaching Beds Area during the 1984 site investigation (Figure 2-8). One soil boring was drilled in the northern bed to a depth of 50 feet. Another boring was drilled in the center of the southern bed and four additional borings were drilled outside the beds (Figure 2-8) (USAEHA, 1985). Soil samples were analyzed for both metals and explosives.

Soil samples collected from the six soil borings were analyzed for total copper, barium, cadmium, chromium, lead, selenium, mercury, silver, as well as the USEPA EP toxicity metals (USAEHA,1985). The samples contained low concentrations of total chromium (0.14 to 4.73 mg/kg) and lead (0.25 to 1.02 mg/kg) Selenium concentrations ranging from 0.25 to 1.91 mg/kg were detected at various depths in samples from Borings 1 through 6 (Benioff, et al., 1988).

Soil samples from the six soil borings were analyzed for explosives (Table 2-8). The analytical data suggest that a downward migration of explosive residue has occurred in the TNT Leaching Bed Area. This is especially evident for 1,3,5-TNB, which was detected 50 feet beneath the northern bed at a concentration of 11 mg/kg. 2,4,6-TNT, RDX, and HMX were also present at a depth of 40 feet under the northern bed. In borings outside the beds, 1,3,5-TNB was detected at concentrations of up to 28 mg/kg to depths of at least 27 feet.

TABLE 2-7

CONCENTRATIONS OF EXPLOSIVES IN SURFACE SOIL SAMPLES
TNT LEACHING BEDS AREA
APRIL AND OCTOBER, 1984
(mg/kg)[a]

Sample[b]	Month Collected	1,3-DNB	2,4-DNT	2,6-DNT	HMX	RDX	Tetryl	1,3,5-TNB	2,4,6-TNT
A	APRIL	NA	12	<1.0	<1.0	<1.0	<5.0	NA	16,000
	OCTOBER	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0	15	76
B	APRIL	NA	<1.0	<1.0	<1.0	<1.0	<5.0	NA	20
	OCTOBER	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0	7.4	<1.0
C	APRIL	NA	<1.0	<1.0	<1.0	<1.0	<5.0	NA	110
	OCTOBER	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0	20	710
D	APRIL	NA	<1.0	<1.0	<1.0	<1.0	<5.0	NA	12
	OCTOBER	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0	19	460
E	APRIL	NA	4.4	<1.0	<1.0	22	<5.0	NA	9,100
	OCTOBER	<1.0	<1.0	<1.0	<1.0	200	<5.0	240	2,400
F	APRIL	NA	3.2	<1.0	<1.0	74	<5.0	NA	4,500
	OCTOBER	<1.0	<1.0	<1.0	<1.0	310	<5.0	140	12,000
G	APRIL	NA	5.1	<1.0	<1.0	190	<5.0	NA	6,700
	OCTOBER	<1.0	<1.0	<1.0	<1.0	390	<5.0	100	5,400
H	APRIL	NA	10	<1.0	<1.0	190	<5.0	NA	16,000
	OCTOBER	<1.0	<1.0	<1.0	<1.0	480	<5.0	87	5,700
I	APRIL	NA	4.4	<1.0	<1.0	160	<5.0	NA	1,300
	OCTOBER	NA	NA	NA	NA	NA	NA	NA	NA
J	APRIL	NA	<1.0	<1.0	<1.0	<1.0	<5.0	NA	76
	OCTOBER	NA	NA	NA	NA	NA	NA	NA	NA

[a]Values are given to two significant figures. NA means not analyzed.
[b]See Figure 2-7 for sample locations. Samples are composites over the first 15 cm (6 in.) of soil depth.
Sources: USAEHA, 1984; USAEHA, 1985.

TABLE 2-8

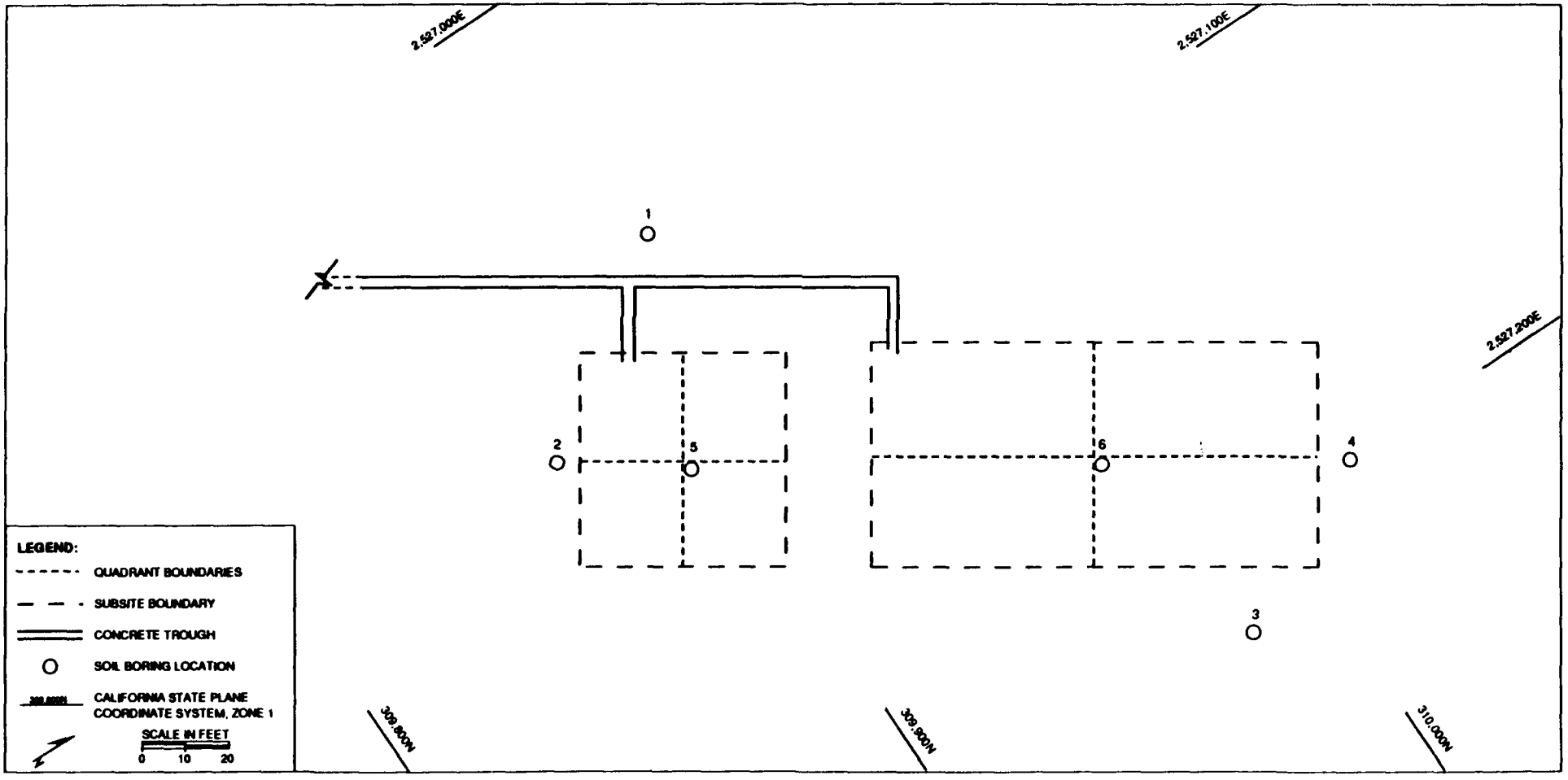
CONCENTRATIONS OF EXPLOSIVES
SUBSURFACE SOIL SAMPLES
TNT LEACHING BEDS AREA
(mg/kg)[a]

Borehole[b]	Sample Depth (ft)	HMX	RDX	1,3,5-TNB	2,4,6-TNT
1	0-2	ND	ND	ND	ND
	5-7	ND	ND	ND	ND
	10-12	ND	ND	ND	ND
	16-18	ND	ND	28	ND
	20-22	ND	ND	4.2	ND
2	0-2	ND	ND	ND	ND
	4-6	ND	ND	ND	ND
	9-11	ND	ND	ND	ND
	14-16	ND	ND	6.8	ND
	19-21	ND	ND	5.8	ND
3	5-7	ND	ND	ND	ND
	10-12	ND	ND	ND	ND
	15-17	ND	ND	1.9	ND
	25-27	ND	ND	3.4	ND
4	0-2	ND	ND	ND	ND
	10-12	ND	ND	ND	ND
	15-17	ND	ND	ND	ND
	20-22	ND	ND	ND	ND
5	4-6	ND	ND	11	44
	9-11	ND	ND	27	14
	19-21	ND	ND	16	4.4
6	0-2	<1.0	110	16	194
	4-6	3.9	8.6	11	2.4
	9-11	8.6	25	36	<1.0
	14-16	5.0	4.2	26	8.2
	20-22	5.9	2.8	9.4	7.4
	29-31	2.4	4.5	4.7	5.9
	39-41	3.9	7.3	8.0	7.9
	49-51	<1.0	<1.0	11	<1.0

[a] Concentrations given to two significant figures. ND means parameter analyzed but not detected. Detection limits were 1 mg/kg for all parameters except tetryl (5 mg/kg), which was not detected. Other explosives not detected were 2,4-DNT, 2,6-DNT, and 1,3-DNB.

[b] See Figure 2-8 for borehole locations.
Sources: USAEHA 1984, 1985.

All soil samples were collected in 1984.



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SOIL BORING LOCATIONS FROM PREVIOUS FIELD INVESTIGATIONS: TNT LEACHING BEDS SUBSITE

FIGURE 2-8

As shown on Table 2-8, 1,3,5-TNB was detected in the two deepest samples in Borings 1, 2, and 3.

2.3.2.3 Groundwater Samples

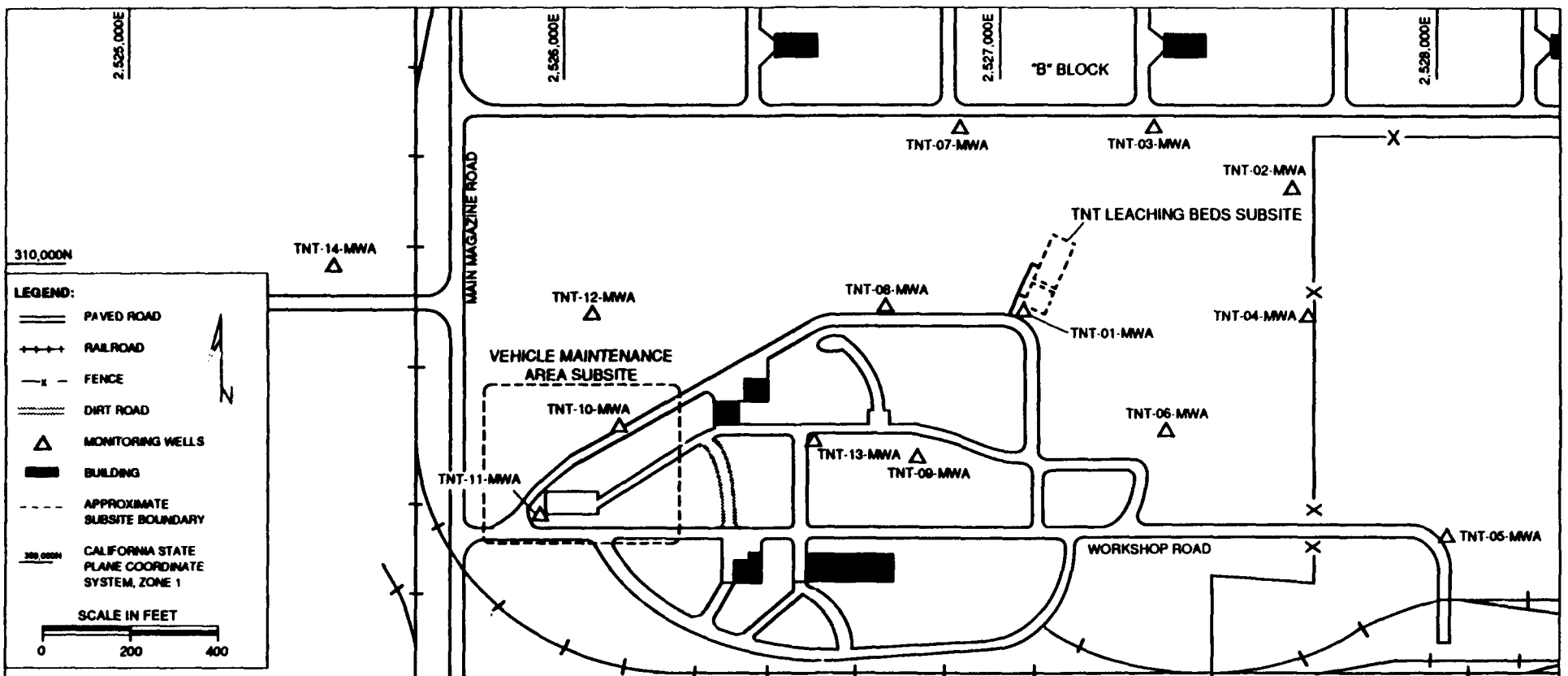
Groundwater samples were collected from monitoring wells TNT-01-MWA through TNT-10-MWA (Figure 2-9) in the area of the TNT Leaching Beds in November 1986 (USAEHA, 1987b). Water samples were analyzed for metals, explosives, VOCs and BNAs (Tables 2-9 through 2-11). Concentrations of several metals species were higher in well TNT-10-MWA than in the other wells. Specifically, TNT-10-MWA had elevated concentrations of boron (1.29 mg/L), barium (0.062 mg/L), beryllium (0.008 mg/L), total chromium (0.303 mg/L), and iron (0.134 mg/L) (Table 2-9) (Benioff, et al., 1988).

Table 2-10 summarizes the groundwater explosives data collected from monitoring wells TNT-01-MWA through TNT-10-MWA in November 1986. TNT-01-MWA and TNT-02-MWA contained relatively high values of 1,3,5-TNB (up to 1,200 μg/L), 2,4-DNT (up to 520 μg/L) and RDX (up to 250 μg/L) (USAEHA 1986, 1987).

Groundwater samples collected from these wells were also analyzed for VOCs and BNAs. Samples were collected on November 23 and 24, 1986, and were not filtered or preserved before shipment (USAEHA, 1987b). Table 2-11 summarizes the VOC and BNA results for those compounds detected in one or more samples.

Trichloroethylene (TCE) was detected in wells TNT-01-MWA, TNT-08-MWA, TNT-09-MWA, and TNT-10-MWA at concentrations ranging from 15 to 330 μg/L (Table 2-11). Well TNT-10-MWA had the highest concentration of TCE (330 μg/L) and also contained carbon tetrachloride, chloroform, 1,2-dichloroethane, methylene chloride, and bis(2-ethylhexyl)phthalate.

In April 1988, four additional wells, TNT-11-MWA, TNT-12-MWA, TNT-13-MWA, and TNT-14-MWA (Figure 2-7), were constructed and sampled to help determine the source of the contamination in well TNT-10-MWA (USAEHA, 1988a). Wells TNT-01-MWA and



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MONITORING WELL LOCATIONS FROM PREVIOUS FIELD INVESTIGATIONS: TNT LEACHING BEDS AREA

FIGURE 2-9

TABLE 2-9

CONCENTRATIONS OF METALS AND MACROPARAMETERS IN GROUNDWATER IN THE TNT LEACHING BEDS AREA (mg/L)[a]

Parameter	Well									
	TNT-1[b]-MWA	TNT-2-MWA	TNT-3-MWA	TNT-4-MWA	TNT-5-MWA	TNT-6-MWA	TNT-7-MWA	TNT-8-MWA	TNT-9-MWA	TNT-10-MWA
Antimony	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	0.018	0.005	0.011	0.007	0.013	0.007	0.013	0.013	0.015	0.008
Barium	0.018	0.033	0.024	0.034	0.048	0.051	0.018	0.033	0.030	0.062
Beryllium	0.001	<0.001	<0.001	0.008	<0.001	<0.001	<0.001	<0.001	<0.001	0.008
Boron	0.78	0.96	0.81	0.91	0.80	1.11	1.21	1.02	0.94	1.29
Cadmium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Calcium	13.2	44.9	20.3	42.1	42.0	54.3	15.4	18.1	26.2	65.3
Chromium	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.303
Cobalt	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Copper	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Iron	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.076	0.02	<0.02	0.134
Lead	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Magnesium	3.75	12.6	6.9	13.0	13.9	17.1	4.47	4.21	6.97	13.4
Manganese	<0.010	0.012	<0.010	<0.010	0.011	0.062	0.014	<0.010	<0.010	0.010
Nickel	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.001
Potassium	8.21	12.0	7.29	13.8	19.7	14.2	7.06	9.58	11.9	12.9
Selenium	0.002	0.005	0.001	0.004	0.005	0.007	0.002	0.001	0.001	0.001
Silver	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Sodium	183	256	173	220	192	360	227	195	153	277
Thallium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Zinc	0.082	0.028	0.038	0.026	0.020	0.024	0.038	0.030	0.026	0.037

[a]See Figure 2-9 for well locations.

[b]Analysis of a duplicate sample gave concentrations that deviated from the values given here for TNT-1 MWA by less than 6% for all parameters except zinc, which had a duplicate value of 0.019 mg/L.

Source: USAEHA 1987b.

Samples collected in November, 1986.

TABLE 2-10

CONCENTRATIONS OF EXPLOSIVES IN GROUNDWATER
TNT LEACHING BEDS AREA
(μg/L)[a]

Well[b]	2,4-DNT		2,6-DNT	HMX	RDX	Tetryl	TNB	TNT
	A[c]	B[d]						
TNT-1 MWA	520	80	<1	<100	<30	<10	1,200	<1
Duplicate	52	70	<1	<100	<30	<10	1,100	<1
Aug. 1985[e]	98	NA	<1	<100	90	<10	930	<1
TNT-2 MWA								
Nov. 1986	32	30	<1	<100	250	<10	71	3.1
Aug. 1985[e]	3.0	NA	<1	<100	<30	<10	9	<1
TNT-3 MWA	<1	<10	<1	<100	<30	<10	<1	<1
TNT-4 MWA	9.3	<10	<1	<100	<30	<10	<1	<1
TNT-5 MWA	<1	<10	<1	<100	<30	<10	<1	<1
TNT-6 MWA	<1	<10	<1	<100	<30	<10	<1	<1
TNT-7 MWA	2.0	<10	<1	<100	<30	<10	3.4	<1
TNT-8 MWA	<1	<10	<1	<100	<30	<10	<1	<1
TNT-9 MWA	<1	<10	<1	<100	<30	<10	3.0	<1
TNT-10 MWA	<1	<10	<1	<100	<30	<10	<1	<1

[a] Concentrations are given to two significant figures. NA means not analyzed.

[b] See Figure 2-9 for well locations.

[c] Samples were filtered in the field using a 0.45-μm filter and preserved, using sulfuric acid, to a pH between 2 and 4 prior to shipment to the USAEHA laboratories for explosives analysis.

[d] Samples were not filtered or preserved before being shipped in iced coolers to the USAEHA laboratories for analysis for VOCs and BNAs.

[e] Early sampling dates; all other samples were collected in November 1986.

Sources: USAEHA 1987b, 1988b.

TABLE 2-11

CONCENTRATIONS OF DETECTED VOCs AND BNAs IN GROUNDWATER AT THE TNT LEACHING BEDS AREA (μg/L)[a]

	VOCs					BNAs	
Well[b]	Carbon Tetra-chloride	Chloroform	1,2-Dichloro-ethane	Methylene Chloride	Trichloro-ethylene	Bis-(2-ethyl-hexyl) Phthalate	Di-n-octyl Phthalate
TNT-1-MWA[c]	<3	<3	<3	<3	30	<10	<10
TNT-1-MWA Duplicate	<3	<3	<3	<3	29	<10	30
TNT-2-MWA[c]	<3	<3	<3	4	<3	<10	<10
TNT-3-MWA	<3	<3	<3	<3	<3	<10	<10
TNT-4-MWA	<3	<3	<3	<3	<3	<10	<10
TNT-5-MWA	<3	<3	<3	<3	<3	<10	20
TNT-6-MWA	<3	<3	<3	<3	<3	<10	<10
TNT-7-MWA	<3	<3	<3	<3	<3	<10	<10
TNT-8-MWA	<3	<3	<3	<3	15	<10	<10
TNT-9-MWA	<3	<3	<3	<3	16	40	<10
TNT-10-MWA	170	1,000	120	6	330	<10	<10
Background	<3	<3	<3	<3	<3	<10	<10

[a] Only those compounds are listed that were detected in one or more samples. Detection limits were 3 μg/L for the VOCs and 10 μg/L for almost all acid and base-neutral extractables.

[b] See Figure 2-9 for well locations.

[c] Analyses of VOCs in samples drawn in August 1985 showed 35 μg/L trichloroethylene and 4 μg/L toluene in TNT-1-MWA. None were detected in TNT-2-MWA (USAEHA, 1987b).

Samples collected in November, 1986.

Source: USAEHA (1987b).

TNT-07-MWA through TNT-14-MWA were also sampled due to their proximity to TNT-10-MWA (Table 2-12). The data indicated the likelihood of a VOC source other than the TNT leaching beds (Benioff, et al., 1988).

2.3.3 Honey Lake

Table 2-13 presents water quality data collected by the RWQCB collected between November 7, 1986 and April 27, 1987. The data show that the water is of moderate quality with total dissolved solids (TDS) concentrations below 1,500 mg/L (Benioff, et al., 1988). No data are available on contamination of sediments in the eastern part of Honey Lake located near SIAD.

TABLE 2-12

CONCENTRATIONS OF DETECTED VOCs
IN GROUNDWATER AT THE TNT LEACHING BEDS AREA
(μg/L)[a]

Well[b]	Purgeable Organics[b] Carbon Tetrachloride	Chloroform	1,2-Dichloroethane	Methylene Chloride	Trichloroethylene
TNT-1-MWA	<5	<5	<5	<5	32
TNT-7-MWA	<5	<5	<5	<5	9
TNT-8-MWA	<5	<5	<5	<5	16
TNT-9-MWA	<5	<5	<5	<5	13
TNT-10-MWA	206	82	<5	<5	565
TNT-11-MWA	28	19	<5	<5	156
TNT-12-MWA	<5	<5	<5	<5	<5
TNT-13-MWA	<5	<5	<5	<5	7
TNT-14-MWA	<5	<5	<5	<5	5

[a] Only those compounds are listed that were detected in one or more samples. Detection limits were 5 μg/L for the VOCs.
[b] EPA Method 624
[c] See Figure 2-9 for well locations.

Samples collected in April 1988.

Sources: USAEHA (1988a).

TABLE 2-13

CHEMICAL PARAMETERS IN WATER FROM HONEY LAKE[a] (mg/L)[b]

Parameter	Nov. 7, 1986	Dec. 10, 1986	April 27, 1987
Cations/Metals			
Arsenic	-	0.10	0.10
Barium	-	0.17	-
Boron	2.95	1.44	2.25
Cadmium	-	<0.002	-
Calcium	22.6	-	-
Chromium	-	0.014	-
Copper	-	0.035	-
Fluoride	-	1.1	1.4
Iron	0.040	15.31	-
Lead	-	<0.01	-
Magnesium	5.3	-	-
Manganese	-	0.38	-
Mercury	-	<0.0005	-
Molybdenum	-	<0.005	0.029
Potassium	15.8	-	-
Selenium	-	<0.001	$<10^{-6}$
Silver	-	0.004	-
Sodium	490	-	-
Zinc	-	0.045	-
Macroparameters			
Chloride	-	203.5	227.4
Nitrate Plus Nitrite	-	0.2	-
pH	-	8.8	8.9
Phosphorous	-	1.32	-
Silicon, as SiO_2	490	-	-
Specific Conductance (μmho/cm)	-	1,372	2,300
Sulfate	-	159	171.8
Total Dissolved Solids	-	1,149	1,446

[a] Samples were collected 50 feet from the eastern shore of Honey Lake north of SIAD.

[b] Except for pH and specific conductance.

Section 3

Applicable or Relevant and Appropriate Requirements



3.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Applicable or relevant and appropriate requirements (ARARs) are used to determine the appropriate extent of site cleanup, develop site-specific remedial response objectives, develop remedial action alternatives, and direct site cleanup. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and the National Contingency Plan (NCP), requires that hazardous waste site remedial actions, including those at federal facilities, comply with federal ARARs. SARA also requires attainment of state ARARs if they are more stringent than federal ARARs, legally enforceable, and consistently enforced statewide.

3.1 APPLICABILITY OF REGULATORY REQUIREMENTS AT FEDERAL FACILITIES

Section 120 of CERCLA provides guidance for the remediation of hazardous constituents released from federal facilities. CERCLA requires that each department, agency, and instrumentality of the United States, including executive, legislative, and judicial branches of the government be subject to and comply with CERCLA. Under Executive Order 12580 - Superfund Implementation, the President delegated to the Secretary of Defense the responsibility of responding to releases or threats of releases of hazardous contaminants from any facility or vessel under jurisdiction of the Department of Defense (DOD). Section 2701 of SARA - the Environmental Restoration Program, authorizes the Secretary of Defense to carry out a program of environmental restoration at facilities under its jurisdiction. DOD environmental restoration activities must be carried out in a manner consistent with Section 120 of CERCLA.

3.2 DEFINITION AND DEVELOPMENT OF ARARs

An ARAR may be either "applicable," or "relevant and appropriate," but not both. According to the NCP, "applicable" and "relevant and appropriate" are defined as follows:

- Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under state or federal environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and are more stringent than federal requirements may be applicable.

- Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under state or federal environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate.

Requirements that are applicable or relevant and appropriate must be met by CERCLA remedial actions; other types of standards or guidance information fall into the "to be considered" (TBC) category. TBCs are federal and state advisories or guidance that are not legally binding and do not have the status of potential ARARs. However, if there are no specific ARARs for a chemical or site condition, or if existing ARARs are not deemed sufficiently protective, then guidance or advisory criteria should be identified and used to ensure public health and environmental protection.

Section 121(d)(4) of CERCLA identifies the following six circumstances under which ARARs may be waived. An ARAR may only be waived for on-site remedial actions.

- The remedial action selected is only a part of a total remedial action (interim remedy) and the final remedy will attain the ARAR upon its completion.

- Compliance with the ARAR will result in a greater risk to human health and the environment than alternative options.

- Compliance with the ARAR is technically impracticable from an engineering perspective.

- An alternative remedial action will attain an equivalent standard of performance through the use of another method or approach.

- The ARAR is a state requirement that the state has not consistently applied (or demonstrated the intent to apply consistently) in similar circumstances.

- For Section 104 Superfund-financed remedial actions, compliance with the ARAR will not provide a balance between protecting human health and the environment and the availability of Superfund money for response at other facilities.

3.3 ARARs DEVELOPMENT

Identification of ARARs must be done on a site-specific basis. Neither SARA nor the NCP provides across-the-board standards for determining whether a particular remedy will affect an adequate cleanup at a particular site. Rather, the process recognizes that each site will have unique characteristics that must be evaluated and compared to those requirements that apply under the given circumstances.

There are several different types of requirements that CERCLA actions may have to comply with: chemical-specific, location-specific, and action-specific.

3.3.1 Chemical-Specific ARARs

Chemical-specific ARARs are usually health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment. If a chemical has more than one ARAR, the most stringent ARAR generally should be complied with. Both ARARs and TBCs should be subject to a site-specific risk assessment to ensure exposure levels are within acceptable limits for the protection of human health and other environmental receptors. In some cases, such as multiple exposure pathways or multiple contaminants, a risk assessment may indicate that an ARAR alone is not sufficiently protective and TBCs, including risk-based limits, will be used to establish cleanup requirements.

3.3.2 Location-Specific ARARs

Location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they are in specific locations. Some examples of special locations include floodplains, wetlands, historic places, and sensitive ecosystems or habitats.

3.3.3 Action-Specific ARARs

Action-specific ARARs are requirements or limitations on specific potential remedial actions at a hazardous waste facility. The type and nature of these requirements is dependent upon the particular remedial or removal action taken at a site, and thus different actions or technologies are often subject to different action-specific ARARs.

3.4 IDENTIFICATION OF CHEMICAL-SPECIFIC AND LOCATION-SPECIFIC ARARS

For the SIAD Phase I RI, potential chemical-specific and location-specific ARARs and TBCs have been identified by reviewing the USEPA draft guidance document, CERCLA Compliance with Other Laws Manual, and state-specific regulations and criteria (USEPA, 1988). Action-specific requirements will be identified when remedial alternatives are developed in the Feasibility Studies conducted for the Phase I SIAD sites.

3.4.1 Chemical-Specific ARARs

Groundwater. Maximum Contaminant Levels (MCLs) established for drinking water by USEPA under the Safe Drinking Water Act (40 CFR Part 141) are applicable requirements when water will or would be used as a drinking water source for community supplies for 25 or more people, or 15 or more service connections. MCLs and non-zero Maximum Contaminant Level Goals (MCLGs) are relevant and appropriate requirements in other cases where surface water or groundwater is or may be directly used for drinking water, in which case the MCLs or MCLGs should be met in the surface water or groundwater itself. USEPA

has also developed Secondary MCLs (SMCLs) which are nonenforceable limits designed to establish minimum aesthetic qualities in drinking water (40 CFR Part 143).

California has adopted the USEPA MCLs and has promulgated some additional or more stringent state MCLs for drinking water contaminants. The state has also established Secondary Drinking Water Standards (SDWSs) that, in contrast to the federal SMCLs, are enforceable standards. Additionally, the DHS has established numerical criteria SALs for selected chemicals in drinking water for which state MCLs have not yet been established. While SALs are considered "technically non-enforceable standards," DHS has established a policy by which any water system not meeting the SALs is required to take corrective action. Because California enforces these recommended standards as if they were promulgated, SALs definitely qualify as TBCs and perhaps should also be considered potentially relevant and appropriate requirements.

Applied Action Levels (AALs) are developed according to procedures outlined in The California Site Mitigation Decision Tree Manual (DHS, 1986). These values are based on *maximum* acceptable exposure of biological receptors to substances associated with hazardous waste sites and facilities. Thus, AALs are derived by considering health effects without dealing with technical feasibility, economic concerns, or other factors. Since AALs are entirely health-based, they are different on both a criterion and use basis from standards developed by other agencies and divisions of Department of Health Services (e.g., MCLs promulgated by the Public Water Supply Branch), and therefore are TBCs for SIAD.

The USEPA Office of Drinking Water provides Drinking Water Health Advisories (HAs) as technical guidance for the protection of public health. HAs are not enforceable federal standards, and, therefore, are TBCs for SIAD. HAs are concentrations of a substance in drinking water estimated to have negligible deleterious effects in humans, when ingested, for a specific period of time. Lifetime HAs are not derived for compounds which are potentially carcinogenic for humans because of the difference in assumptions concerning toxic threshold for carcinogenic and noncarcinogenic effects.

Surface Water. If the designated use of a surface water body includes consumption of water and fish, then federal Ambient Water Quality Criteria (AWQC) may also be TBCs. AWQC are established by USEPA under the Clean Water Act for the protection of human health and aquatic life. There is no surface water at any of the five SIAD priority sites. Therefore, AWQC are not relevant to the Phase I RI/FS.

Soil and Air. Chemical-specific soil and air ARARs are not available for SIAD contaminants. Reference doses (RfDs), cancer potency factors (CPFs), and AALs are considered TBCs for SIAD.

Potential chemical-specific ARARs and TBCs for the contaminants found in groundwater and soil at the five priority sites during the Phase I are presented in Tables 3-1, 3-2, and 3-3. As shown in Table 3-1, there are no ARARs for the explosive compounds found at SIAD. Unless noted, RfDs, CPFs, and HAs listed in Table 3-3 are from the USEPA Integrated Risk Information System (IRIS), August 1990.

3.4.2 Location-Specific ARARs

Potential location-specific ARARs were identified and assessed with the aid of regulatory personnel. Potential location-specific ARARs at the SIAD are listed in Appendix B.

TABLE 3-1

POTENTIAL STATE AND FEDERAL CHEMICAL - SPECIFIC ARARs AND TBCs

Chemical	USEPA MCL	USEPA Proposed MCL (TBC)	USEPA MCLG	USEPA Proposed MCLG (TBC)	USEPA SMCL (TBC)	USEPA Proposed SMCL (TBC)	California DHS MCL	California DHS SDWS	California DHS State Action Level
VOC (µg/L)									
Acetone	-	-	-	-	-	-	-	-	-
Benzene	5.0	-	0	-	-	-	1.0	-	-
Carbon Disulfide	-	-	-	-	-	-	-	-	-
Carbon Tetrachloride	5.0	-	0	-	-	-	0.5	-	-
Chlorobenzene	-	100	-	-	-	100	30.0	-	-
Chloroform	100 [a,b]	-	-	-	-	-	-	-	-
1,2-Dichlorobenzene	-	600	-	-	-	10	-	-	130.0
1,3-Dichlorobenzene	-	-	-	-	-	-	-	-	130.0
1,4-Dichlorobenzene	75	-	75	-	-	5.0	5.0	-	-
1,2-Dichloroethane	5.0	-	0	-	-	-	0.5	-	-
1,1-Dichloroethene	7.0	-	7.0	-	-	-	6.0	-	-
Dichloromethane	-	-	-	-	-	-	-	-	40.0
1,2-Dichloropropane	-	5.0	-	-	-	-	5.0	-	-
Ethylbenzene	-	700	-	680	-	30	680	-	-
Phenol	-	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	-	-	-	-	-	-	1	-	-
Tetrachloroethene	-	5.0	-	0	-	-	5.0	-	-
Toluene	-	2,000	-	2,000	-	40	-	-	100
1,1,1-Trichloroethane	200	-	200	-	-	-	200	-	-
Trichloroethene	5.0	-	0	-	-	-	5.0	-	-
Trichlorofluoromethane	-	-	-	-	-	-	-	-	150.0
Xylenes	-	10,000	-	440	-	20	1,750	-	-
BNAs (µg/L)									
Bis(2-ethylhexyl)phthalate	-	-	-	-	-	-	-	-	-

TABLE 3-1 (Continued)

POTENTIAL STATE AND FEDERAL 1CHEMICAL - SPECIFIC ARARs AND TBCs

Chemical	USEPA MCL	USEPA Proposed MCL (TBC)	USEPA MCLG	USEPA Proposed MCLG (TBC)	USEPA SMCL (TBC)	USEPA Proposed SMCL (TBC)	California DHS MCL	California DHS SDWS	California DHS State Action Level
Inorganics (μg/L)									
Arsenic, inorganic	50 [b]	-	-	50	-	-	50	-	-
Barium	1,000 [b]	5,000	-	1,500	-	-	1,000	-	-
Cadmium	10.0 [b]	5.0	-	5.0	-	-	10	-	-
Calcium	-	-	-	-	-	-	-	-	-
Chloride	-	-	-	-	250,000	-	-	250,000	-
Chromium (VI)	50 [c]	100 [c]	-	100 [c]	--	-	50 [c]	--	-
Cobalt	-	-	-	-	--	-	-	--	-
Copper	-	-	-	-	1,000	-	-	1,000	-
Dissolved Residue	-	-	-	-	500,000	-	-	500,000	-
Lead, inorganic	50	-	-	20	-	-	50	-	-
Mercury, inorganic	2.0	-	-	-	-	-	2.0	-	-
Molybdenum	-	-	-	-	-	-	-	-	-
Nickel	-	-	-	-	-	-	-	-	-
Selenium	10.0	50.0	-	-	-	-	10	-	-
Sodium	-	-	-	-	20,000	-	-	-	-
Sodium	-	-	-	-	-	-	-	250,000	-
Vanadium	-	-	-	-	-	-	-	-	-
Zinc	-	-	-	-	5,000	-	-	5,000	-
Pesticides (μg/L)									
Aldrin	-	-	-	-	-	-	-	-	50
Chlordane	-	2.0	-	0	-	-	0.1	-	-
p,p'-DDD	-	-	-	-	-	-	--	-	-
p,p'-DDE	-	-	-	-	-	-	--	-	-
p,p'-DDT	-	-	-	-	-	-	-	-	-
Heptachlor	-	0.4	-	0	-	-	-	-	0.01
Heptachlor Epoxide	-	0.2	-	0	-	-	-	-	0.01

TABLE 3-1 (Continued)

POTENTIAL STATE AND FEDERAL 1CHEMICAL - SPECIFIC ARARs AND TBCs

Chemical	USEPA						California DHS		
	MCL	Proposed MCL (TBC)	MCLG	Proposed MCLG (TBC)	SMCL (TBC)	Proposed SMCL (TBC)	MCL	SDWS	State Action Level
Explosives (µg/L)									
2,4-Dinitrophenol	-	-	-	-	-	-	-	-	-
2,4-Dinitrotoluene	-	-	-	-	-	-	-	-	-
HMX	-	-	-	-	-	-	-	-	-
RDX	-	-	-	-	-	-	-	-	-
Tetryl, total	-	-	-	-	-	-	-	-	-
1,3,5-Trinitrobenzene	-	-	-	-	-	-	-	-	-
2,4,6-Trinitrotoluene	-	-	-	-	-	-	-	-	-

MCL = Maximum Contaminant Level (40 CFR 141)
Proposed MCLs and MCLGs were proposed in 54 FR 22061, May 22, 1989
MCLG = Maximum Contaminant Level Goal (40 CFR 141)
SMCL = Secondary Maximum Contaminant Level
SDWS = Secondary Drinking Water Standards (State of California)
California MCLs and SDWSs are promulgated in CAC, Title 22, Chapter 15
California State Action Levels were obtained from DHS, Public Water Supply Branch
TBC = "To be considered" materials
Dissolved Residue = Total Dissolved Solids

[a] MCL based on total concentration of trihalomethane compounds (Interim, 1979)
[b] Interim MCL value.
[c] Based on chromium (total)

TABLE 3-2

POTENTIAL STATE CHEMICAL - SPECIFIC TBCS

Chemical	California DHS AAL (Water) (µg/L) (TBC)	California DHS AAL (Air) (µg/m³) (TBC)	California DHS AAL (Soil Contact) (mg/kg) (TBC)	California Proposition 65 Dose (TBC)
VOC (µg/L)				
Acetone	-	-	-	-
Benzene	0.2	0.07	-	20
Carbon Disulfide	-	-	-	-
Carbon Tetrachloride	-	-	-	5.0
Chlorobenzene	-	-	-	-
Chloroform	6	0.6	-	9.0
1,2-Dichlorobenzene	-	-	-	-
1,3-Dichlorobenzene	-	-	-	-
1,4-Dichlorobenzene	-	-	-	-
1,2-Dichloroethane	-	-	-	9.0
1,1-Dichloroethene	-	-	-	-
Dichloromethane	-	-	-	-
1,2-Dichloropropane	-	-	-	-
Ethylbenzene	2,000	100	-	-
Phenol	-	-	-	-
1,1,2,2-Tetrachloroethane	-	-	-	-
Tetrachloroethene	-	-	-	14.0
Toluene	2,000	200	-	-
1,1,1-Trichloroethane	300	300	-	-
Trichloroethene	7	7	-	60.0
Trichlorofluoromethane	-	-	-	-
Xylenes	2,000	400	30,000	-
BNAs (µg/L)				
Bis(2-ethylhexyl)phthalate	-	-	-	-
Inorganics (µg/L)				
Arsenic, inorganic	-	-	-	10.0
Barium	350	5	-	-
Cadmium	-	-	-	1.0
Calcium	-	-	-	-

TABLE 3-2 (Continued)

POTENTIAL STATE CHEMICAL - SPECIFIC TBCS

Chemical	California DHS AAL (Water) (µg/L) (TBC)	California DHS AAL (Air) (µg/m³) (TBC)	California DHS AAL (Soil Contact) (mg/kg) (TBC)	California Proposition 65 Dose (TBC)
Chloride	-	-	-	-
Chromium (VI)	50,000[d]	50[d]	-	-
Cobalt	-	-	-	-
Copper	4,000	200	-	-
Lead, inorganic	-	-	-	0.5
Mercury, inorganic	0	0.07	-	-
Molybdenum	-	-	-	-
Nickel	400	0.1	-	-
Selenium	-	-	-	-
Sodium	-	-	-	-
Sulfate	-	-	-	-
Vanadium	-	-	-	-
Zinc	8,000	800	-	-
Pesticides (µg/L)				
Aldrin	-	-	-	0.4
Chlordane	-	0.02	-	-
p,p'-DDD	-	-	-	-
p,p'-DDE	-	-	-	-
p,p'-DDT	-	-	-	2.0
Heptachlor	0.01	0.01	-	0.2
Heptachlor Epoxide	0.02	0.002	-	0.8
Explosives (µg/L)				
2,4-Dinitrophenol	-	-	-	-
2,4-Dinitrotoluene	-	-	-	2.0
HMX	-	-	-	-
RDX	-	-	-	-
Tetryl, total	-	-	-	-
1,3,5-Trinitrobenzene	-	-	-	-
2,4,6-Trinitrotoluene	-	-	-	-

TABLE 3-2 (Continued)

POTENTIAL STATE CHEMICAL - SPECIFIC TBCS

Rfd = Reference Dose
CPF = Cancer Potency Factor
AAL = Applied Action Level (Source: The California Site Mitigation Decision Tree Manual, 1986).
TBC = "To be considered" materials

[a] Unless noted, RfDs and CPFs listed are from the USEPA Integrated Risk Information System (IRIS), August 1990.
[b] Value is from the USEPA Superfund Public Health Evaluation Manual (October 1986); IRIS does not presently reference an RfD on CPF for this compound.
[c] Source: Dufour (1989)
[d] Based on chromium (III)
[e] Source: USEPA Health Effects Assessment Summary Tables (October 1989).

TABLE 3-3

POTENTIAL FEDERAL CHEMICAL - SPECIFIC TBCS

Chemical	USEPA Oral Rfd (mg/kg/d) (TBC)[a]	USEPA Inh. Rfd (mg/kg/d) (TBC)[a]	USEPA Oral CPF (mg/kg/d)-1 (TBC)[a]	USEPA Inh. CPF (mg/kg/d)-1 (TBC)[a]	Drinking Water Health Advisories (µg/L) 1-Day 10 kg	10-Day 10 kg	Longer Term 10 kg	Longer Term 70 kg	Lifetime 70 kg
VOC (µg/L)									
Acetone	0.1	3.0[b]	-	-	-	-	-	-	-
Benzene	-	-	0.029	0.029	235	235	-	-	-
Carbon Disulfide	0.1	-	-	-	-	-	-	-	-
Carbon Tetrachloride	0.007[d]	-	0.13[d]	0.13[d]	4,000	160	71	250	25
Chlorobenzene	0.02	0.0057	-	-	-	-	-	-	-
Chloroform	0.01	-	0.0061	0.081	-	-	-	-	-
1,2-Dichlorobenzene	0.09	-	-	-	-	-	-	-	-
1,3-Dichlorobenzene	-	-	-	-	9,000	9,000	9,000	30,000	600
1,4-Dichlorobenzene	-	-	-	-	10,000	10,000	10,000	40,000	75
1,2-Dichloroethane	-	-	0.091	0.091	740	740	740	2,600	-
1,1-Dichloroethene	0.009	-	0.6	1.2	-	-	-	-	-
Dichloromethane	0.06	-	0.0075	0.014	1,330	1,500	500	1,750	1,750
1,2-Dichloropropane	-	-	-	-	9,000	9,000	9,000	30,000	600
Ethylbenzene	0.1	-	-	-	30,000	3,000	1,000	3,000	700
Phenol	0.6	-	-	-	-	-	-	-	-
1,1,2,2-Tetrachloroethane	-	-	0.2	0.2	-	-	-	-	-
Tetrachloroethene	0.01	-	0.05[b]	0.0017[b]	2,000	2,000	1,400	5,000	500
Toluene	0.3	1.5[b]	-	-	-	-	-	-	-
1,1,1-Trichloroethane	0.09	-	-	-	100,000	40,000	40,000	100,000	200
Trichloroethene	-	-	0.011	0.0046[b]	-	-	-	-	-
Trichlorofluoromethane	0.3	-	-	-	-	-	-	-	-
Xylenes	2	0.4[b]	-	-	-	-	-	-	-
BNAs (µg/L)									
Bis(2-ethylhexyl)phthalate	0.02	-	-	-	-	-	-	-	-

TABLE 3-3 (*Continued*)

POTENTIAL FEDERAL CHEMICAL - SPECIFIC TBCS

	USEPA								
					Drinking Water Health Advisories (µg/L)				
	Oral Rfd (mg/kg/d)	Inh. Rfd (mg/kg/d)	Oral CPF (mg/kg/d)-1	Inh. CPF (mg/kg/d)-1	1-Day	10-Day	Longer Term		Lifetime
Chemical	(TBC)[a]	(TBC)[a]	(TBC)[a]	(TBC)[a]	10 kg	10 kg	10 kg	70 kg	70 kg
Inorganics (µg/L)									
Arsenic, inorganic	-	-	-	-	-	-	-	-	
Barium	0.001[d]	0.005[d]	-	-	-	-	-	-	
Cadmium	0.0005	-	-	6.1	-	-	-	-	
Calcium	-	-	-	-	-	-	-	-	
Chloride	-	-	-	-	-	-	-	-	
Chromium (VI)	-	0.0051[b,c]	-	-	1,400	1,400	240	840	170
Cobalt	1.0[d]	-	-	-	-	-	-	-	-
Copper	-	-	-	-	-	-	-	-	-
Lead, inorganic	0.0014[b]	0.00043[b]	-	-	-	-	-	-	-
Mercury, inorganic	0.0003[d]	-	-	-	-	-	-	-	-
Molybdenum	-	-	-	-	-	-	-	-	-
Nickel	0.02	-	-	-	1,000	1,000	100	600	100
Selenium	0.003[b]	0.001[b]	-	-	-	-	-	-	-
Sodium	-	-	-	-	-	-	-	-	-
Sodium	-	-	-	-	-	-	-	-	-
Vanadium	-	-	-	-	-	-	-	-	-
Zinc	0.21	0.01[b]	-	-	-	-	-	-	-
Pesticides (µg/L)									
Aldrin	0.00003	-	17	17	-	-	-	-	-
Chlordane	0.00006	-	1.3	1.3	60	60	0.5	2	2
p,p'-DDD	-	-	0.24	-	-	-	-	-	-
p,p'-DDE	-	-	0.34	-	-	-	-	-	-
p,p'-DDT	0.005	-	0.34	0.34	-	-	-	-	-
Heptachlor	0.0005	-	4.5	4.5	10	10	5	17.5	17.5
Heptachlor Epoxide	0.000013	-	9.1	9.1	-	-	0.15	0.5	0.44

TABLE 3-3 (Continued)

POTENTIAL FEDERAL CHEMICAL - SPECIFIC TBCS

Chemical	USEPA Oral Rfd (mg/kg/d) (TBC)[a]	Inh. Rfd (mg/kg/d) (TBC)[a]	Oral CPF (mg/kg/d)-1 (TBC)[a]	Inh. CPF (mg/kg/d)-1 (TBC)[a]	Drinking Water Health Advisories (µg/L) 1-Day 10 kg	10-Day 10 kg	Longer Term 10 kg	Longer Term 70 kg	Lifetime 70 kg
Explosives (µg/L)									
2,4-Dinitrophenol	-	-	-	-	-	-	-	-	-
2,4-Dinitrotoluene	-	-	-	-	-	-	-	-	-
HMX	0.05	-	-	-	5,000	5,000	5,000	2,000	400
RDX	0.003	-	-	-	100	100	100	400	2
Tetryl, total	-	-	-	-	-	-	-	-	-
1,3,5-Trinitrobenzene	0.00005	-	-	-	-	-	-	-	-
2,4,6-Trinitrotoluene	0.0005	-	0.03	-	20	20	20	20	2

Rfd = Reference Dose
CPF = Cancer Potency Factor
AAL = Applied Action Level (Source: The California Site Mitigation Decision Tree Manual, 1986)
TBC = "To be considered" materials

[a] Unless noted, RfDs, CPFs and Drinking Water Health Advisories listed are from the USEPA Integrated Risk Information System (IRIS), August 1990.
[b] Value is from the USEPA Superfund Public Health Evaluation Manual (October 1986); IRIS does not presently reference an RfD on CPF for this compound.
[c] Based on chromium (III)
[d] Source: USEPA Health Effects Assessment Summary Tables (October 1989)

Section 4

Field Program Description and Rationale



4.0 FIELD PROGRAM DESCRIPTION AND RATIONALE

The SIAD Phase I RI field program consisted of the following major elements:

- unexploded ordnance clearance;
- soil gas survey;
- geophysical survey;
- test pits;
- surface soil sampling;
- well development;
- groundwater sampling;
- soil borings and subsurface soil sampling;
- monitoring well installation;
- borehole geophysical logging;
- location and vertical elevation survey; and
- background soil and groundwater sampling.

Table 4-1 presents the field sampling program elements implemented at the five priority SIAD sites. In addition, six 250-foot-deep soil borings were drilled and sampled at six locations throughout SIAD to characterize the stratigraphy and gather data for the basin-wide groundwater model. The program elements, as well as a summary of equipment decontamination, waste management, and health and safety practices carried out during the Phase I RI, are described in detail in the following sections.

4.1 UNEXPLODED ORDNANCE CLEARANCE

Before Phase I RI site survey and sampling actively began, locations at each of the five sites slated for invasive soils work were cleared of UXO by Environmental Hazards Specialists International, Inc. (EHS), of Belvedere, North Carolina. EHS specializes in the identification and removal of UXO. Sites were cleared for ferrous and nonferrous metals to depths of 3 feet below the ground surface using ferrous and nonferrous metal detectors and an MK-26 ordnance detector.

Metal detectors were passed 4 to 6 inches over the surface of each site within a 2-foot radius for soil gas locations and 17-foot radius for soil boring locations. For test pit clearance, the

TABLE 4-1

SUMMARY OF THE PHASE I FIELD PROGRAM
SIERRA ARMY DEPOT

Site	UXO Clearance	Soil Gas Survey	Remote Sensing Geophysics	Trenches, Test Pits, and Test Pit Sampling	Soil Borings and Subsurface Soil Sampling	Borehole Geophysics	Monitoring Well Installation	Groundwater Sampling	Aquifer Testing	Location and Vertical Elevation Survey	Surface Soil Sampling
Abandoned Landfill	All soil boring, monitoring well, soil gas, and test pit locations.	Target compounds:* BETX; total hydrocarbons; TCA; TCE; PCE; CCL4, CH2Cl2; CHCl2, 1,2-DCA.	MAG; EM; GPR	Eleven test pits excavated. Soil samples collected at the bottom of four of the test pits.	Four soil borings drilled in center of four most significant geophysical anomalies. Split-spoon samples collected for stratigraphic and chemical analysis every five feet to 50 feet and every ten feet thereafter to top of water table.	NA	Three monitoring wells installed around site perimeter. Split-spoon samples collected for stratigraphic analysis every 5 feet to 50 feet and every 10 feet thereafter to borehole terminus.	Two rounds	One hour constant discharge test at each well.	All wells and borings.	NA
Chemical Burial Site	All soil boring, monitoring well, soil gas and test pit locations.	Target compounds:* BETX; total hydrocarbons; TCA; TCE; PCE; CCL4; CH2Cl2; CHCl3, 1,2-DCA.	MAG; EM; GPR	Three test pits excavated. Soil samples collected at the bottom of the test pits.	Soil borings drilled in the center of each test pit. Split-spoon samples collected for stratigraphic and chemical analysis every five feet to 50 feet and every ten feet thereafter to top of water table.	NA	Two monitoring wells installed on the north and south side of the site. Split-spoon samples collected for stratigraphic analysis every 5 feet to 50 feet and every 10 feet thereafter to borehole terminus.	Two rounds	One hour constant discharge test at each well.	All wells and borings	NA

TABLE 4-1 (Continued)

SUMMARY OF THE PHASE I FIELD PROGRAM
SIERRA ARMY DEPOT

Site	UXO Clearance	Soil Gas Survey	Remote Sensing Geophysics	Trenches, Test Pits, and Test Pit Sampling	Soil Borings and Subsurface Soil Sampling	Borehole Geophysics	Monitoring Well Installation	Groundwater Sampling	Aquifer Testing	Location and Vertical Elevation Survey	Surface Soil Sampling
Construction Debris Landfill	All soil boring, monitoring well, and test pit locations.	NA	MAG; EM; GPR	Three test pits exca-vated. Soil samples collected at the bottom of one of the test pits.	Two soil borings drilled, one in the center of a test pit. Split-spoon samples collected for stratigraphic and chemical analysis every five feet to 50 feet and every ten feet thereafter to top of water table.	NA	Construction Debris Landfill wells coincide with Chemical Burial Site wells.	NA	NA	All wells and boringNA	
DRMO Trench Area	All soil boring, monitoring well, soil gas, and test pit locations.	Target compounds:* TCA; TCE; PCE; total hydrocarbons.	MAG; EM; GPR	Eight test pits excavated. Soil samples collected at the bottom of three of the test pits.	Seven soil borings drilled. Split-spoon samples collected for stratigraphic and chemical analysis every 5 feet to 50 feet and every 10 feet thereafter to top of water table.	NA	Three monitoring wells installed on the north, west and south side of the site. Split-spoon samples collected for stratigraphic analysis every 5 feet to 50 feet and every 10 feet thereafter to borehole terminus.	Two rounds	One hour constant discharge test at two of three wells.	All wells and borings.	NA
TNT Leaching Beds Area	All soil boring, monitoring well,soil gas and test pit locations.	Target compounds:* BETX; total hydrocarbons; TCA; TCE; PCE; CCL4; CH2Cl2; CHCl3, 1,2-DCA.	NA	NA	Thirteen soil borings drilled. Split-spoon samples collected for stratigraphic and chemical analysis every five feet to water table.	NA	Ten monitoring wells installed. Two water table wells drilled north and northeast of the leaching beds. One hundred foot ("B" zone) and 143-foot ("C" zone). Wells installed near TNT 1, 2, 7, and 10 MWA.	Two rounds	One hour constant discharge test at one water table well, four hour step tests at each "B" and "C" zone well.	All wells and borings.	Eight composite samples, one from each quadrant of the two leaching beds.

TABLE 4-1 (Continued)

SUMMARY OF THE PHASE I FIELD PROGRAM
SIERRA ARMY DEPOT

Site	UXO Clearance	Soil Gas Survey	Remote Sensing Geophysics	Trenches, Test Pits, and Test Pit Sampling	Soil Borings and Subsurface Soil Sampling	Borehole Geophysics	Monitoring Well Installation	Groundwater Sampling	Aquifer Testing	Location and Vertical Elevation Survey	Surface Soil Sampling
Deep Soil Borings and Piezometer Locations	All Locations	NA	NA	NA	Six soil borings drilled to 250 feet. Continuous core collected from each boring for stratigraphic analysis. Background soil samples collected from DSB 1, 2, and 4.	Electric and caliper logs	Piezometers installed at DSB 1, 2, 4, and 6. DSB 4 developed into a background well.	Two rounds	NA	All wells and borings.	NA
Production Wells	NA	NA	NA	NA	NA	NA	NA	Two rounds	NA	From map	NA

* Target Compounds:

BETX - Benzene, ethylbenzene, toluene, xylene
TCA - Trichloroethane
TCE - Trichloroethene
PCE - Perchloroethene
CCL_4 - Carbon tetrachloride
CH_2C1_2 - Methylene chloride
$CHC1_3$ - Chloroform
1,2-DCA- 1,2-dichloroethane
NA - Not Applicable

ground surface above the proposed test pit location was initially scraped with a backhoe and then cleared using an MK-26 ordnance detector and metal detectors. If a positive response was registered by any of these instruments, the surface in the vicinity of the anomalous readings was scraped until the source of the disturbance was identified. Site clearance proceeded until the area surrounding each site was cleared of metal debris.

No UXO was found at any location (Appendix C). All metal anomalies detected were the result of miscellaneous surface metal debris. All areas where anomalies were detected were cleared with the exception of an anomaly near TNT-97-SG. This anomaly was probably caused by a buried utility and no sample was collected.

4.2 SOIL GAS SURVEYS

Soil gas surveys were conducted at the Abandoned Landfill, the Chemical Burial Site, the DRMO Trench Area, and the TNT Leaching Beds Area to identify and delineate the presence of VOCs in the vadose zone or in groundwater below the probe. Most soil gas data were collected and analyzed prior to the initiation of the soil boring program in order to help select soil boring locations. Tracer Research, Inc. (TRC) of Tucson, Arizona, performed the soil gas survey as a subcontractor to JMM. Sampling and analysis was performed as outlined in the SIAD Sampling Design Plan, January 1990. Procedures and results are presented in Appendix D.

The following subsections describe the rationale for selecting soil gas sample locations and the target compounds at each soil gas survey site. Generally, the number of compounds included in a VOC soil gas scan determines the analytical run time required for any given sample. Consequently this affected the number of soil gas samples that could be collected and analyzed each day. In order to use the TRC mobile soil gas laboratory and equipment most efficiently, it was determined that an optimum of 12 to 15 soil gas samples should be collected and analyzed daily. As a result, the number of target chlorinated VOC compounds that could be analyzed during each run was limited to seven. Target compounds included benzene, ethyl benzene, toluene, xylene (BETX), total hydrocarbons, TCA, TCE, PCE, 1,2-DCA, methylene chloride, chloroform, and carbon tetrachloride. Unbiased samples were

collected at the nodes of grids established at each site. Biased samples were selected according to data collected and evaluated in the field. Table 4-2 summarizes the soil gas program for the SIAD Phase I RI.

4.2.1 Abandoned Landfill

Large quantities of many types of chemical wastes including paint sludges, paint thinners, solvents, and cleaning fluids, may have been disposed of at the Abandoned Landfill (Benioff, et al., 1988). A separate trench was reported to have been used for waste oil disposal (Benioff, et al., 1988). Because no analytical soil or groundwater data were available for this site prior to the RI, soil gas survey target compounds were selected based on the VOCs that are routinely associated with the chemical wastes reported to have been disposed of at the Abandoned Landfill as well as chemicals that have been detected in soil and groundwater at other SIAD sites.

Seventy-three soil gas samples were collected and analyzed within the Abandoned Landfill Area (Figure 4-1). Fifty-six unbiased soil gas samples were collected at the nodes of a 200-foot triangular grid covering an area approximately 1,300 feet by 1,400 feet. The unbiased grid was laid out with a transit and stadia rod. The unbiased samples were collected at predetermined locations to provide a uniform and representative distribution of soil gas data across the Abandoned Landfill. The sampling points were measured and laid out with a transit and stadia rod irrespective of Abandoned Landfill Area surface features. Unbiased samples could not be collected on successive days because snow impeded the access to many of the sampling locations.

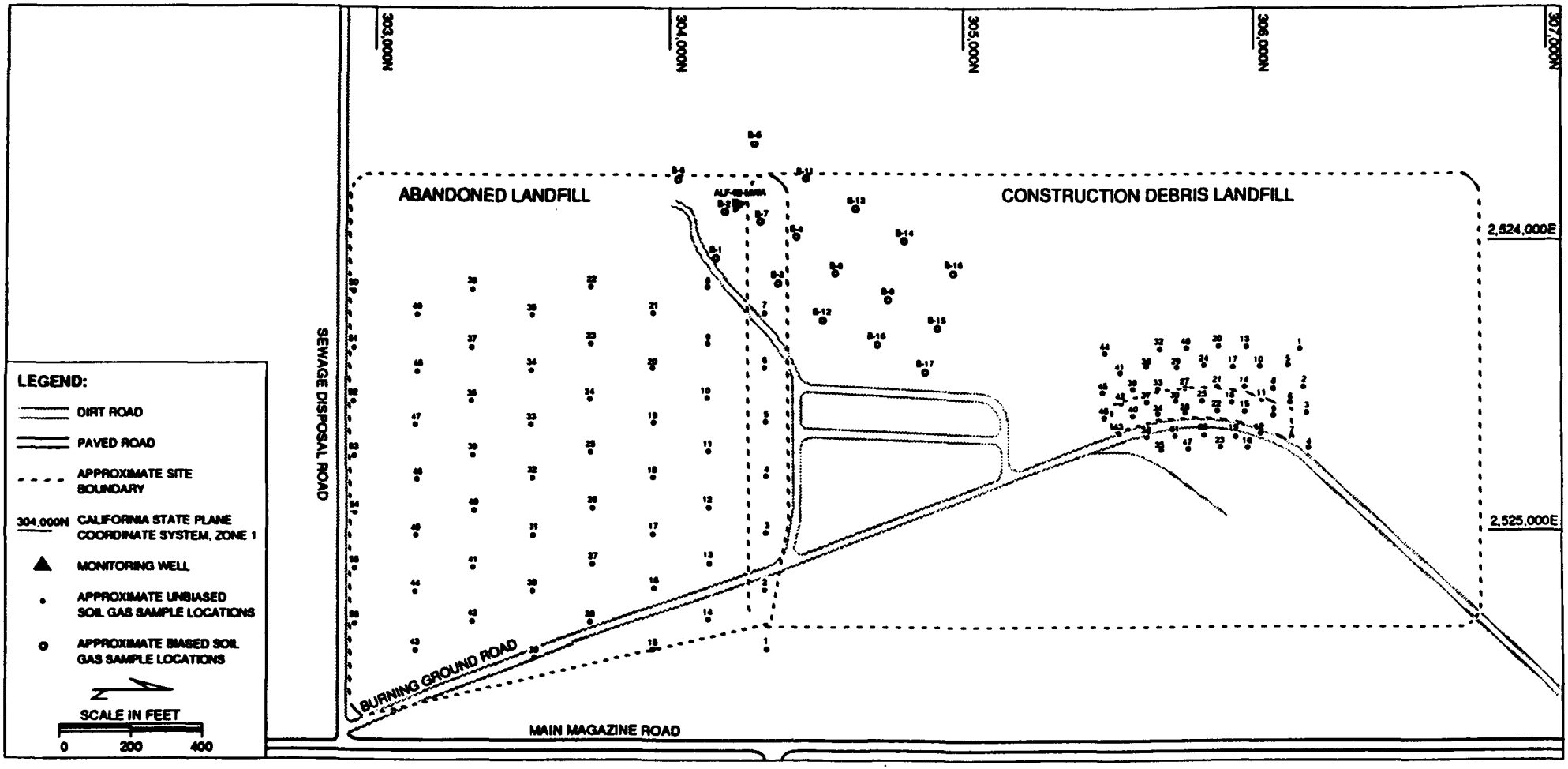
Seventeen biased soil gas samples were collected within an area that focused on Monitoring Well ALF-02-MWA. The sample locations were placed at the nodes of a 200-foot rectangular grid that diagonally traverses the northwest corner of the Abandoned Landfill and the southwest corner of the Construction Debris Landfill (Figure 4-1). The purpose of the biased samples was to identify the source of organic vapors detected with a photoionization detector (PID) meter in the borehole during the drilling of ALF-02-MWA.

TABLE 4-2

SUMMARY OF SOIL GAS SURVEY: ABANDONED LANDFILL, CHEMICAL BURIAL SITE, TNT LEACHING BEDS, AND DRMO TRENCH AREA

Site	Grid Spacing	Number of Unbiased Samples	Number of Biased Samples	Approximate Area Covered by Survey
Abandoned Landfill	200 feet	56	17	1,300 x 1,400 feet
Chemical Burial Site	50 feet	46	0	400 x 700 feet
TNT Leaching Beds Area	100 feet	100	10	1,600 x 900 feet
DRMO Trench Area	NA	0	5	400 x 600 feet

NA - Not Applicable



SIERRA ARMY DEPOT
SOIL GAS SAMPLE LOCATIONS:
ABANDONED LANDFILL/CHEMICAL BURIAL SITE/CONSTRUCTION DEBRIS LANDFILL

FIGURE 4-1

Biased sample locations were located using a Brunton compass and 200-foot measuring tape. The locations of the biased soil gas samples were selected on the basis of soil gas data collected in the field. As each biased soil gas sample was collected and analyzed, the rectangular grid was expanded by two to three nodes. The direction of the grid expansion was based on soil gas data that had just been collected and analyzed. (Analytical data is presented in Section 6.0.)

Analytical data gathered from the first three biased soil gas samples suggested TCE could be used as the single target compound for this site (see Section 5.0). By searching exclusively for TCE, the analytical run time was shortened from approximately 40 minutes to approximately 10 minutes. This shortened run time allowed more analyses to be performed.

4.2.2 Chemical Burial Site

The Chemical Burial Site is located within the Construction Debris Landfill (Figure 4-1). Chemicals buried at the Chemical Burial Site included pesticides, toluene, xylene, paint, 1,1,1-trichloroethane, and mercuric oxide (Benioff, et al., 1988). No analytical soil or groundwater data were available for this site prior to the RI. Soil gas survey target compounds were selected based on the VOCs that are routinely associated with the chemicals disposed of at the Chemical Burial Site and chemicals that have been detected in soil and groundwater at other sites within SIAD. Target compounds included benzene, toluene, ethyl benzene, xylene, total hydrocarbons, TCA, TCE, PCE, 1,2-DCA, methylene chloride, chloroform, and carbon tetrachloride.

Forty-six unbiased soil gas samples were collected and analyzed within the Chemical Burial Site (Figure 4-1). No biased soil gas samples were collected due to the low levels of VOCs found in this area (see Section 5.0). The soil gas samples were collected at the nodes of a 50-foot triangular grid that covered an area approximately 400 feet by 700 feet (Figure 4-1). The unbiased samples were collected at predetermined locations to provide a uniform and representative distribution of soil gas data across the Chemical Burial Site. The sampling points were measured and laid out with a Brunton compass and a 200-foot measuring tape irrespective of the Chemical Burial Site surface features. Soil gas samples could not be

collected on successive days because snow impeded the access to many of the sampling locations.

4.2.3 TNT Leaching Beds Area

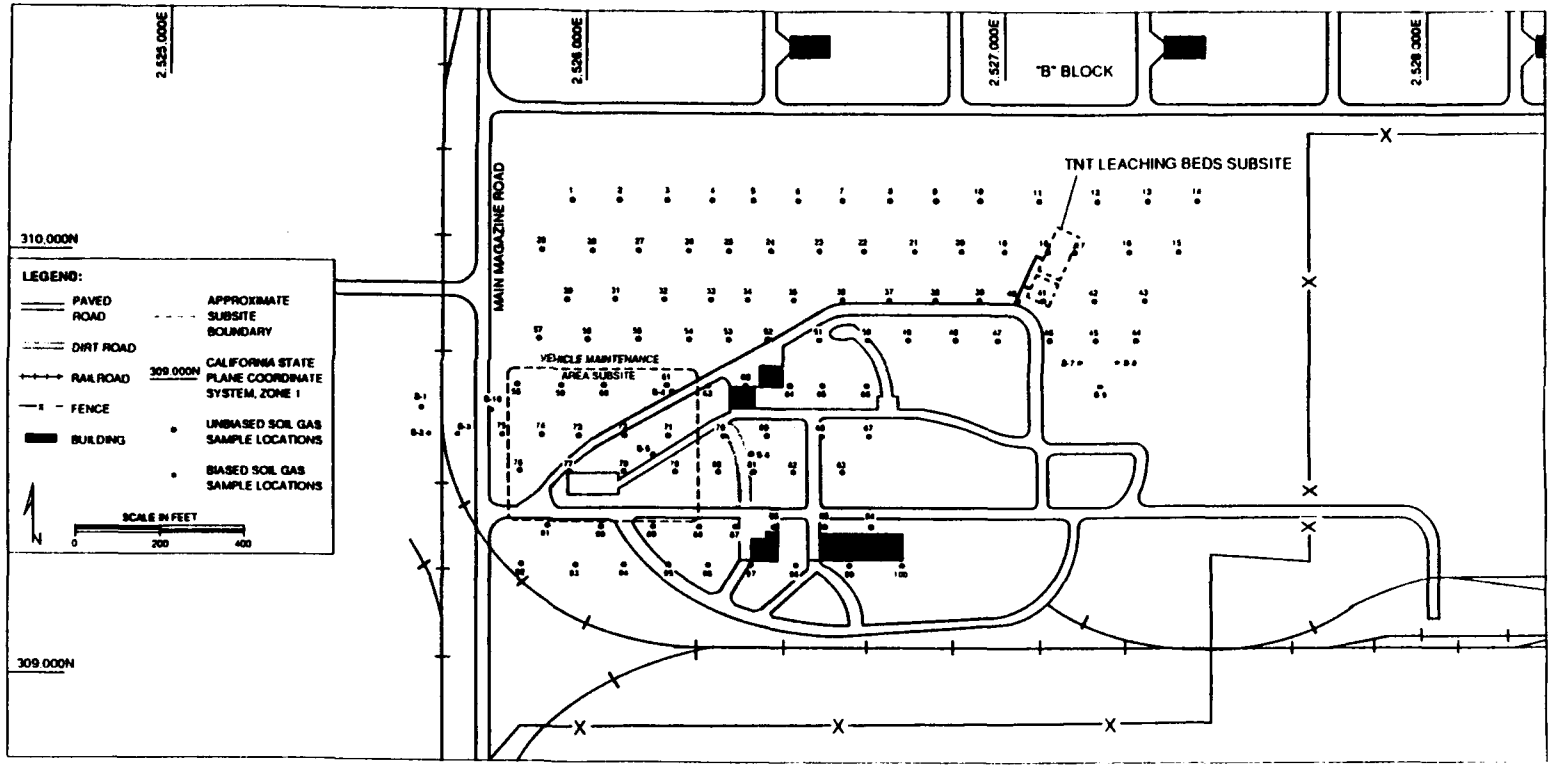
In 1987, elevated levels of TCE, carbon tetrachloride, chloroform, 1,2-DCE, and methylene chloride were found in various monitoring wells located in the southwestern portion of the TNT Leaching Beds Area (USAEHA, 1987). The soil gas survey was designed to identify the source of the VOCs found in these wells. Potential sources were the Vehicle Maintenance Area Subsite, the septic tank/tile field, flammable liquids storage area, and the site of a previously removed underground storage tank. Target compounds were selected based on the chemicals that are commonly used in these potential source areas and chemicals that have been detected previously in TNT Leaching Beds Area soils and groundwater.

One hundred and ten soil gas samples were collected and analyzed within the TNT Leaching Beds Area (Figure 4-2). One hundred unbiased soil gas samples were collected at the nodes of a 100-foot triangular grid that covered an area approximately 1,600 feet by 900 feet (Figure 4-2). Unbiased samples were collected at predetermined locations to provide a representative distribution of soil gas data across the TNT Leaching Beds Area. These points were measured and laid out using a Brunton compass and 200-foot measuring tape irrespective of the TNT Leaching Beds Area surface features.

The 10 biased soil gas sample locations were selected on the basis of soil gas data gathered in the field (Figure 4-2). Sample locations were established using a Brunton compass and 200-foot measuring tape.

4.2.4 Additional Soil Gas Locations

Five soil gas samples were collected at the DRMO Trench Area in an attempt to identify the source of VOCs that were detected during the Phase I RI drilling while monitoring wells and installing soil borings in this area (see Sections 4.6 and 4.7). TCA, TCE, PCE, and total hydrocarbons were the target compounds. These compounds were selected because they were



SIERRA ARMY DEPOT

SOIL GAS SAMPLE LOCATIONS: TNT LEACHING BEDS AREA

FIGURE 4.2

the most commonly detected VOCs in the soil gas and are most representative of the chemical contamination detected at other SIAD sites. Sample locations were established using a Brunton compass and 200-foot measuring tape.

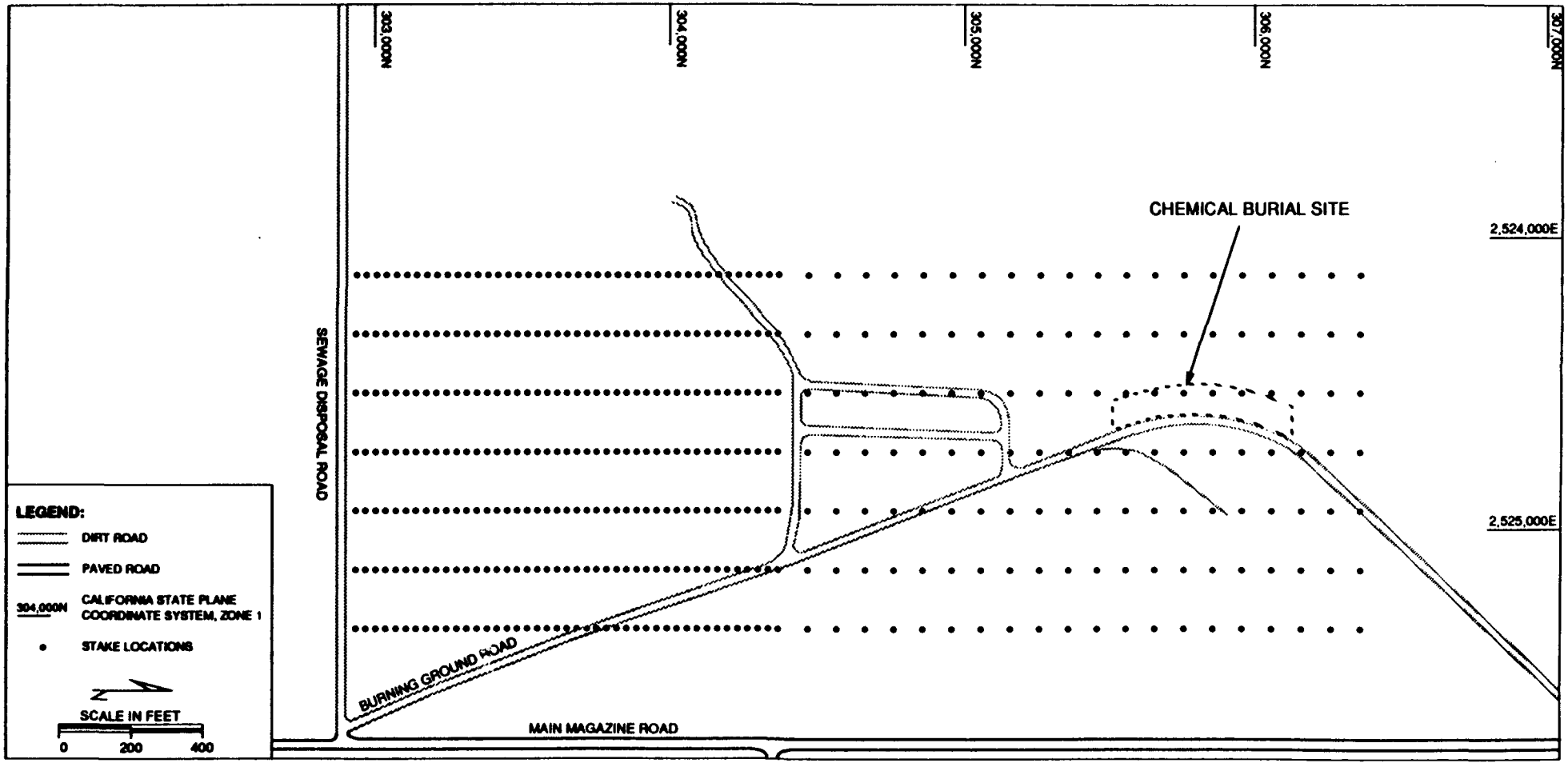
4.3 GEOPHYSICAL SURVEYS

Geophysical surveys were performed at four sites by NORCAL Geophysical Consultants, Inc., during the SIAD Phase I RI. The purpose was to locate buried landfill debris, clear drilling sites, and if possible, determine the lateral extent of fill material. Three geophysical methods were used to perform the survey: electromagnetic terrain conductivity (EM), vertical magnetic gradient (MAG), and ground penetrating radar (GPR). The geophysical surveys followed procedures outlined in the SIAD Sampling Design Plan (JMM, 1990a). Detail descriptions of procedures and results are presented in Appendix E.

Prior to data acquisition, survey grids were measured and laid out in each of the four sites (Figures 4-3 through 4-6) by JMM personnel. A Brunton compass and 200-foot measuring tape were used to locate the grid at the Chemical Burial Site and DRMO Trench Area. A stadia rod and a TOPCON transit were used at the Abandoned Landfill and Construction Debris Landfill. Survey markers consisted of wood stakes (with flagging) or pin flags that were placed in the ground. Footage was marked directly on the stakes. The markers were located at 20- to 100-foot intervals along designated lines in each area to be surveyed. NORCAL used these markers to establish horizontal control for each geophysical survey grid.

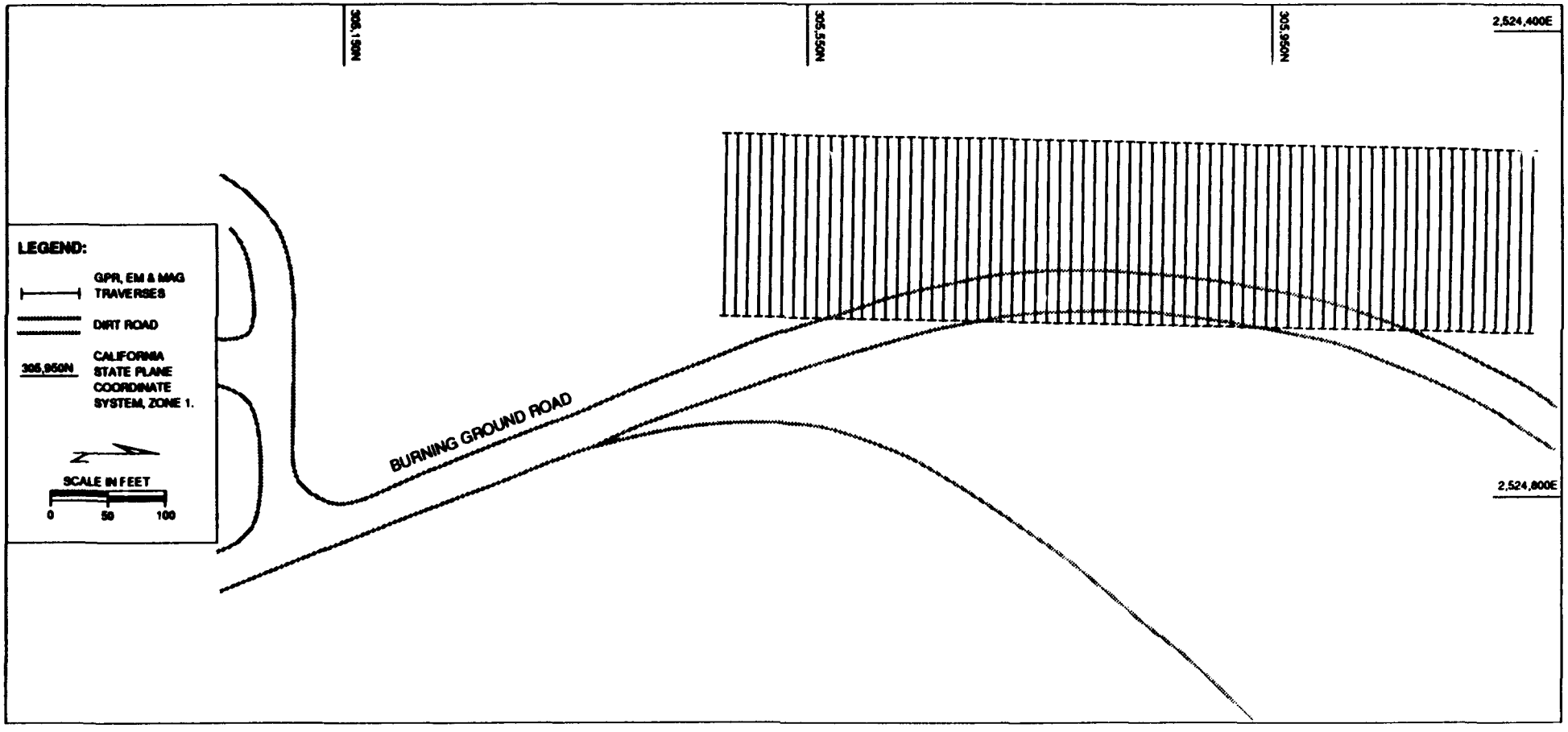
4.4 TEST PITS

Twenty-four test pits were excavated by EHS International at SIAD Phase I sites. Test pits were excavated to clear drilling sites of landfill debris and possible UXO, to uncover and identify the sources of geophysical anomalies, and to locate and characterize landfills and trenches. Test pits were excavated according to procedures outlined in the SIAD Sampling Design Plan (JMM, 1990a).



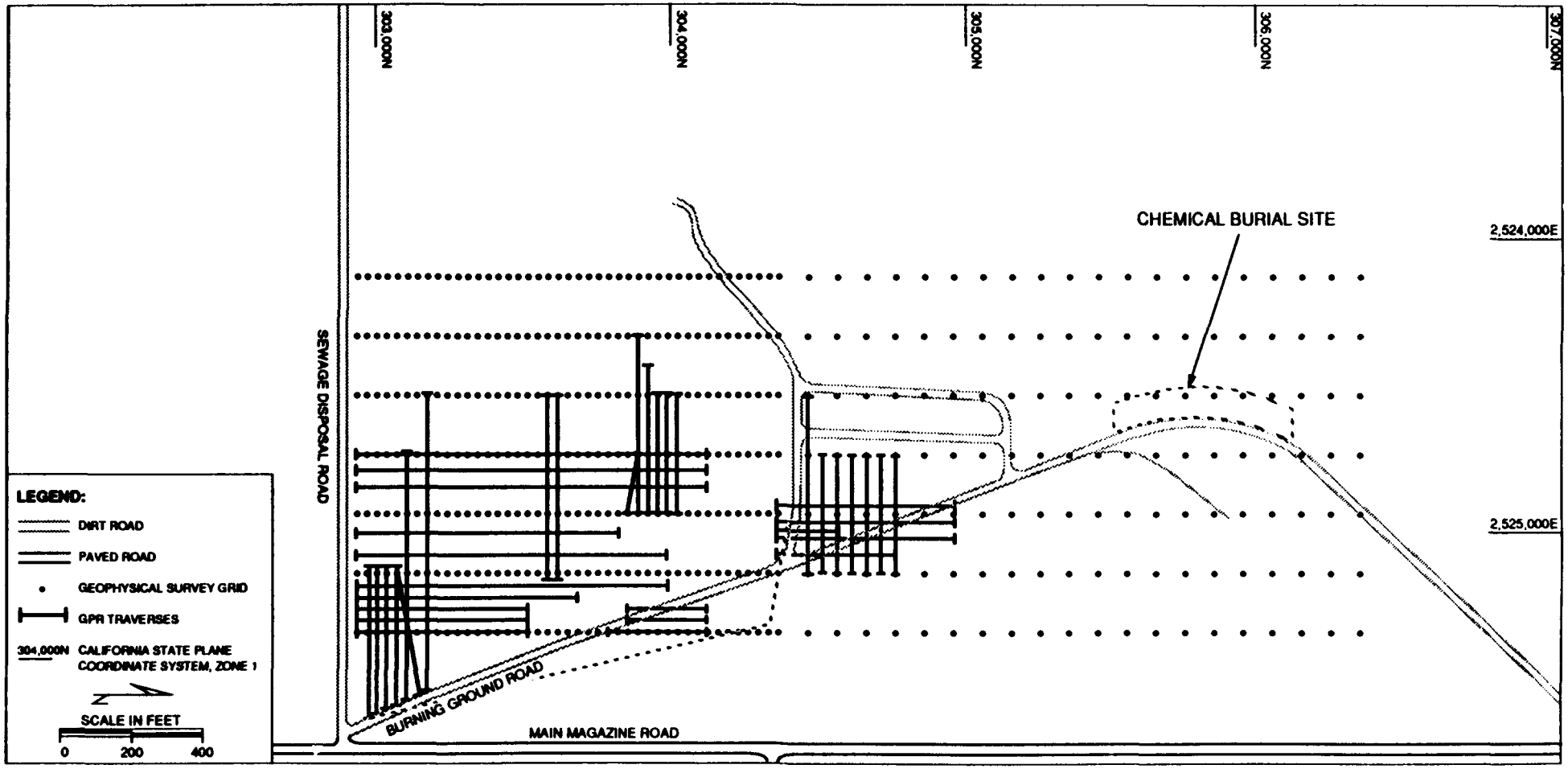
SIERRA ARMY DEPOT
GEOPHYSICAL SURVEY GRID:
ABANDONED LANDFILL /CHEMICAL BURIAL SITE /CONSTRUCTION DEBRIS LANDFILL

FIGURE 4-3



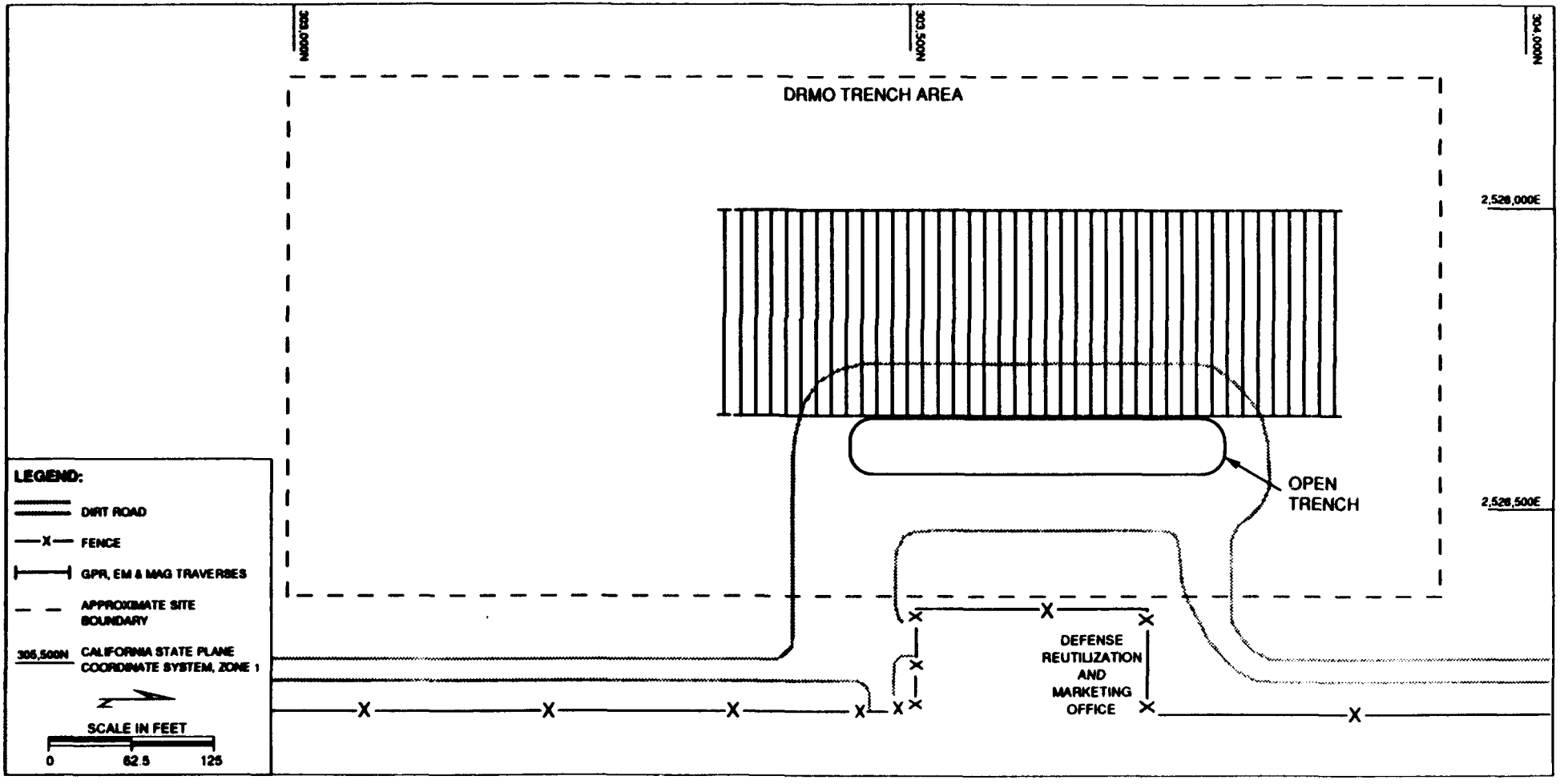
SIERRA ARMY DEPOT
GEOPHYSICAL TRAVERSE LOCATIONS:
CHEMICAL BURIAL SITE

FIGURE 4-4



SIERRA ARMY DEPOT
GEOPHYSICAL TRAVERSE LOCATIONS:
ABANDONED LANDFILL /CONSTRUCTION DEBRIS LANDFILL

FIGURE 4-5



SIERRA ARMY DEPOT
GEOPHYSICAL TRAVERSE LOCATIONS:
DRMO TRENCH AREA

FIGURE 4-6

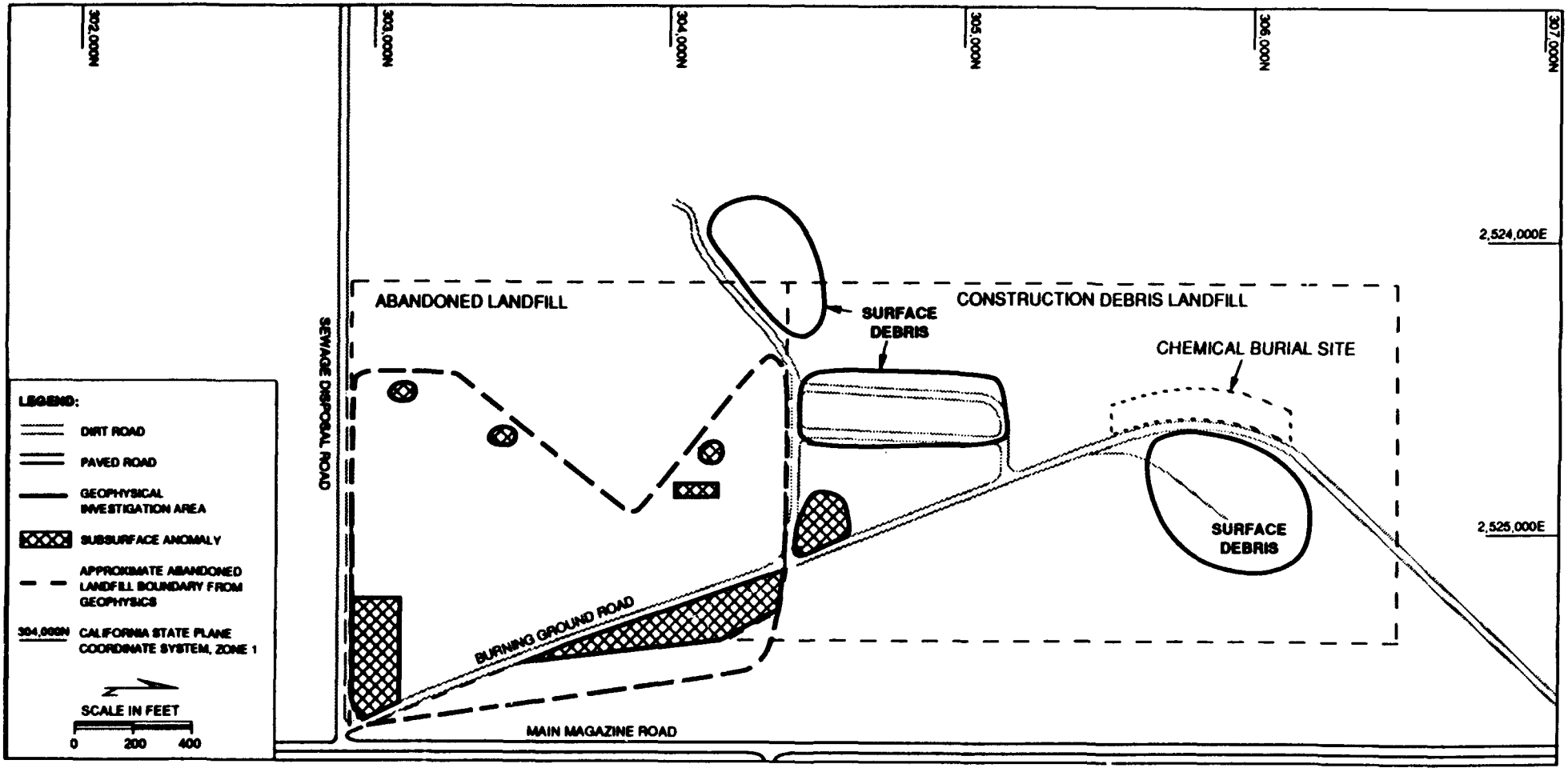
Six test pits were selected based on historical data and 18 were selected based on geophysical data (Figures 4-7 through 4-9). Table 4-3 summarizes the test pit excavation program.

Prior to test pit excavation, the immediate area was scraped to minimize the possibility of personnel or equipment coming into contact with UXO. Surface scraping was performed using a backhoe equipped with a 5.5-foot-wide shovel. Surface scrapes were approximately 30 feet by 5.5 feet by 0.5 feet. Test pits were dug with a 30-inch-wide bucket and were between 12 and 48 feet long (Table 4-3). Test pits were excavated to a depth of 5 feet or until native soil was encountered. At most locations, native soil was encountered within the first 24 inches (Table 4-3). In these cases excavation continued to a depth of 5 feet. Analytical samples were collected from the bottom of test pits at a depth of 5 feet below the ground surface. These sample locations were surveyed and coincided with soil boring locations. All test pits were logged, backfilled, and staked within 24 hours of excavation.

Eleven test pits were excavated at the Abandoned Landfill (Figure 4-8). All 11 test pits were excavated to uncover and identify the sources of geophysical anomalies detected during the geophysical survey (Table 4-3). Four pits were sampled for chemical analysis at a depth of 5 feet below ground surface. The remaining seven test pits were logged to physically characterize the landfill, and then backfilled.

Six test pits were excavated at the Chemical Burial Site/Construction Debris Landfill (Figure 4-8). The test pit locations were selected on the basis of a combination of geophysical and historical data (Table 4-3). Three of the six test pits were sampled at a depth of 5 feet below ground surface.

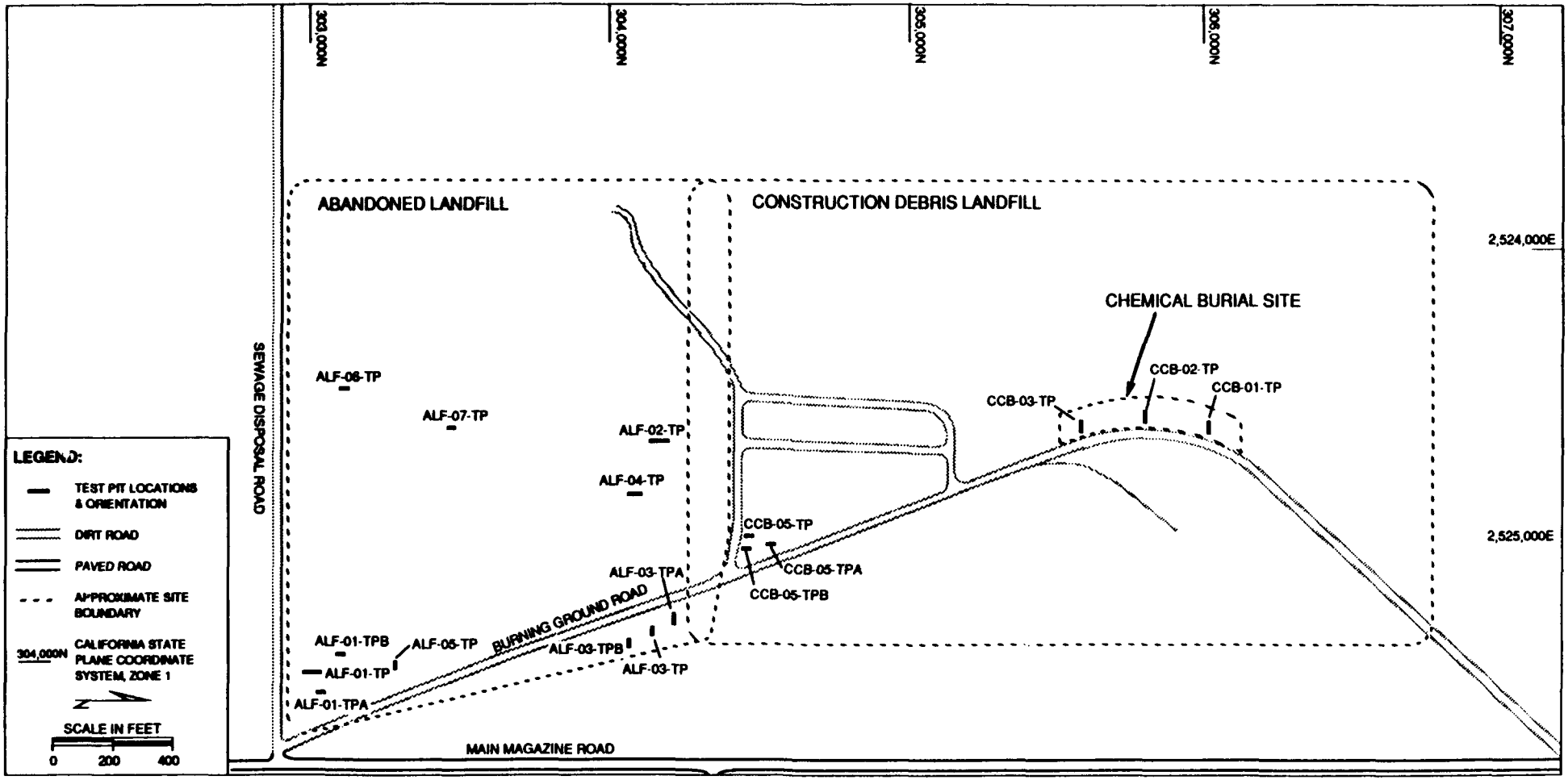
Seven test pits were excavated at the DRMO Trench Area (Figure 4-9). Three test pits were sampled for chemical analysis at a depth of 5 feet below ground surface. The test pit locations were selected on the basis of a combination of geophysical and historical data.



SIERRA ARMY DEPOT

GEOPHYSICAL ANOMALY LOCATIONS:
ABANDONED LANDFILL/CONSTRUCTION DEBRIS LANDFILL/CHEMICAL BURIAL SITE

FIGURE 4-7

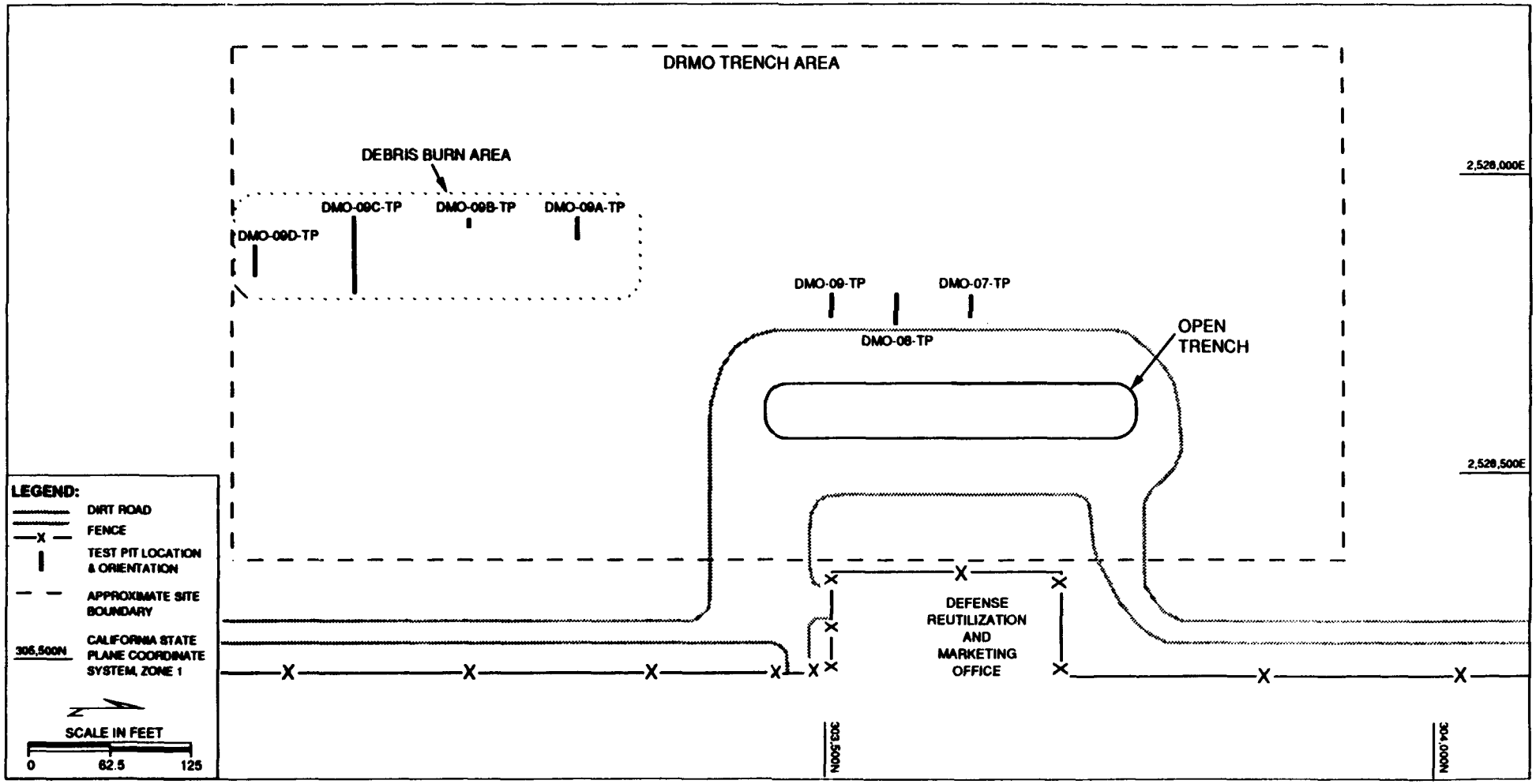


SIERRA ARMY DEPOT

TEST PIT LOCATIONS:

ABANDONED LANDFILL/CHEMICAL BURIAL SITE/CONSTRUCTION DEBRIS LANDFILL

FIGURE 4-8



SIERRA ARMY DEPOT
TEST PIT LOCATIONS: DRMO TRENCH AREA

FIGURE 4-9

TABLE 4-3

LOCATION AND DIMENSIONS OF TEST PITS
SIERRA ARMY DEPOT

Test Pit Area	Test Pit Location	Coordinates[1]	Dimensions	Sampled	Depth to Natural Soil	Condition/ Status
Abandoned Landfill	1. ALF 01 SB: 317.0 ft. west of Main Magazine Rd. along Sewage Disposal Rd. and 130.0 ft. north of Sewage Disposal Rd.	E: 2,525,436 N: 303,009	33.7 feet long; 5.0 feet deep.	Sample taken at 5.0 foot interval	0.5 ft.	Backfilled and Soil Boring
	2. ALF 01 A: 58.0 ft. east and 19.0 ft. north of ALF 01 SB.	NA	15.0 feet long; 10.0 feet deep.	NA	0.5 ft.	Backfilled
	3. ALF 01 B: 58.0 ft. west and 57.0 ft. north of ALF 01 SB.	NA	15.0 feet long; 8.0 feet deep.	NA	0.5 ft.	Backfilled
	4. ALF 02 SB: 479.0 ft. west of intersection of Burning Ground Rd. and first access left off of Burning Ground Rd. and 272.0 ft. due south of Access Rd.	E: 2,524,645 N: 304,147	40.8 feet long; 7.0 feet deep.	Sample taken at 5.0 foot interval	2.0 ft.	Backfilled and Soil Boring
	5. ALF 03 SB: 295.0 ft. south-south-east of intersection of Access Rd. and Burning Ground Rd. and 43.0 ft. east of Burning Ground Rd.	E: 2,525,284 N: 304,141	19.6 feet long; 9.0 feet deep.	Sample taken at 5.0 foot interval	9.0 ft.	Backfilled and Soil Boring
	6. ALF 03 N: 76.0 ft. north of ALF 03 SB and 43.0 ft. east of Burning Ground Rd.	NA	33.0 feet long; 9.0 feet deep.	NA	6.5 ft.	Backfilled
	7. ALF 03 S: 80.0 ft. south of ALF 03 SB and 42.0 ft. east of Burning Ground Rd.	NA	28.0 feet long; 9.0 feet deep.	NA	6.5 ft.	Backfilled

TABLE 4-3 (Continued)

LOCATION AND DIMENSIONS OF TEST PITS
SIERRA ARMY DEPOT

Test Pit Area		Test Pit Location	Coordinates[1]	Dimensions	Sampled	Depth to Natural Soil	Condition/ Status
	8.	ALF 04 SB: 337.0 ft. west of Burning Ground Rd. along Access Rd. and 332.0 ft. south of Access Rd.	E: 2,524,806 N: 304,077	25.6 feet long; 6.0 feet deep.	Sample taken at 5.0 foot interval	0 ft.	Backfilled and Soil Boring
	9.	ALF 5: 434.0 ft. north-northwest of "T" of intersection of Burning Ground Rd. and 75.0 ft. west of Burning Ground Rd.	NA	18.0 feet long; 4.5 feet deep.	NA	0 ft.	Backfilled
	10.	ALF 6: 1,100.0 ft. west of "Y" of intersection of Burning Ground Rd. and Sewage Disposal Rd.; 260.0 ft. north of Sewage Disposal Rd. and 98.0 ft. east of geophysical grid stakes (400, 240) and (400, 280).	NA	12.0 feet long; 7.0 feet deep.	NA	6.0 ft.	Backfilled
	11.	ALF 7: 900.0 ft. west of "Y" of intersection as above; 600.0 ft. north of Sewage Disposal Rd. 10.0 ft. east of geophysical grid stake (600, 640) and 33.0 ft. north of stake (600, 600).	NA	12.0 feet long; 6.5 feet deep.	NA	0 ft.	Backfilled
Chemical Burial Site	1.	CCB 01 SB: 159.0 ft. south-south-west of Mineral Waste Area Operational Requirements sign (read from north) and 57.0 ft. west of Burning Ground Rd.	E: 2,524,617 N: 305,939	29.7 feet long; 6.5 feet deep.	Sample taken at 5.0 foot interval	3.5 ft.	Backfilled and Soil Boring
	2.	CCB 02 SB: 161.0 ft. south of CCB 01 SB and 62.0 ft. west of Burning Ground Rd.	E: 2,524,598 N: 305,781	30.9 feet long; 6.0 feet deep.	Sample taken at 5.0 foot interval	1.0 ft.	Backfilled and Soil Boring

TABLE 4-3 (Continued)

LOCATION AND DIMENSIONS OF TEST PITS
SIERRA ARMY DEPOT

Test Pit Area		Test Pit Location	Coordinates[1]	Dimensions	Sampled	Depth to Natural Soil	Condition/ Status
	3.	CCB 03 SB: 184.0 ft. south of CCB 02 SB and 42.0 ft. west of Burning Ground Rd.	E: 2,524,632 N: 305,599	25.5 feet long; 5.5 feet deep.	Sample taken at 5.0 foot interval	0.5 ft.	Backfilled and Soil Boring
Construction Debris Landfill	1.	CCB 05 SB: 149.0 ft. west of intersection of Burning Ground Rd. and Access Rd. and 23.0 ft. north of Access Rd. in open field	E: 2,524,982 N: 304,451	18.0 feet long; 6.5 feet deep.	Sample taken at 5.0 foot interval	1.5 ft.	Backfilled and Soil Boring
	2.	CCB 05 A: 68.0 ft. north and approximately 10 ft. east of CCB 05 SB.	NA	15.0 feet long; 5.0 feet deep.	NA	1.5 ft.	Backfilled
	3.	CCB 05 B: 39.0 ft. east of CCB 05 SB.	NA	15.0 feet long; 9.5 feet deep.	NA	1.5 ft.	Backfilled
DRMO Trench Area	1.	DMO 07 SB: 64.0 ft. north and 3.0 ft. west of DMO 08 SB.	E: 2,528,111 N: 303,616	12.0 feet long; 5.0 feet deep.	Sample taken at 5.0 foot interval	0 ft.	Backfilled and Soil Boring
	2.	DMO 08 SB: 57.0 ft. north of DMO 09 SB.	E: 2,528,120 N: 303,558	21.8 feet long; 5.7 feet deep.	Sample taken at 5.0 foot interval	0 ft.	Backfilled and Soil Boring
	3.	DMO 09 SB: 100.0 ft. west of center of south end of trench	E: 2,528,115 N: 303,499	17.7 feet long; 5.9 feet deep.	Sample taken at 5.0 foot interval	4.0 ft.	Backfilled and Soil Boring
	4.	DMO 9A: 184.0 ft. south and 61.0 ft. west of DMO 09 SB.	NA	12.0 feet long; 6.0 feet deep.	NA	0.5 ft.	Backfilled
	5.	DMO 9B: 78.0 ft. south of test pit "A".	NA	6.0 feet long; 3.0 feet deep.	NA	0.5 ft.	Backfilled

TABLE 4-3 (Continued)

LOCATION AND DIMENSIONS OF TEST PITS
SIERRA ARMY DEPOT

Test Pit Area	Test Pit Location	Coordinates[1]	Dimensions	Sampled	Depth to Natural Soil	Condition/ Status
	6. DMO 9C: 85.0 ft. south of test pit "B".	NA	48.0 feet long; 6.0 feet deep.	NA	0.5 ft.	Backfilled
	7. DMO 9D: 73.0 ft. south and 21.0 ft. east of test pit "C".	NA	18.0 feet long; 6.0 feet deep.	NA	0.5 ft.	Backfilled

[1] California State Plane Coordinate System

NA - Not Applicable

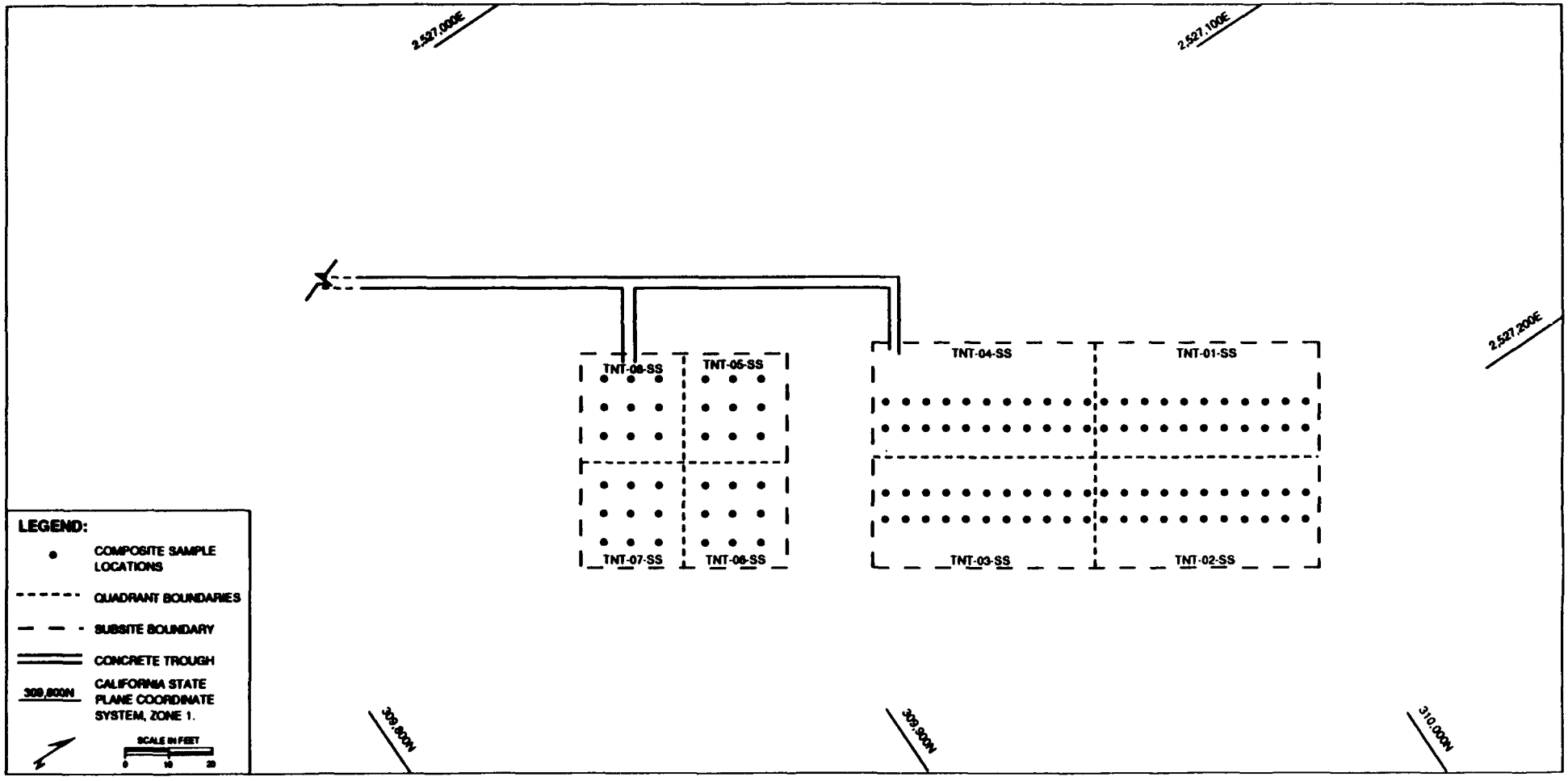
4.5 SURFACE SOIL AND SEPTIC TANK SAMPLING - TNT LEACHING BEDS AREA

Composite surface soil samples were collected from each of the four quadrants located within the two TNT Leaching Beds to characterize the surface soil contamination (Figure 4-10). Analytical parameters are presented on Table 4-4. Twenty subsamples, approximately 150 cubic centimeters (cc) each, were collected from each of the four quadrants of the northern leaching bed at the nodes of a 40-foot-by-6-foot grid. Nine subsamples, approximately 200 cc each, were collected from the southern leaching bed at the nodes of a 12.5-foot-by-12.5-foot grid. Each subsample was taken approximately 2 feet and 4 feet apart in the northern and southern leaching bed, respectively. Grid orientation was biased toward areas displaying visual contamination, which was typically concentrated in the lower portions of the leaching beds (Figure 4-10). Soil samples were mixed in a stainless steel bowl with stainless steel spoons. The homogenized sample mixture was placed into appropriate sample containers and stored as per QA requirements. One duplicate sample was also collected. Sampling implements were decontaminated between each sampling event as described in Section 4.13, Equipment Decontamination Procedures.

The two septic tanks located in the TNT Leaching Beds Area were inspected and found to be empty. No samples were collected.

4.6 SOIL BORINGS AND SUBSURFACE SOIL SAMPLING

Thirty-six soil borings were drilled during the Phase I RI to characterize SIAD contaminant distribution, physical soil properties, soil chemistry, and stratigraphy. Thirty shallow soil borings were drilled to the water table (ranging from 50 to 90 feet below grade) at the five Phase I RI sites. Six deep soil borings were drilled to 250 feet below grade at locations throughout SIAD. Soil boring installation and sampling procedures followed the SIAD Sampling Design Plan (JMM, 1990a). Table 4-5 and 4-6 present the chemical analysis schedule, soil boring locations, and depths. All boring logs are presented in Appendix F.



SIERRA ARMY DEPOT
SURFACE SOIL COMPOSITE SAMPLING LOCATIONS:
TNT LEACHING BEDS SUBSITE

FIGURE 4-10

TABLE 4-4

SURFACE SOIL SAMPLING AND ANALYSIS SCHEDULE
SIERRA ARMY DEPOT

Site ID	TTLC Metals[1]	Explosives[2]	STLC Metals[3]
TNT-1-SS	X	X	X
TNT-2-SS	X	X	X
TNT-3-SS	X	X	X
TNT-4-SS	X	X	X
TNT-5-SS	X	X	X
TNT-6-SS	X	X	X
TNT-7-SS	X	X	X
TNT-8-SS	X	X	X

(1) California total threshold limit concentration (TTLC) metals: Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Cobalt, Copper, Fluoride Salts, Lead, Mercury, Molydenum, Nickel, Selenium, Silver, Thallium, Vanadium, Zinc.

(2) 2,4-Dinitrotoluene, 2,4,6-Trinitrotoluene (TNT), 1,3,5-Trinitrobenzene, Cyclotetramethylenetera Aitramine (Hmx or HMX), 2,6-Dinitrotoluene, Tetryl, Hexahydro 1,3,4-Triazine (RDX).

(3) California soluble threshold limit concentration (STLC) metals using the waste extraction test (specific analytes, not to exceed 8 metals, are dependent on results of TTLC testing).

TABLE 4-5

SUMMARY OF SOIL ANALYSES IN SOIL BORINGS
SIERRA ARMY DEPOT

Site ID	Number of Samples Analyzed										
	PP Metals[1]	CN	Phenols	Asb	TTLC[2]	Geotechnical Parameters	VOC	BNA	PEST/ PCB	PCDD/ PCDF	Explosives[3]
ALF-1-SB	14	14	14	4		2	14	14	14	1	
ALF-2-SB	13	13	13	4		2	13	13	13	1	
ALF-3-SB	13	13	13	4		2	13	13	13	1	
ALF-4-SB	13	13	13	4		0	13	13	13	1	
CCB-1-SB	12	12	12			1	12	12	12	1	
CCB-2-SB	12	12	12			2	12	12	12	1	
CCB-3-SB	13	13	13			1	13	13	13	1	
CCB-4-SB	14	14	14			1	14	14	14	1	
CCB-5-SB	10	10	10			1	10	10	10	1	
DMO-6-SB					14*	2	14	14	14		
DMO-7-SB					13*	1	13	13	13		
DMO-8-SB					15*	2	15	15	15		
DMO-9-SB					14*	2	14	14	14		
DMO-10-SB					13*	1	13	13	13		
DMO-11-SB					14*	1	14	14	14		
DMO-12-SB					15*	1	15	15	15		
DMO-13-SB					15*	1	15	15	15		
DSB-1						7					
DSB-2					3	8					
DSB-3					3	5					
DSB-4						10					
DSB-5					4	10					
DSB-6						8					
TNT-7-SB	11					1	5				11
TNT-8-SB	11					1	5				11
TNT-9-SB	11					1	5				11
TNT-10-SB	10					1	5				10

TABLE 4-5 (Continued)

SUMMARY OF SOIL ANALYSES IN SOIL BORINGS
SIERRA ARMY DEPOT

Site ID	Number of Samples Analyzed										
	PP Metals[1]	CN	Phenols	Asb	TTLC[2]	Geotechnical Parameters	VOC	BNA	PEST/ PCB	PCDD/ PCDF	Explosives[3]
TNT-11-SB	10					1	5				10
TNT-12-SB	10					1	5				10
TNT-13-SB	10					1	4				10
TNT-14-SB	10					1	4				10
TNT-15-SB	10					1	4				10
TNT-16-SB	10					1	4				10
TNT-17-SB	10					1	4				10
TNT-18-SB	10					1	5				10
TNT-19-SB	10					1	5				10
TOTAL	247	114	114	16	123	84	287	227	227	9	133

* Hexavalent Chromium for 5-foot sample only.

(1) Antimony, Arsenic, Beryllium, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Silver, Thallium, Zinc.

(2) TTLC metals include: Antimony, Arsenic, Barium, Beryllium, Cadmium, Chromium, Cobalt, Copper, Fluoride Salts, Lead, Mercury, Molydenum, Nickel, Selenium, Silver, Thallium, Vanadium, Zinc.

TTLC metals include all Priority Pollutant metals. WET analyses were performed to obtain soluble concentrations for all metals with total concentrations greater than the STLC.

(3) 2,4-Dinitrotoluene, 2,4,6-Trinitrotoluene (TNT), 1,3,5-Trinitrobenzene, Cyclotetramethylenetera Aitramine (Hmx), 2,6-Dinitrotoluene, Tetryl, Hexahydro-1, 3,4-Triazime (RDX).

TABLE 4-6

SUMMARY OF SOIL BORING
DEPTHS, SAMPLES AND MATERIALS
SIERRA ARMY DEPOT

Site Boring No.	Location[1] (Coordinates) E	 N	Boring Depths (Ft)	Number of Analytical Samples Obtained	Number of Geotech Samples	Cement Grout (ft)
TNT Leaching Beds						
TNT-7-SB	2,525,945	309,486	55	11	1	55
TNT-8-SB	2,526,071	309,448	55	11	1	55
TNT-9-SB	2,526,126	309,474	55	11	1	55
TNT-10-SB	2,526,200	309,503	50	10	1	50
TNT-11-SB	2,526,163	309,590	50	10	1	50
TNT-12-SB	2,527,166	310,004	50	10	1	50
TNT-13-SB	2,527,192	309,990	50	10	1	50
TNT-14-SB	2,527,167	309,947	51	10	1	51
TNT-15-SB	2,527,143	309,960	50	10	1	50
TNT-16-SB	2,527,109	309,913	50	10	1	50
TNT-17-SB	2,527,129	309,898	50	10	1	50
TNT-18-SB	2,527,121	309,882	50	10	1	50
TNT-19-SB	2,527,100	309,896	50	10	1	50
DRMO						
DMO-6-SB	2,528,106	303,659	95	14	2	95
DMO-7-SB	2,528,111	303,616	90	13	1	90
DMO-8-SB	2,528,120	303,553	95	15	2	95
DMO-9-SB	2,528,115	303,499	90	14	2	90
DMO-10-SB	2,528,232	303,663	90	13	1	90
DMO-11-SB	2,528,235	303,623	90	14	1	90
DMO-12-SB	2,528,271	303,693	95	15	1	95
DMO-13-SB	2,528,287	303,618	95	15	1	95
Abandoned Landfill						
ALF-1-SB	2,525,436	303,009	95	14	2	95
ALF-2-SB	2,524,645	304,147	89	13	2	89
ALF-3-SB	2,525,284	304,141	90	13	2	90
ALF-4-SB	2,524,806	304,077	85	13	0	85
Construction Debris Landfill and Chemical Burial Site						
CCB-1-SB	2,524,617	305,939	80	12	1	80
CCB-2-SB	2,524,598	305,781	85	12	2	85
CCB-3-SB	2,524,632	305,599	88	13	1	88
CCB-4-SB	2,524,660	305,029	89	14	1	89
CCB-5-SB	2,524,982	304,451	70	10	1	70

TABLE 4-6 (Continued)

SUMMARY OF SOIL BORING
DEPTHS, SAMPLES AND MATERIALS
SIERRA ARMY DEPOT

Site Boring No.	Location[1] (Coordinates) E	N	Boring Depths (Ft)	Number of Analytical Samples Obtained	Number of Geotech Samples	Cement Grout (ft)
Additional Locations						
DSB-1	2,506,259	344,467	250	3	7	250
DSB-2	2,516,070	329,566	250	3	8	250
DSB-3	2,525,689	339,416	250	0	5	250
DSB-4	2,525,793	325,657	250	3	10	250
DSB-5	2,517,749	300,988	250	0	10	250
DSB-6	2,527,096	309,680	250	0	8	250
Totals			3,677	369	84	3,677

[1] California State Plane Coordinate System

Geotechnical sampling analyses are presented in Appendix G. Boring depths were based on first water encountered; therefore, total number of samples are different from what is listed in the Sampling Design Plan.

4.6.1 Abandoned Landfill

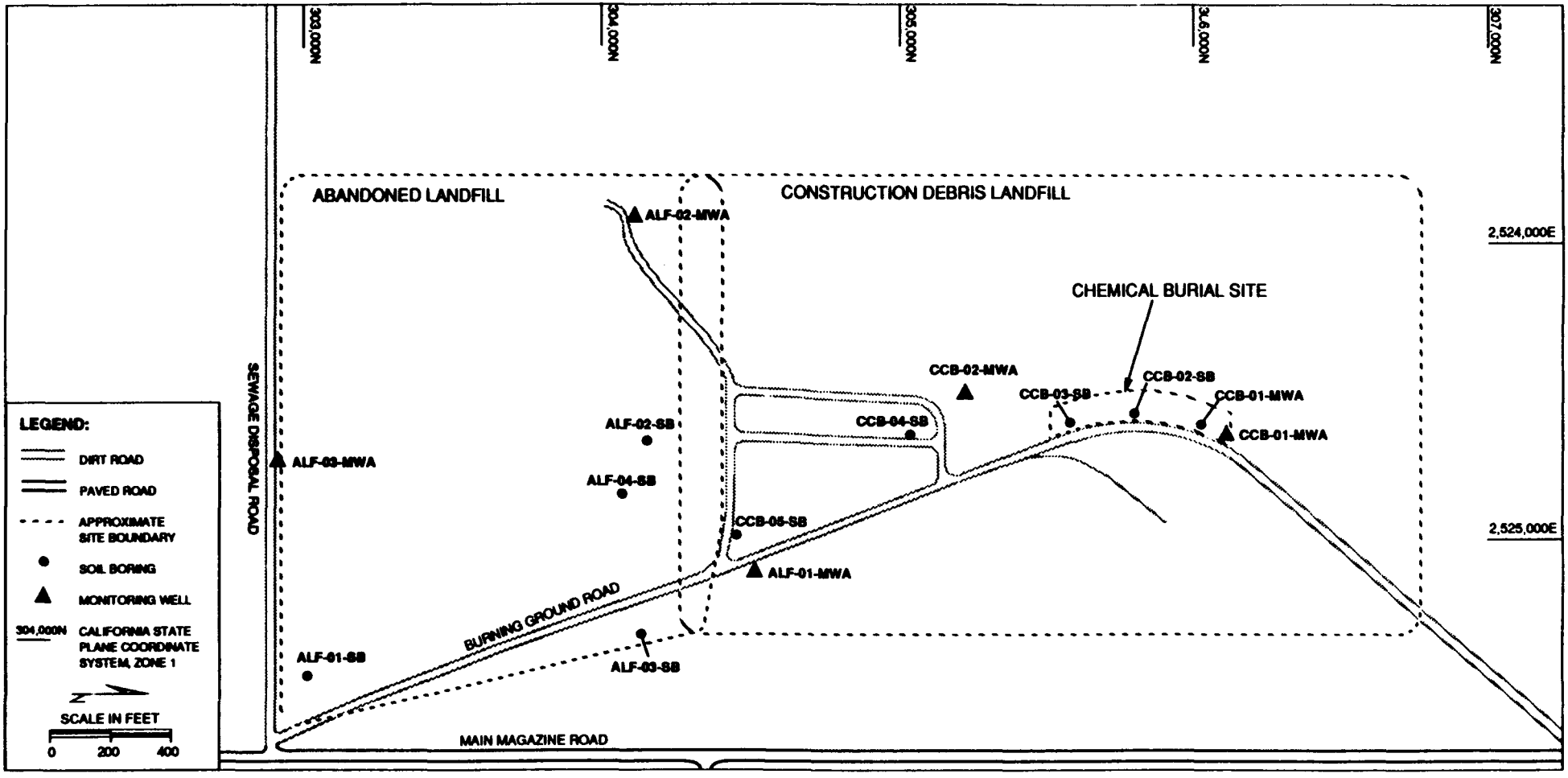
Four shallow HSA borings were drilled at the Abandoned Landfill (Figure 4-11). Soil borings were located in areas that registered geophysical anomalies. Each boring was drilled to the water table, located between 85 feet to 95 feet below grade in this area. The soil borings located within the boundaries of the Abandoned Landfill were cleared for UXO by EHS International. This was accomplished by excavating each boring site with a backhoe to a depth of 5 feet or until native soil was encountered (see Section 4.4). The excavations were logged and sampled prior to being backfilled.

4.6.2 Chemical Burial Site

Three shallow HSA borings were drilled in the Chemical Burial Site (Figure 4-11). All three borings were placed in a buried trench which had been identified from historical and geophysical data (Benioff, et al., 1988). Each soil boring was advanced to the water table which was from 79 feet to 89 feet below grade at this site.

4.6.3 Construction Debris Landfill

Two shallow HSA borings were drilled in the Construction Debris Landfill (Figure 4-11). Boring CCB-04-SB was located adjacent to an open trench partially filled with debris. Boring CCB-05-SB was located in the southeast corner of the Construction Debris Landfill in an area that registered geophysical responses above background levels. CCB-04-SB was drilled to the water table, about 89 feet below grade, while CCB-05-SB hit refusal at 70 feet below grade. CCB-05-SB was cleared for UXO by excavating a test pit to a depth of 5 feet.



SIERRA ARMY DEPOT

MONITORING WELL & SOIL BORING LOCATIONS:
ABANDONED LANDFILL/CHEMICAL BURIAL SITE/CONSTRUCTION DEBRIS LANDFILL

FIGURE 4-11

4.6.4 DRMO Trench Area

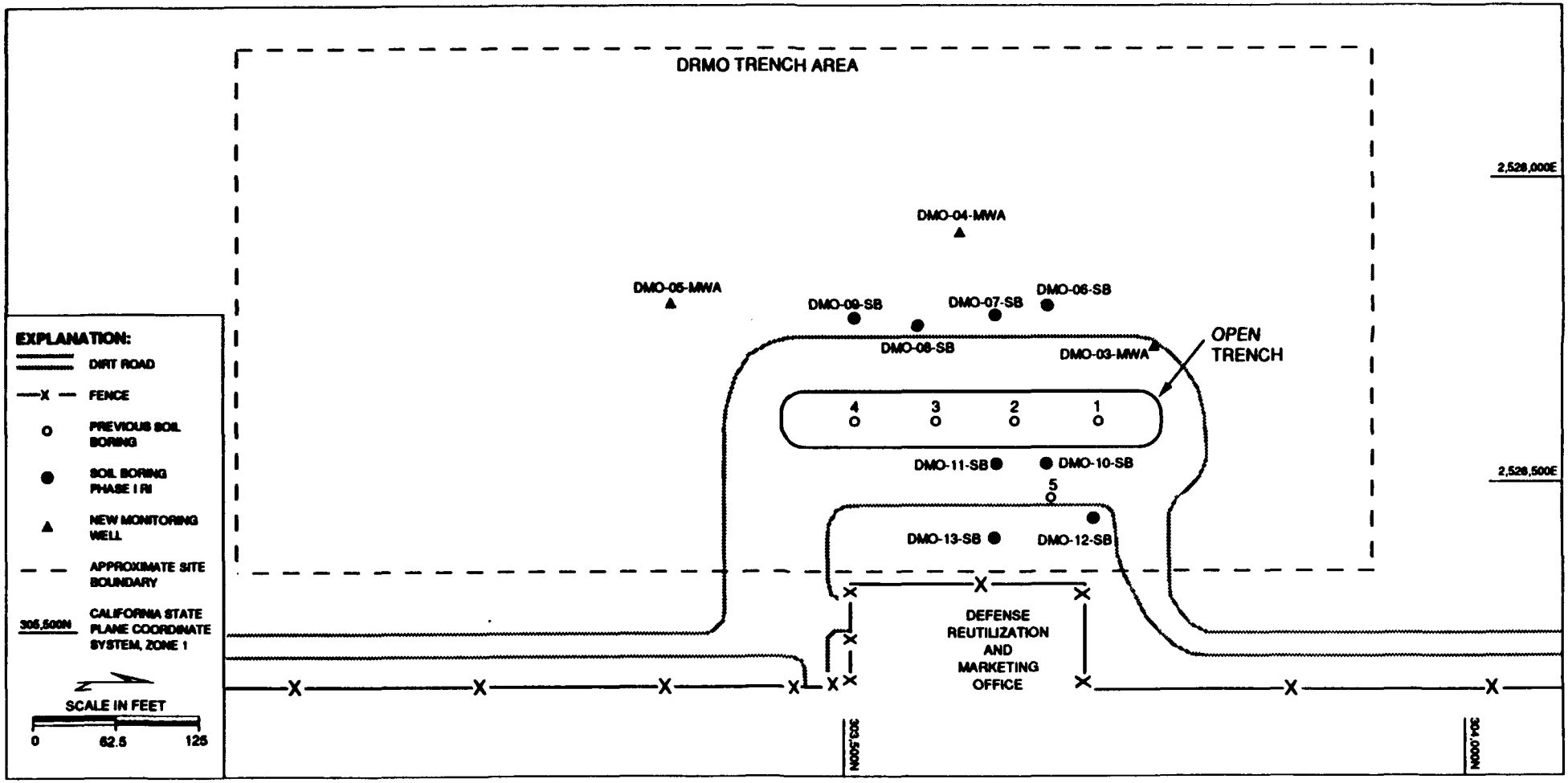
Eight HSA borings were drilled in the DRMO Trench Area (Figure 4-12). Criteria for determining the location of these borings were derived from historical data. Four borings, DMO-06-SB through DMO-09-SB, were located over the suspected location of a covered trench. These four borings were drilled at 50-foot intervals along the north trending axis of the suspected buried trench (Figure 4-12) located approximately 50 feet east of the open trench. Two borings, DMO-10-SB and DMO-11-SB, were located about 5 feet east of the open trench. The borings were drilled at an angle of 5 to 10 degrees in order to obtain samples below the open trench. The remaining borings DMO-12-SB and DMO-13-SB, were located in an area in which elevated concentrations of metals had been detected during a previous investigation (Benioff, et al., 1988). The borings are located immediately north and south of DMO-5-SB (Benioff, et al., 1988). Each of the borings was drilled to the water table, located approximately 90 to 100 feet below grade at this site.

4.6.5 TNT Leaching Beds Area

Thirteen HSA soil borings were drilled in the TNT Leaching Beds Area, eight in the TNT Leaching Beds Subsite (Figure 4-13), and five in the Vehicle Maintenance Area Subsite (Figure 4-14).

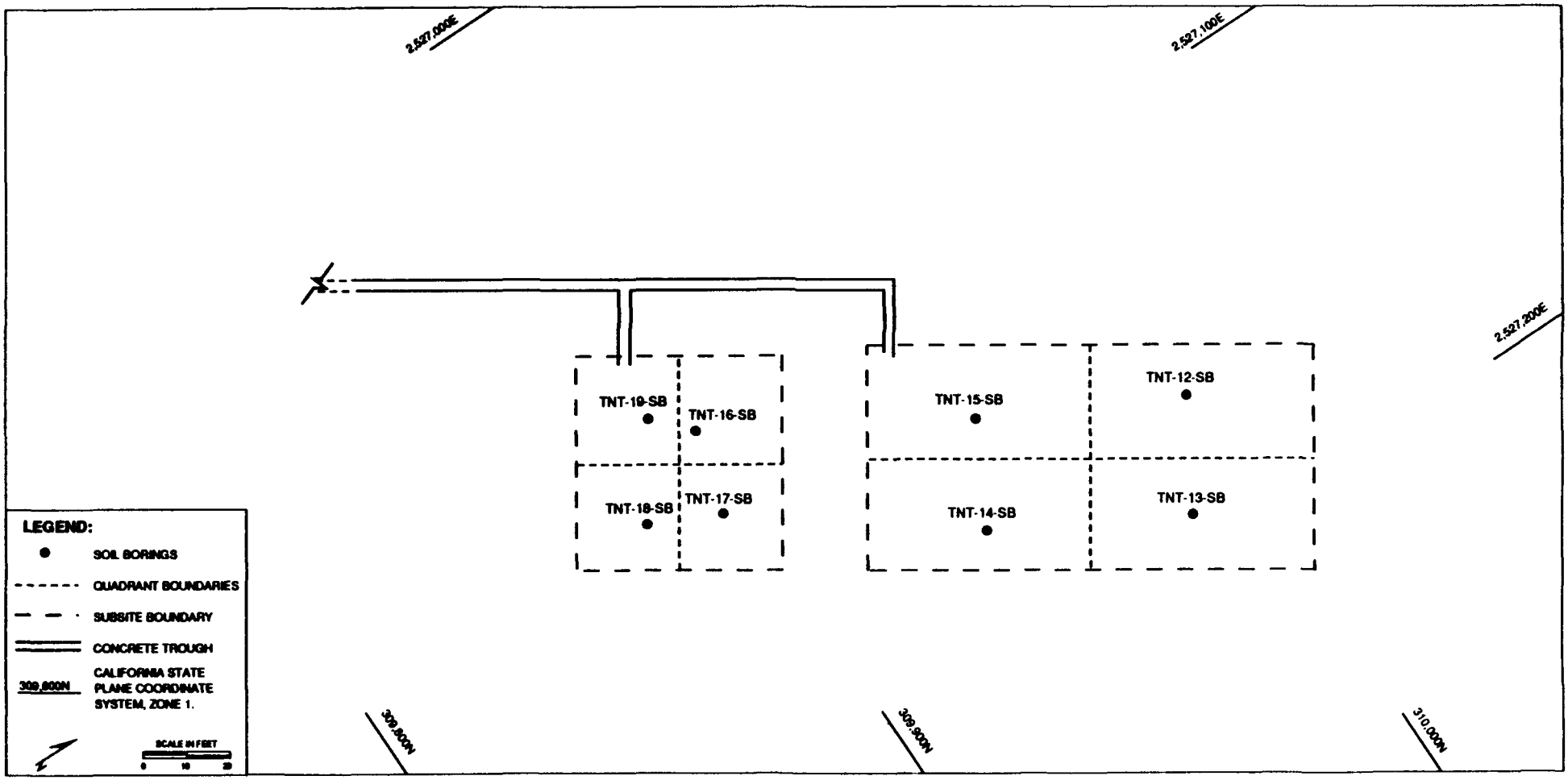
TNT Leaching Beds Area Subsite

Prior to drilling and sampling, each of the two leaching beds was divided into four quadrants (Figure 4-13). Soil borings were installed near the center of each quadrant for a total of eight borings. All borings were advanced to the water table, located approximately 50 to 55 feet below grade in this location.



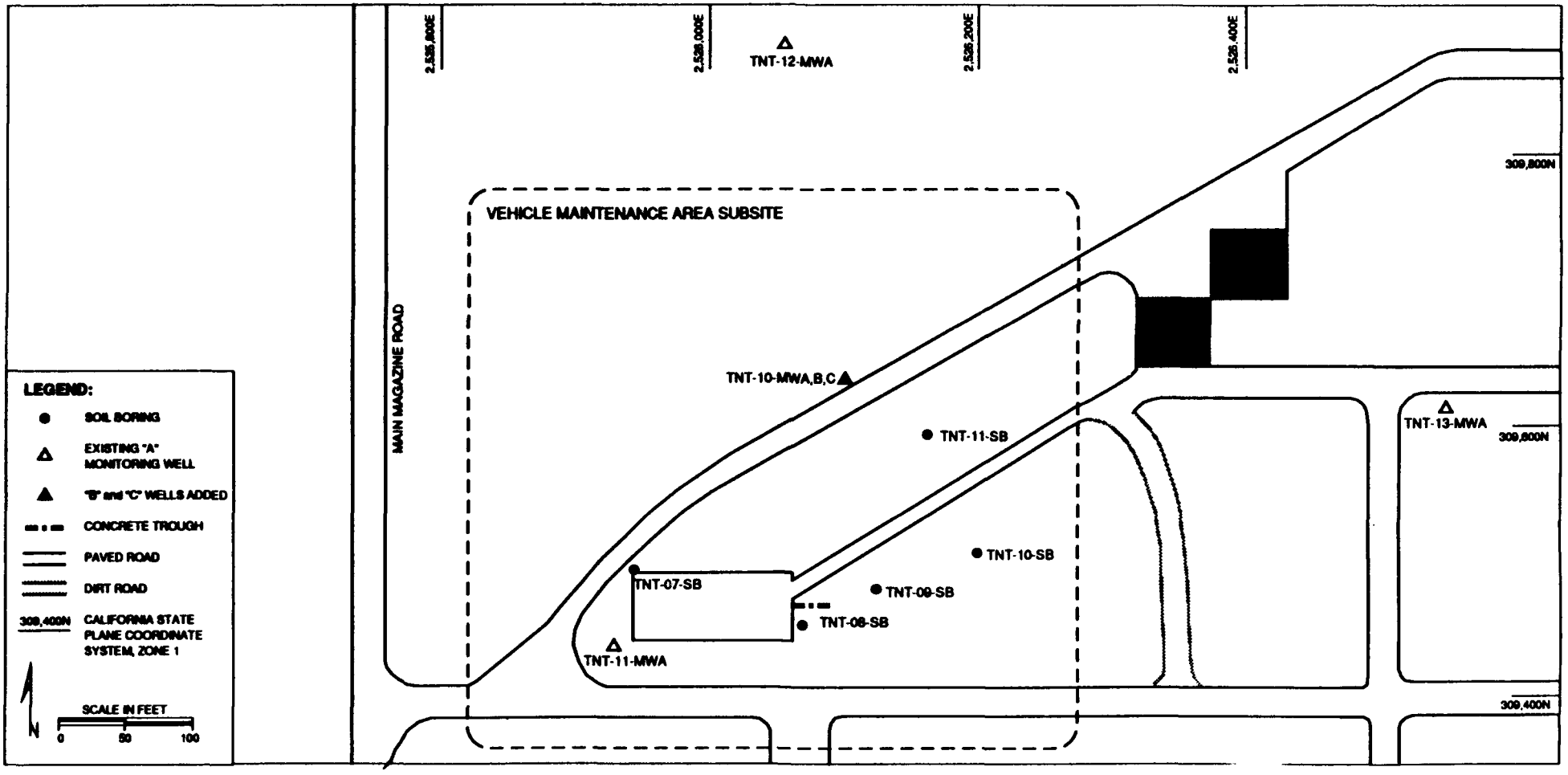
SIERRA ARMY DEPOT
MONITORING WELL AND SOIL BORING LOCATIONS:
DRMO TRENCH AREA

FIGURE 4-12



SIERRA ARMY DEPOT
SOIL BORINGS:
TNT LEACHING BEDS SUBSITE

FIGURE 4-13



SIERRA ARMY DEPOT
MONITORING WELL AND SOIL BORING LOCATIONS:
VEHICLE MAINTENANCE AREA SUBSITE

FIGURE 4-14

Vehicle Maintenance Subsite

Five soil borings were drilled and sampled at 5-foot intervals to the water table at the Vehicle Maintenance Area Subsite (Figure 4-14). The borings were located in an area where relatively high levels of TCE, chloroform, and carbon tetrachloride were detected during the soil gas survey. Borings TNT-07-SB and TNT-08-SB were located adjacent to the western and eastern edges, respectively, of the concrete pad of the former Vehicle Maintenance Building foundation. TNT-09-SB was positioned along a concrete trench connected to the east side of the concrete pad. It is suspected that solvents and other wastes from the Vehicle Maintenance Building may have been discharged to the trench and collected within a surface depression about 140 feet east of the building. TNT-10-SB was located in this surface depression. Boring TNT-11-SB was positioned between TNT-10-SB and TNT-10-MWA in an area where soil gas readings were relatively high. All borings extended to the water table, located 50 to 55 feet below grade.

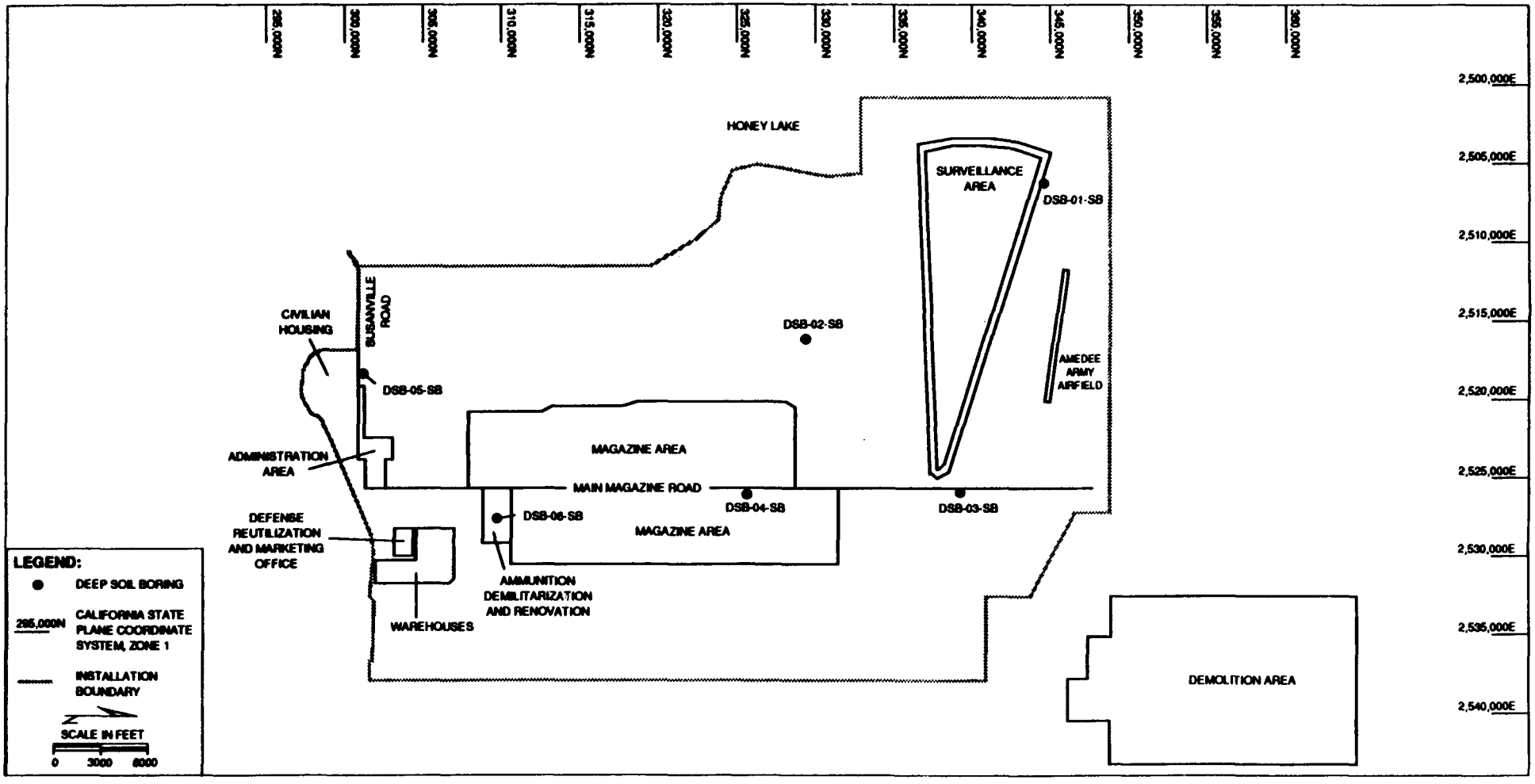
4.6.6 Deep Soil Borings

Six 250-foot-deep soil borings were drilled and continuously cored at six locations scattered throughout SIAD (Figure 4-15). These borings were placed in order to characterize the sediments underlying SIAD, and provide data necessary for hydrogeologic and contaminant fate evaluations.

When total depth was reached on each borehole, an electric log and caliper survey were performed by Welenco, Inc., of Reno, Nevada. A gamma ray log was also performed in borehole DSB-3. A detailed discussion of the techniques, quality assurance, interpretation, and summary of results is presented in Appendix H.

4.7 MONITORING WELL INSTALLATION

Eighteen monitoring wells and four piezometers were installed as part of the Phase I RI. Monitoring wells and piezometers were installed to determine the groundwater quality and hydrogeologic properties of the aquifer. Table 4-7 summarizes the monitoring well



SIERRA ARMY DEPOT
DEEP SOIL BORING LOCATIONS

FIGURE 4-15

TABLE 4-7

SUMMARY OF MONITORING WELL CONSTRUCTION[a]
SIERRA ARMY DEPOT

Site Well Number	Borehole Diameter (in)	Borehole Depth (ft)	Schedule 40 4" PVC Screen (interval/length)	Schedule 40 4" PVC Casing (interval/length)	Filter Pack (interval/thickness)	Bentonite Pellet Seal (interval/thickness)	Cement Grout (interval/thickness)
TNT Leaching Beds							
TNT-1-MWB[b,c]	11	103	100-90 ft/10 ft	90-0 ft/90 ft	103-85 ft/18 ft	85-80 ft/5 ft	80-0 ft/80 ft
TNT-1-MWC	12	147	138-128 ft/10 ft	128-0 ft/128 ft	138-123 ft/15 ft	123-118 ft/5 ft	118-0 ft/118 ft
TNT-2-MWB[b,c]	11	102	100-90 ft/10 ft	90-0 ft/90 ft	100-85 ft/15 ft	85-75 ft/10 ft	75-0 ft/75 ft
TNT-2-MWC	12	142	140-130 ft/10 ft	130-0 ft/130 ft	140-125 ft/15 ft	125/120 ft/5 ft	120-0 ft/120 ft
TNT-7-MWB	11	104	102-92 ft/10 ft	92-0 ft/92 ft	102-87 ft/15 ft	87-82 ft/5 ft	82-0 ft/82 ft
TNT-7-MWC	12	147	140-130 ft/10 ft	130-0 ft/130 ft	140-125 ft/15 ft	125-120 ft/5 ft	120-0 ft/120 ft
TNT-10-MWB	11	102	100-90 ft/10 ft	90-0 ft/90 ft	102-85 ft/17 ft	85-80 ft/5 ft	80-0 ft/80 ft
TNT-10-MWC	12	146	135-125 ft/10 ft	128-0 ft/128 ft	135-120 ft/15 ft	120-115 ft/5 ft	115-0 ft/115 ft
TNT-15-MWA	11	74	70-50 ft/20 ft	52-0 ft/52 ft	74-45.7 ft/24.3 ft	46-41 ft/5 ft	41-0 ft/41 ft
TNT-16-MWA	11	72	71-51 ft/20 ft	53-0 ft/53 ft	71-46.5 ft/25.5 ft	46.5-41.5 ft/5 ft	41.5-0 ft/41.5 ft
DRMO Trench Site							
DMO-3-MWA	11	109	108.7-88.7 ft/20 ft	90-0 ft/90 ft	109-82 ft/26.5 ft	82-77 ft/5 ft	77-0 ft/77 ft
DMO-4-MWA	11	109	108.7-88.7 ft/20 ft	90-0 ft/90 ft	109-83 ft/26 ft	83.0-78 ft/5 ft	78-0 ft/78 ft
DMO-5-MWA	11	110	109.7-89.7 ft/20 ft	91-0 ft/91 ft	110-83 ft/26 ft	83-77 ft/5 ft	77-0 ft/77 ft
Abandoned Landfill							
ALF-1-MWA	11	105	104.5-85.0 ft/20.0 ft	86-0 ft/86 ft	105-80 ft/25 ft	80-72 ft/8 ft	72-0 ft/72 ft
ALF-2-MWA	11	107	106.7-87.7 ft/20 ft	88-0 ft/88 ft	107-82 ft/25 ft	82-77 ft/5 ft	77-0 ft/77 ft
ALF-3-MWA	11	106	106-86 ft/20 ft	86-0 ft/86 ft	106-81 ft/25 ft	81-75.5 ft/5 ft	77.5/75.5 ft
Construction Debris Landfill/Chemical Burial Site							
CCB-1-MWA	11	91.5	91-71 ft/20 ft	71-0 ft/71 ft	91.5-65.5 ft/26 ft	65.5-60.2 ft/5 ft	60-0 ft/60 ft
CCB-2-MWA	11	104	103.7-83.7 ft/20 ft	83.7-0 ft/83.7 ft	104-77 ft/27 ft	77-72 ft/5 ft	72-0 ft/72 ft

TABLE 4-7 (Continued)

SUMMARY OF MONITORING WELL CONSTRUCTION[a]
SIERRA ARMY DEPOT

Site Well Number	Borehole Diameter (in)	Borehole Depth (ft)	Schedule 40 4" PVC Screen (interval/length)	Schedule 40 4" PVC Casing (interval/length)	Filter Pack (interval/thickness)	Bentonite Pellet Seal (interval/thickness)	Cement Grout (interval/thickness)
Additional Locations							
DSB-1-MWA	8	33	32-27 ft/5 ft*	27-0 ft/27 ft*	33-21 ft/12 ft	21-16 ft/5 ft	16-0 ft/16 ft
DSB-2-MWA	8	41.5	40-35 ft/5 ft*	35-0 ft/35 ft*	41.5-30 ft/10 ft	30-25 ft/5 ft	25-0 ft/25/ft
DSB-4-MWA	8	45	40-20 ft/20 ft*	20-0 ft/20 ft*	45-15 ft/25 ft	15-10 ft/5 ft	10-0 ft/10 ft
DSB-6-MWA	8	73	71-66 ft/5 ft*	66-0 ft/66 ft*	73-60 ft/13 ft	60-55 ft/5 ft	55-0 ft/55 ft

* - 2" Schedule 40 PVC
** - Bentonite Slurry
[a] - Interval/length measured from surface
[b] - Bentonite pellets (1') and slurry (4') were used to seal this well

installation program. Monitoring wells were installed according to procedures outlined in the SIAD Sampling Design Plan (JMM, 1990a). All well construction diagrams are presented in Appendix F.

4.7.1 Abandoned Landfill

Three monitoring wells, ALF-01-MWA, ALF-02-MWA, and ALF-03-MWA, were installed at the Abandoned Landfill (see Figure 4-11). These wells were located to intercept possible contaminants traveling downgradient or towards the Herlong potable supply wells. These wells were screened at the interface of the saturated and unsaturated zones.

4.7.2 Chemical Burial Site/Construction Debris Landfill

Two monitoring wells were installed at this site; one in the northern part of the Chemical Burial Site CCB-01-MWA, and one about 250 feet south of the Chemical Burial Site, CCB-02-MWA (see Figure 4-11). Both wells are located within the central portion of the Construction Debris Landfill. The wells were placed at these locations to monitor shallow groundwater beneath the Chemical Burial Site and Construction Debris Landfill and to intercept potential contaminants coming from the Chemical Burial Site. These monitoring wells were screened at the interface of the saturated and unsaturated zones.

4.7.3 DRMO Trench Area

Three monitoring wells, DMO-03-MWA, DMO-04-MWA, and DMO-05-MWA, were installed at this site (see Figure 4-12). DMO-03-MWA was placed at the north end of the trench. DMO-04-MWA is located west of the trench, between the trench and Honey Lake. It was positioned to intercept potential contaminants travelling from the trench toward Honey Lake. DMO-05-MWA is south of the trench area, between this area and Herlong potable supply wells numbers 2 and 8. This well is intended to intercept and monitor the presence of potential contaminants traveling from the DRMO Trench Area toward the potable supply wells. These monitoring wells were screened at the interface of the saturated and unsaturated zones.

4.7.4 TNT Leaching Beds Area

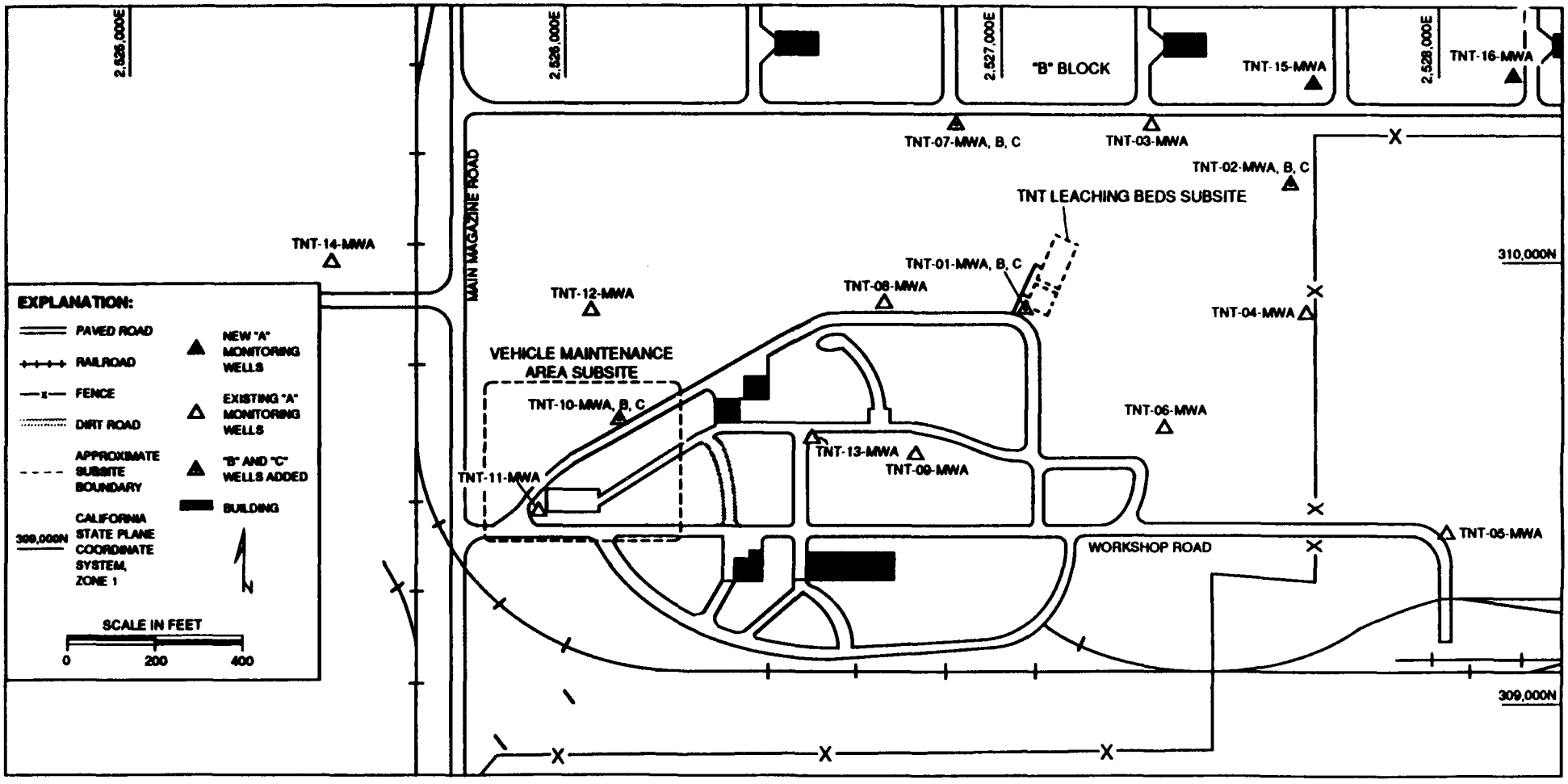
Ten monitoring wells were installed in the TNT Leaching Beds Area during this phase of work (Figure 4-16). Two wells, TNT-15-MWA and TNT-16-MWA, are water table wells that were installed north and northeast of the TNT Leaching Beds Area Subsite in order to monitor the migration of contaminants from the leaching beds. These monitoring wells were screened at the interface of the saturated and unsaturated zones.

The remaining eight wells are located appromately 10 and 20 feet from existing wells TNT-01-MWA, TNT-02-MWA, TNT-07-MWA, and TNT-10-MWA, to create a three-well cluster at each of these sites. Each well within a cluster is designated as being an "A", "B", or "C" zone well. "A" zone wells, previously installed by USAEHA (see Section 2.2), are water table wells and extend approximately 55 to 65 feet below ground surface. "B" zone wells extend approximately 100 to 105 feet below ground surface (approximately 40 feet below the water table) and are located approximately 10 feet from the "A" zone wells. "C" zone wells extend approximately 140 to 150 feet below grade (approximately 80 to 90 feet below the water table) and are located approximately 10 feet from "B" zone wells. The bottom 10 feet of each well in the cluster is screened. Screened intervals were selected after a stratigraphic evaluation was made of the continuous core from DSB-6-SB, which was also drilled in the TNT Leaching Beds Area. Monitoring well boreholes were logged from the drill cuttings.

Well clusters were installed to assess the potential for vertical contaminant migration. The assessment was made by sampling and performing step tests on the "B" and "C" zone wells while measuring aquifer response in up to three nearby wells (see Section 4.11).

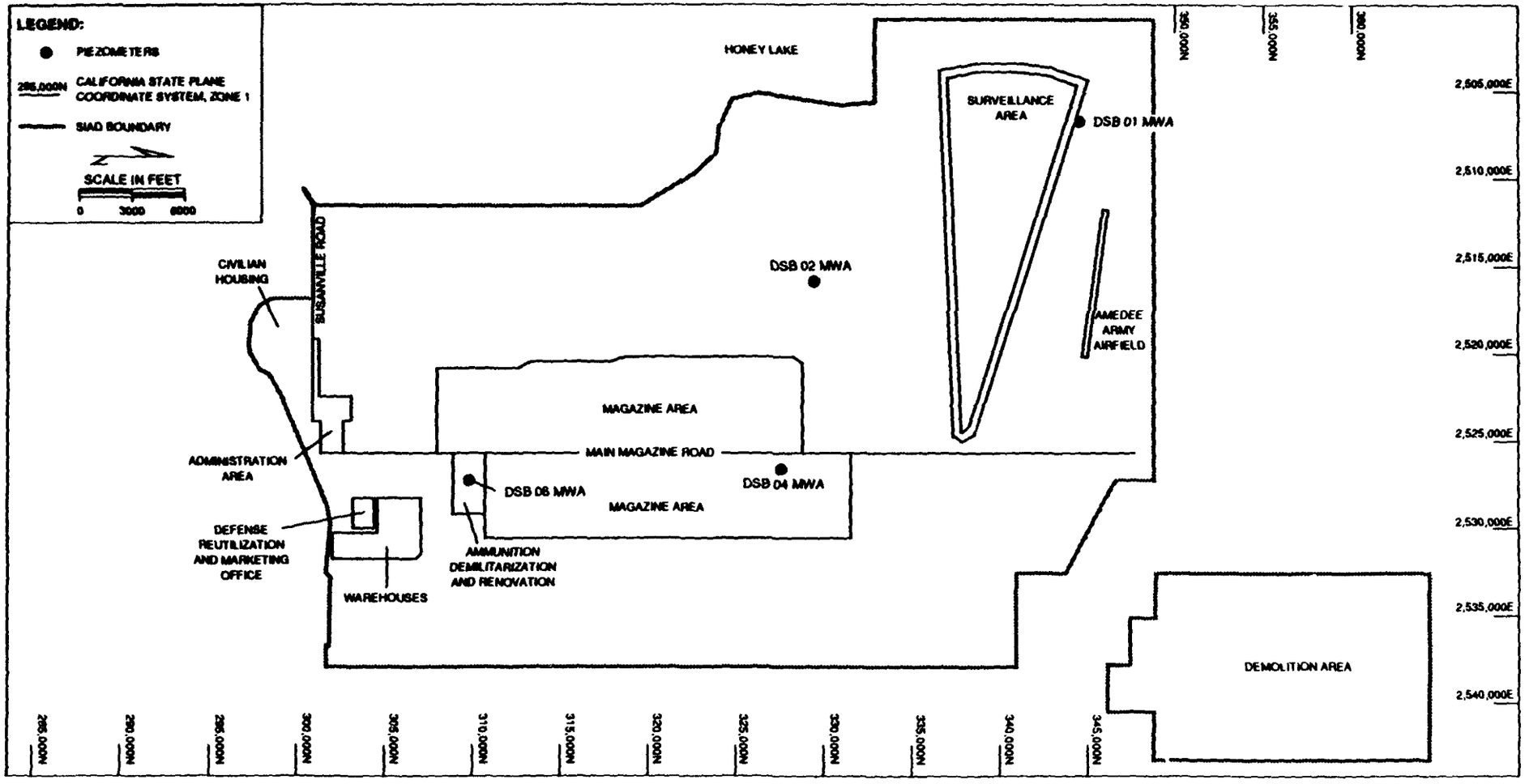
4.7.5 Piezometer and Background Well Locations

Four piezometers, DSB-01-MWA, DSB-02-MWA, DSB-04-MWA, and DSB-06-MWA (Figure 4-17), were installed approximately 10 feet from the deep soil borings DSB-01-SB, DSB-02-SB, DSB-04-SB, and DSB-06-SB, respectively (Figure 4-15). The purpose of the piezometers is to record water level data only. DSB-04-MWA was also used as a background water source. The piezometers have 5 feet of screen which is set approximately



SIERRA ARMY DEPOT
MONITORING WELLS:
TNT LEACHING BEDS AREA

FIGURE 4-16



SIERRA ARMY DEPOT
PIEZOMETER LOCATIONS

FIGURE 4-17

20 feet below the water table. DSB-04-MWA was constructed with 20 feet of screen, of which approximately 5 feet is above the water table.

4.8 WELL DEVELOPMENT

The purpose of well development is to assure communication between a well and the aquifer. Development of the monitoring wells was performed in accordance with procedures outlined in the SIAD Sampling Design Plan (JMM, 1990a). It is noted that additional volumes of water were removed during aquifer testing. Well development data is presented in Appendix F and Table 4-8.

4.9 GROUNDWATER SAMPLING

Groundwater samples were collected from 33 new and existing monitoring wells (15 2-inch wells and 18 4-inch wells) and three of the four potable supply wells. One of the potable supply wells, PSW-5, was not sampled because it was inoperative during both rounds of sampling. Sampling rounds were conducted in May and June 1990. The sampling and analysis schedule is presented in Table 4-9. Sampling procedures were performed in accordance with the SIAD Sampling Design Plan (JMM, 1990a). See Appendix I for field data.

DMO-3-MWA, DMO-5-MWA, TNT-08-MWA, TNT-09-MWA, TNT-12-MWA, and TNT-15-MWA were purged using a modified process because of slow recovery. These wells were either pumped or bailed dry and allowed to recover to at least 80 percent of static level. Each monitoring well was pumped dry a second time and allowed to recover to 80 percent before a groundwater sample was collected.

The potable supply wells PSW-2, PSW-8, and PSW-9 (Figure 4-18) were purged by running the submersible pumps installed in the wells until five well volumes had been discharged. Approximately 20,000 gallons of purge water for PSW-8 and PSW-9 and 35,000 gallons of purge water were discharged for PSW-2. Potable supply well purge water was used to fill the Herlong water storage tower or for SIAD irrigation. These wells were sampled from a

TABLE 4-8

SUMMARY OF WELL DEVELOPMENT
SIERRA ARMY DEPOT

Well No.	Development Date	Water Level 24 Hrs. Prior to Development (Ft. from TOC)	Water Lost During Filter Added During Drilling (Gals)	Water Added During Construction (Gals)	Water in Well Prior to Development (Gals)	Water In Saturated Annulus (Gals)	pH	Specific Conductance (umhos)	Screen Length (Ft.)	Volume Removed-Development (Gals)	Volume Removed Aquifer Test (Gals)	Pumping Rate (GPM)
ALF-01-MWA	3/14/90	91.53	NA	25	8	19	MD	880	20	190	360	5
ALF-02-MWA	3/15/90	87.66	NA	15	12	29	MD	1,400	20	400	120	2.5
ALF-03-MWA	3/16/90	95.4	NA	20	12	19	MD	1,600	20	230	360	2.5
CCB-01-MWA	3/12/90	79.45	NA	15	9	20	6.78	590	20	250	360	2.5
CCB-02-MWA	3/13/90	87.73	NA	15	7	16	MD	850	20	200	360	2
DMO-03-MWA	3/17/90	96.13	NA	15	10	23	7.84	1,400	20	150	70	1
DMO-04-MWA	[illegible] 90	96.3	NA	15	9	22	7.69	1,100	20	200	170	5
DMO-05-MWA	4/3/90	95.28	NA	15	10	21	7.9	1,100	20	90	NA	0.25
DSB-01-MWA	3/29/90	13.97	NA	NA	2	20	8.95	11,500	5	30		BAILED
DSB-02-MWA	3/29/90	20.2	NA	NA	3	22	7.84	32,500	5	30		BAILED
DSB-04-MWA	3/29/90	24.6	NA	NA	3	22	7.54	10,000	20	70		BAILED
TNT-01-MWB	4/2/90	58.88	NA	NA	28	68	7.31	1,180	10	220	765	3
TNT-01-MWC	3/20/90	58.18	300	M/A	54	129	6.14	920	10	1,500	3,130	5
TNT-02-MWB	3/27/90	56.18	NA	NA	29	70	7.7	1,200	10	1,500	4,930	5
TNT-02-MWC	3/27/90	89.94	300	NA	56	135	6.42	900	10	2,500	2,800	5
TNT-07-MWB	3/30/90	58.14	NA	NA	30	71	5.95	1,150	10	500	2,830	5
TNT-07-MWC	3/28/90	58.78	300	NA	53	127	7.45	1,000	10	2,000	4,164	5
TNT-10-MWB	4/5/90	43.39	NA	NA	28	69	7.31	1,050	10	280	2,800	5
TNT-10-MWC	3/26/90	58.12	300	NA	52	124	7.4	850	10	1,600	552	5
TNT-15-MWA	3/18/90	54.55	320	15	10	23	7.5	1,800	20	300	NA	0.5
TNT-16-MWA	3/21/90	58.4	50	15	9	21	7.45	950	20	250	150	3

NA - Not Applicable
MD - pH Meter Down

TABLE 4-9

GROUNDWATER SAMPLING AND ANALYSIS SCHEDULE
SIERRA ARMY DEPOT

Site ID	PP Metals[1]	CN	Phenols	Macroparameters[2]		BNA	PEST/ PCB	Explosives[3]
ALF-1-MW	x	x	x	x	x	x	x	
ALF-2-MW	x	x	x	x	x	x	x	
ALF-3-MW	x	x	x	x	x	x	x	
CCB-1-MW	x	x	x	x	x	x	x	
CCB-2-MW	x	x	x	x	x	x	x	
DMO-3-MW	x			x	x	x	x	
DMO-4-MW	x			x	x	x	x	
DMO-5-MW	x			x	x	x	x	
DSB-4-MWA	x							
PSW-2	x	x	x	x	x	x	x	x
PSW-8	x	x	x	x	x	x	x	x
PSW-9	x	x	x	x	x	x	x	x
TNT-1-MWA	x			x	x	x	x	x
TNT-1-MWB	x			x	x	x	x	x
TNT-1-MWC	x			x	x	x	x	x
TNT-2-MWA	x			x	x	x	x	x
TNT-2-MWB	x			x	x	x	x	x
TNT-2-MWC	x			x	x	x	x	x
TNT-3-MWA	x			x	x	x	x	x
TNT-4-MWA	x			x	x	x	x	x
TNT-5-MWA	x			x	x	x	x	x
TNT-6-MWA	x			x	x	x	x	x
TNT-7-MWA	x			x	x	x	x	x
TNT-7-MWB	x			x	x	x	x	x
TNT-7-MWC	x			x	x	x	x	x
TNT-8-MWA	x			x	x	x	x	x
TNT-9-MWA	x			x	x	x	x	x
TNT-10-MWA	x			x	x	x	x	x

TABLE 4-9

GROUNDWATER SAMPLING AND ANALYSIS SCHEDULE
SIERRA ARMY DEPOT
(Continued)

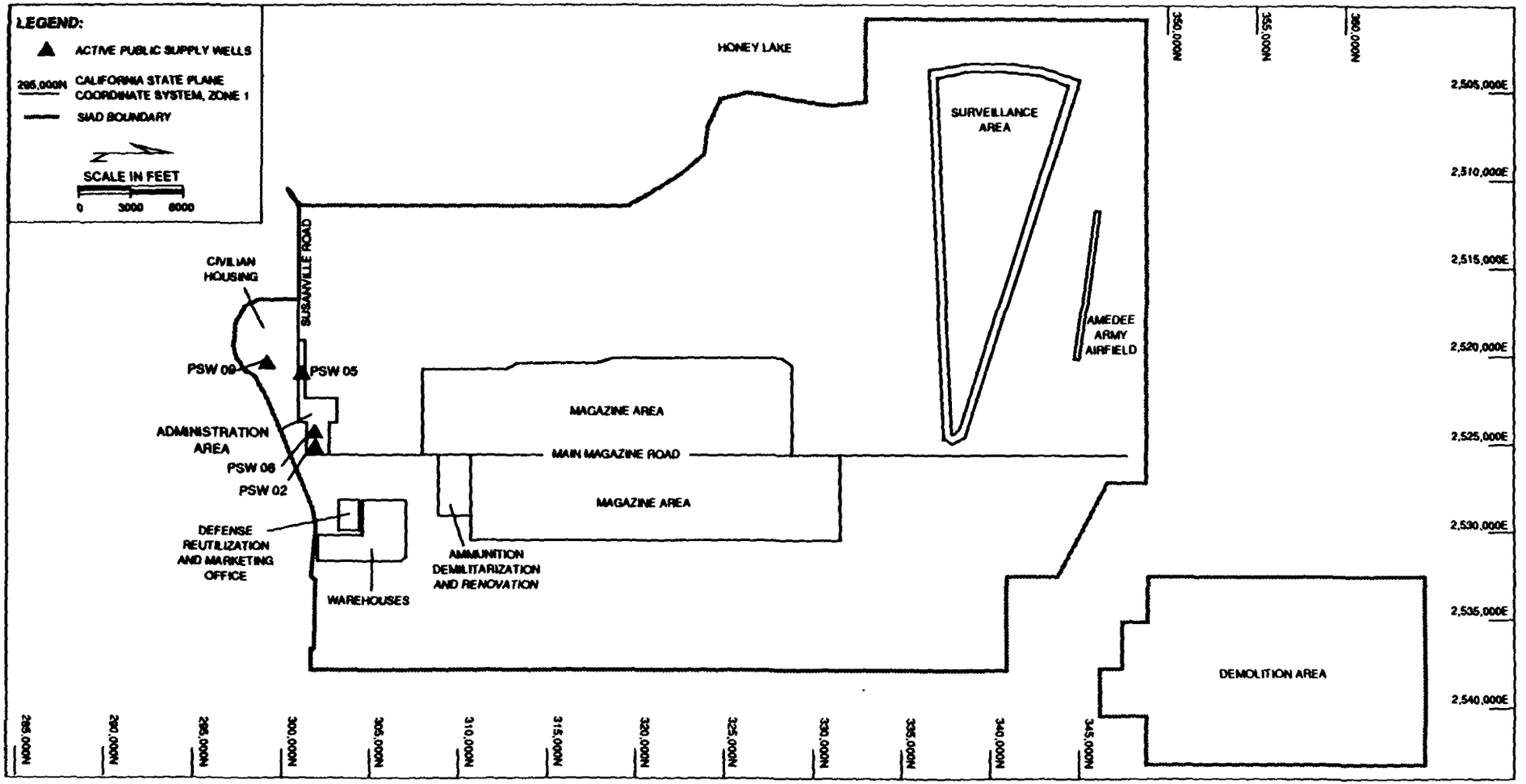
Site ID	PP Metals[1]	CN	Phenols	Macroparameters[2]	VOC	BNA	PEST/ PCB	Explosives[3]
TNT-10-MWB	x			x	x	x	x	x
TNT-10-MWC	x			x	x	x	x	x
TNT-11-MWA	x			x	x	x	x	x
TNT-12-MWA	x			x	x	x	x	x
TNT-13-MWA	x			x	x	x	x	x
TNT-14-MWA	x			x	x	x	x	x
TNT-15-MWA	x			x	x	x	x	x
TNT-16-MWA	x			x	x	x	x	x
Total (Per round of sampling)[4]	**37**	**9**	**9**	**36**	**36**	**36**	**36**	**36**

(1) Antimony, Arsenic, Beryllium, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Silver, Thallium, Zinc.

(2) Sulfate, Field pH, Calcium, Total dissolved solids, Chloride, Field specific conductance, Sodium, Water table elevation.

(3) 2,4-Dinitrotoluene, 2,4,6-Trinitrotoluene (TNT), 1,3,5-Trinitrobenzene, Cyclotetramethylene tetranitramine (HMX), 2,6-Dinitrotoluene, Tetryl, Hexahydro-1, 3,5-Trinitro-1, 3,4-Triazime (RDX).

(4) Two rounds of sampling.



SIERRA ARMY DEPOT
HERLONG PUBLIC SUPPLY WELL LOCATIONS

FIGURE 4-18

tap located inside of each well house. All water treatment systems were turned off and the lines allowed to clear prior to sample collection. Sample preservation and shipment procedures were identical to those for the monitoring wells.

4.10 LOCATION AND VERTICAL ELEVATION SURVEY

All existing monitoring wells, and newly installed monitoring wells and soil borings were surveyed by NST Engineering, a California registered land surveyor, from Susanville, California. The survey established horizontal map coordinates and elevations to within 1.0 foot and 0.05 feet, respectively. The natural ground surface for soil borings and the top of PVC casings for the monitoring wells were surveyed and referenced to the National Geodetic Vertical Datum (NGVD) of 1929. Survey data is presented in Appendix J.

4.11 BACKGROUND SOIL AND GROUNDWATER SAMPLING

Background soil samples were collected during the drilling of piezometers DSB-01-MWA, DSB-02-MWA, and DSB-04-MWA. These sites were selected because they are not proximal to any known potential contaminant source and are distributed throughout SIAD (see Figure 4-15). The purpose of background soil samples was to determine the ambient concentrations of metals in soils within SIAD.

One surface soil sample and two subsurface soil samples, one from the 5-foot interval and one from just above the water table, were collected from DSB-01-MWA and DSB-04-MWA. One surface soil sample and three subsurface soil samples (5-foot interval, 35-foot interval, and just above water table) were collected from DSB-02-MWA. Background soil sampling procedures were identical to those described in Section 4.6.

A water sample collected from DSB-04-MWA was used as a background water sample. This piezometer was selected as a background sampling location because it is the most upgradient piezometer and is not located near a potential hazardous waste site (see Figure 4-15). Background groundwater sampling procedures were identical to those described in Section 4.9.

4.12 AQUIFER TESTING

Hydraulic conductivities and transmissivities were calculated from the aquifer tests. This data was incorporated into the analog model of the site which will be used to predict contaminant transport in the subsurface environment.

One-hour constant discharge tests were conducted on eight of the 10 4-inch diameter water table monitoring wells that were installed as a part of the Phase I RI. Four-hour step tests were conducted on each of the "B" and "C" zone wells installed at the TNT Leaching Beds Area. Aquifer test parameters are presented in Table 4-10.

All of the aquifer tests were conducted with a three-horsepower Grunfos submersible pump. Drawdown and recovery data were recorded logarithmically using an In-Situ Hermit 2000 Datalogger equipped with four pressure transducers. The discharge rates for the tests were selected using well development data for each well. The pumping wells were the only wells monitored during the constant discharge tests.

The initial pumping rates for the step drawdown tests were determined from well development data. The pumping rates were increased to the maximum yield during the second step if it became evident from the drawdown observations that the well being pumped could sustain a much greater flow rate. The final step of each test was a recovery test. Recovery tests were considered complete when a well had recovered to within 0.1 feet of static water level. A minimum of three wells, including the pumping well, were monitored with the datalogger during each step test.

The drawdown in each well was analyzed as a function of time. These data were used to determine the and hydraulic conductivity and, when applicable, the storage coefficient of the aquifer materials surrounding each well.

TABLE 4-10

AQUIFER TEST PARAMETERS

Well Number	Type*	Step 1 Rate (gpm)	Step 1 Time (min)	Step 2 Rate (gpm)	Step 2 Time (min)	Step 3 Rate (gpm)	Step 3 Time (min)	Step 4 Rate (gpm)	Step 4 Time (min)
ALF-1-MWA	CD	6.0	60	Recovery**		NA		NA	
ALF-2-MWA	CD	2.0	60	Recovery		NA		NA	
ALF-3-MWA	CD	6.0	60	Recovery		NA		NA	
CCB-1-MWA	CD	6.0	60	Recovery		NA		NA	
CCB-2-MWA	CD	6.0	60	Recovery		NA		NA	
DMO-3-MWA	CD	1.1	60	Recovery		NA		NA	
DMO-4-MWA	CD	2.8	60	Recovery		NA		NA	
TNT-16-MWA	CD	2.5	60	Recovery		NA		NA	
TNT-1-MWB	ST	6.25	120	7.14	2	Recovery		NA	
TNT-1-MWC	ST	5.66	60	16.7	167	Recovery		NA	
TNT-2-MWB	ST	7.50	65	20.0	222	Recovery		NA	
TNT-2-MWC	ST	6.67	65	15.0	158	Recovery		NA	
TNT-7-MWB	ST	11.10	165	16.7	60	Recovery		NA	
TNT-7-MWC	ST	9.40	60	20.0	180	Recovery		NA	
TNT-10-MWB	ST	12.00	10	10.71	30	20.0	118	Recovery	
TNT-10-MWC	ST	6.90	80	Recovery		NA		NA	

* CD = Constant Discharge Pump Test
ST = Step Drawdown Test

** Recovery test continued until pumping well recovered to within 0.1 ft. of static water level.

NA = Not Applicable

4.13 EQUIPMENT DECONTAMINATION PROCEDURES

All equipment used at SIAD for monitoring well installation, surface soil sampling, soil borings/subsurface soil sampling, and groundwater sampling was thoroughly decontaminated prior to use at each sampling location/drill site. Only USATHAMA-approved source water and deionized water were used for decontamination. No detergents or additives were used during the decontamination procedures.

Drill rigs were steam cleaned between sites. This was done at a central location except when the drill rigs could not be easily maneuvered due to soft sand, as was the case in the TNT Leaching Beds. Soil sampling equipment was either steam cleaned or triple-rinsed with deionized water prior to use at each sample interval. Groundwater sampling equipment was steam cleaned or triple-rinsed with deionized water prior to use at each site.

4.14 WASTE MANAGEMENT

During the course of SIAD field operations, potentially hazardous waste was produced in the form of soil, water, and disposable equipment. Waste soil was generated in the form of cuttings from the drilling of monitoring wells and soil borings. Soil generated from the drilling of monitoring wells was screened onsite with a PID. All drill cuttings from monitoring well borings registering a positive reading were containerized in DOT specification, 17-H 55-gallon drums. The drums were sealed, marked with the corresponding well number, and transported to a central location for storage. Drill cuttings from monitoring wells outside source areas that did not register a positive reading on the PID were spread out on the ground near the well.

All soil generated from soil borings was containerized, sealed, marked with the boring number, and transported to a central location for storage until analysis of the soil samples was completed. Pending approval from USATHAMA, DHS and RWQCB, drums containing uncontaminated soil will be emptied on the ground near the storage site. Drums considered to contain hazardous materials as determined by USATHAMA, DHS and the RWQCB will be left on-site to be handled by the SIAD Environmental Coordinator.

Wastewater was generated from decontamination of equipment, well development, aquifer pumping tests, and well purging prior to groundwater sampling. All water generated up to the end of the first round of groundwater sampling was collected at individual well sites in either DOT specification 17-H 55-gallon drums, 500-gallon water trailers, or a 4,000-gallon water truck. These containers were transported to a central location where the water was pumped into two 21,000-gallon water storage tanks. The water in these tanks was analyzed for the complete suite of SIAD analytes by Enseco, a state-approved laboratory located in Sacramento, California. Analytical results indicated that the water contained no organic analytes at levels above instrument detection limits or MCLs. Metals concentrations were determined to be at or below background levels and were below State of California MCLs. After USATHAMA, DHS and RWQCB approval, this water was discharged to the ground surface in an area approved by the SIAD Environmental Coordinator.

Disposable health and safety equipment was containerized in DOT specification 17-H 55-gallon drums, sealed, marked and stored at a central location. The ultimate disposition of the remaining drummed waste will be handled by the SIAD Environmental Coordinator.

4.15 HEALTH AND SAFETY

The Health and Safety Plan (HASP) was implemented to establish responsibilities, requirements, and procedures for the protection of JMM and subcontractor personnel while performing the SIAD Phase I RI field work. The Onsite Safety Officer (OSO) was responsible for field implementation of the HSP and ensuring that all personnel understood and complied with all safety requirements. Included in this health and safety program were general, daily, and site-specific activities that were performed to ensure a safe working environment. Health and safety activities followed procedures outlined in the SIAD Health and Safety Plan (JMM, 1990b).

Based on the site histories, except for the test pit excavations and TNT Leaching Bed Subsite activities, the initial level of protection for all field activities was Level D. Test pit/trenching activities were done in Level C until it had been determined by atmospheric monitoring that Level D was adequate. Wind direction was continuously monitored and site workers were

positioned upwind of the trenching activities at all times. Surface soil sampling, and soil boring activities conducted at the TNT Leaching Beds Subsite were performed in Level C due to high levels of explosives and metals in the surface soils. Installation of the monitoring wells and soil borings at the DRMO Trench Area began in Level D. Due to positive ambient PID readings in the breathing zone at DMO-04-MW (0.3-75 meter units), DMO-07-SB (1-5 meter units), DMO-09-SB (1.6-7 meter units), and DMO-10-SB (1.6-12.5 meter units) workers were upgraded to Level C.

Noise monitoring was conducted periodically during invasive sampling activities. Recorded noise levels were found to be acceptable (e.g., less than 85-dBa). Radioactivity was also monitored at each site. No radioactivity above background levels were discovered or recorded.

Section 5

SIAD Geology and Hydrogeology

JMM James M. Montgomery
Consulting Engineers Inc.

5.0 SIAD GEOLOGY AND HYDROGEOLOGY

5.1 GEOLOGIC SETTING

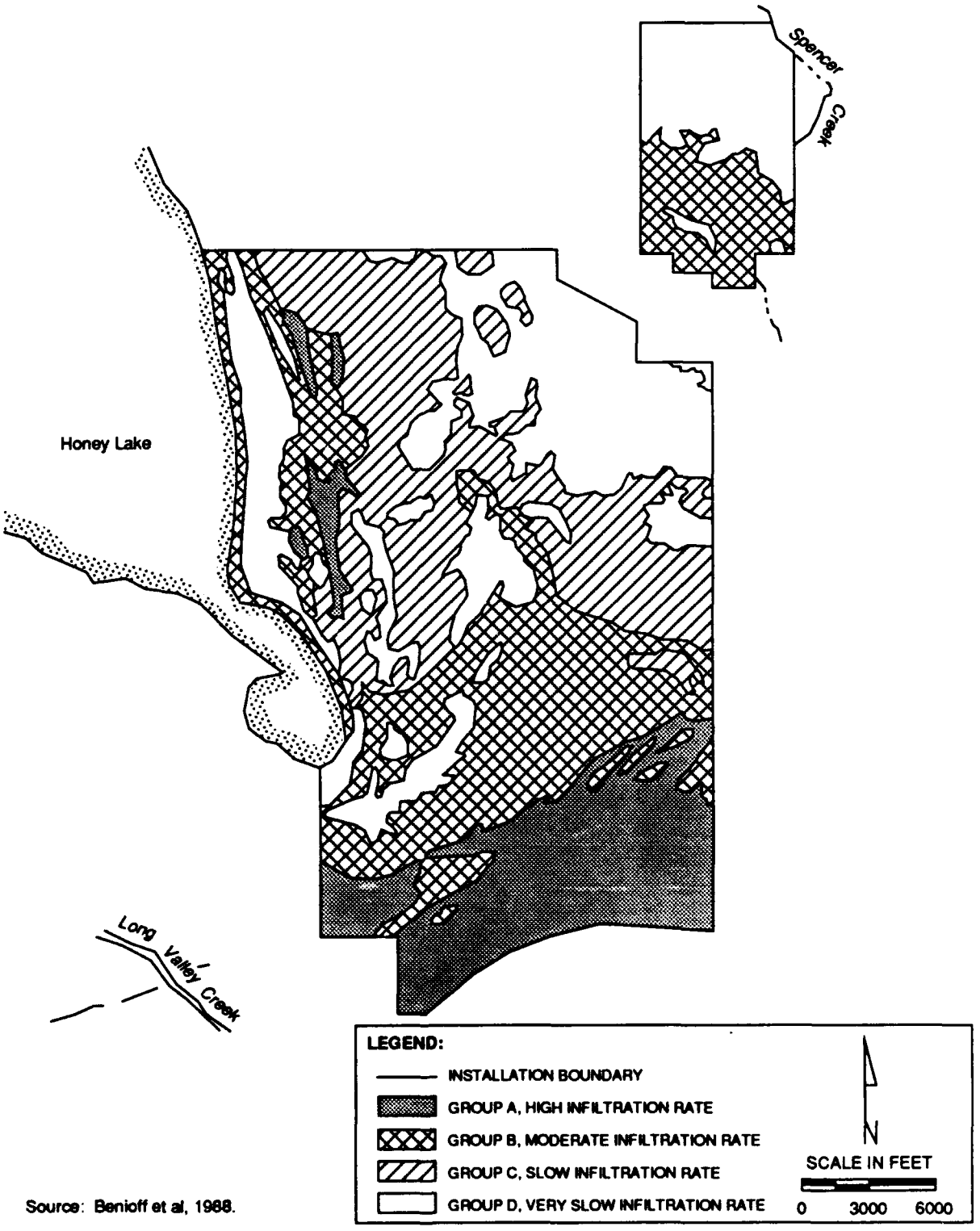
The western border of Honey Lake Valley is defined by the predominantly granitic Diamond Mountains, the easternmost extension of the Sierra Nevada Range. The granitic Fort Sage Mountains are due south of SIAD. The Virginia Mountains are to the southeast and are comprised of volcanic rocks. The northern portion of SIAD is bordered by the volcanic Amedee Mountains and Skedaddle Mountains (see Figure 2-1).

The majority of SIAD is underlain by Pleistocene and Lahontan lake deposits. The southern end of the installation is underlain primarily by Long Valley Creek sand and gravel deposits. Other geologic units occurring on SIAD consist of near-shore lake deposits, Pleistocene lake deposits, Plio-Pleistocene basalts, and Pleistocene basalts (Benioff, et al., 1988).

5.2 SIAD SURFACE SOILS

SIAD soils range from silty clays in the basins to bedrock in the uplands. The U.S. Department of Agriculture (USDA) has classified the SIAD soils into four hydrologic soil groups, A through D, on the basis of water intake. According to the USDA classification, group A has the highest infiltration rate and group D has the lowest. Natural infiltration rates generally range from high (A-type) in the southern portion of SIAD to very slow (D-type) in the northeastern quadrant (Figure 5-1) (USDA, 1968).

Group A covers about 20 percent of SIAD and is comprised of Amedee loamy sand and sandy loam, and Mottsville loamy coarse sand. These soils are typified by deep sands, gravel, or both, that are well to excessively drained. The soils in this group have high infiltration rates, even when thoroughly wetted, and a high water transmission rate. The USDA estimates that the permeabilities for this group range from 5 to more than 10 inches per hour. Group A is positioned on terraces and fans in the extreme southern



Source: Benioff et al, 1988.

SIERRA ARMY DEPOT

AREAL DISTRIBUTION OF SIAD HYDROLOGIC SOIL UNITS

FIGURE 5-1

and northwestern parts of the main depot and in the southern portion of the upper burning and and demolition area (Figure 5-1) (Benioff, et al., 1988). Surface soils at the Phase I RI sites are primarily of the Group A type.

Group B cover about 28 percent of SIAD and has a moderate infiltration and water transmission rate. The USDA (1968) estimates that the permeabilities for this group range from 0.2 to more than 10 inches per hour. These soils have moderately to medium coarse textures and are moderately well to well drained. The SIAD soils in group B are Cobbly alluvial sand, Liebermann sandy loam, Liebermann loam, Liebermann-Herlong complex, and alluvial fans in the southern and northwestern portions of the main depot and occupy most of the southern half of the upper burning and demolition ground (Figure 5-1).

Group C soils cover about 22 percent of SIAD and have slow infiltration and water transmission rates. Permeabilities of group C soils have been estimated (USDA, 1968) to range from 0.05 to 5 inches per hour. These soils have moderately fine to fine textures; some may have a layer that impedes the downward migration of water. The SIAD soil in group C is Caudle loam. This soil is positioned in basins and on low terraces and is found in the central, north central, and west central portions of the main depot (Figure 5-1).

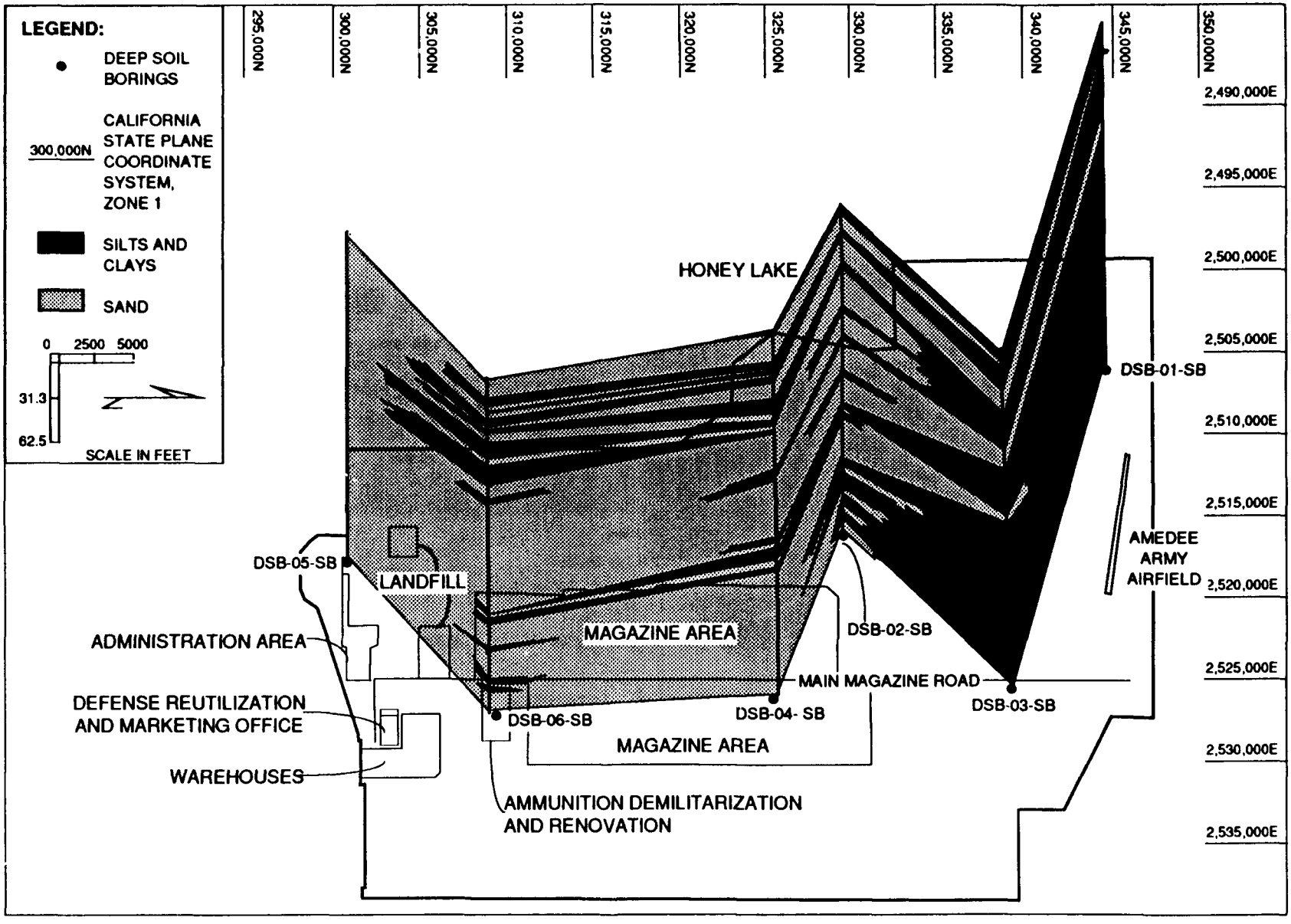
Group D soils cover about 29 percent of SIAD and have very slow infiltration and water transmission rates. The USDA (1968) has estimated that the permeabilities of group D soils fall within the range of 0.01 to 2.5 inches per hour. These soils consist chiefly of clay or claypan near the surface and shallow soils over nearly impervious materials. This group is found largely on basins, basaltic table lands, and basaltic uplands in the northwestern and northeastern portion of the main depot and the northern portion of the upper burning ground. Group D soils on SIAD consist of Calneva silty loam; Calneva loam, moderately alkali; Diaz-Karlo complex; Herlong loam; playas; rock land; Standish loam, moderately alkali; and Standish loam (Figure 5-1).

5.3 SIAD HYDROGEOLOGY

Six 250-foot-deep soil borings, DSB-1-SB through DSB-6-SB, were installed at six locations in order to establish a stratigraphic framework of the SIAD subsurface. Each boring was continuously cored and logged stratigraphy and geophysically. Geophysical logs included downhole resistivity, spontaneous potential, and caliper logs. All soils were assigned United Soil Classification System (USCS) symbols by the JMM rig geologist at the time of collection. Correlations of the SIAD stratigraphy from 0 to 250 feet were made and a fence diagram was constructed using the lithologic data (Figure 5-2). Correlations were also made using geophysical data (Appendix F). Depositional environments were interpreted and a piezometric surface map was constructed (Figure 5-3).

The deep soil borings indicate that soils in the 0- to 250-foot interval become finer grained to the north within SIAD. The soil encountered in the southernmost parts of SIAD as represented by DSB-05-SB, and Herlong potable supply wells (Figure 5-2) consists of nearly 100 percent fine to coarse buff-colored sand and minor gravel that is poorly- to well-sorted and subangular to subround. The soils from the northernmost boring, DSB-01-SB, consist of approximately 95 percent dark green and dark gray silts and clays. The soils from these two borings can be considered to represent the lithologic end members for SIAD. The borings that were installed between these two end member borings, DSB-02-SB, DSB-03-SB, DSB-04-SB, and DSB-06-SB, display heterogeneous grain-size distributions.

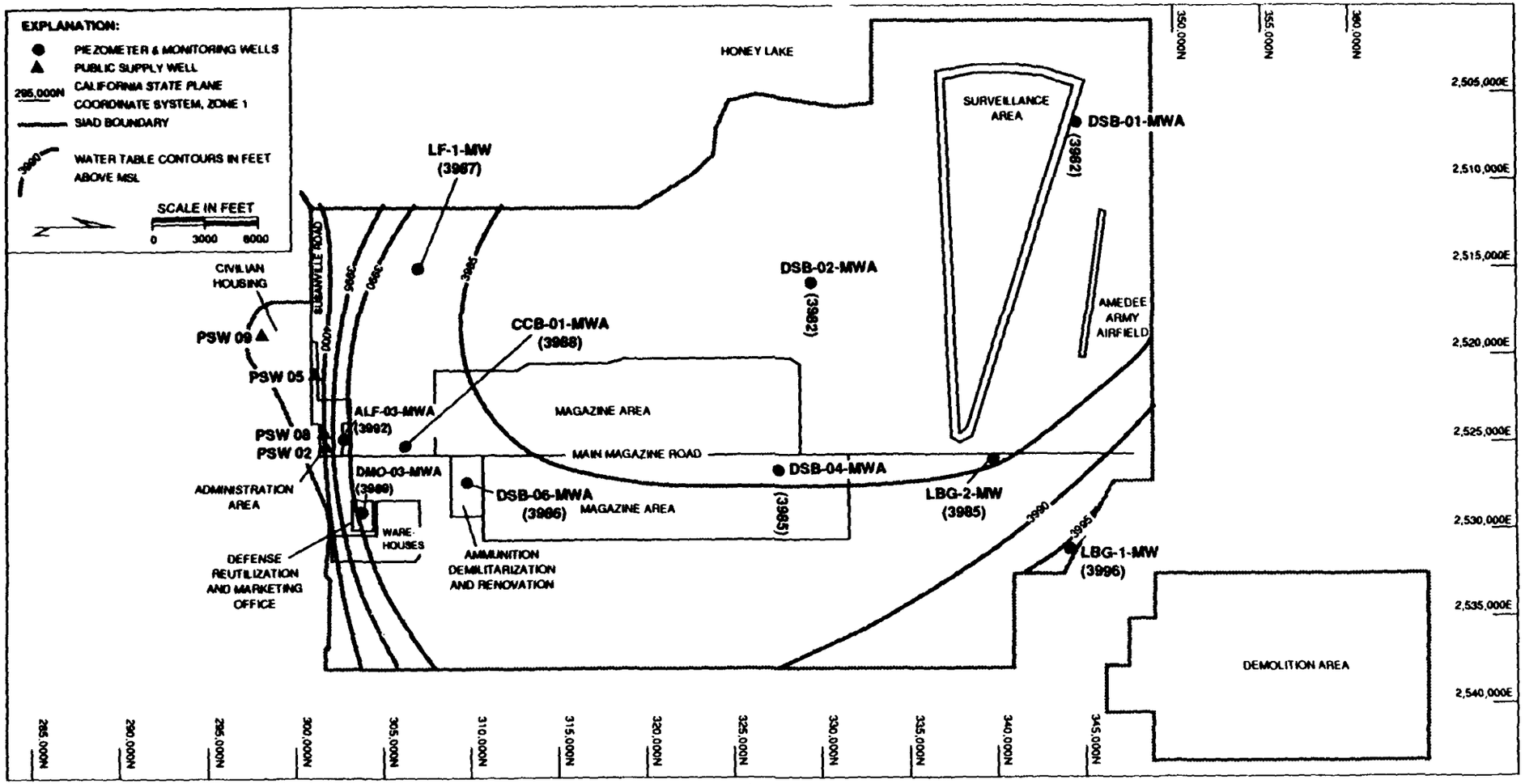
DSB-06-SB and DSB-04-SB are located 8,692 feet and 24,669 feet north of DSB-05-SB, respectively (Figure 5-2). At these locations, silt and clay account for approximately 25 percent of the soil volume, although these fine-grained beds are not evenly distributed throughout the 0- to 250-foot interval at these locations. Silts and clays comprise about 50 percent of soil volume in the 0- to 100-foot interval. These fine-grained beds range in thickness from 1 to 15 feet (Figure 5-2). The fine-grained beds that are predominant in the 0- to 100-foot interval probably create barriers to downward vertical movement of



SIERRA ARMY DEPOT

FENCE DIAGRAM OF 0 -TO 250-FOOT INTERVAL

FIGURE 5-2



SIERRA ARMY DEPOT

PIEZOMETRIC SURFACE (JULY 1990)

FIGURE 5-3

groundwater, as is suggested by the pump tests performed on the cluster wells at the TNT Leaching Beds Area.

Sand-size material comprises up to 90 percent of the 100- to 250-foot interval in both DSB-06-SB and DSB-04-SB. Sand grain size decreases from medium- to coarse-grained in DSB-5-SB (the southern end member) to medium- to fine-grained in DSB-6-SB and DSB-4-SB. Silt and clay beds in the 100- to 250-foot interval from these borings are 1 to 5 feet thick.

The lithology of DSB-02-SB, 3,909 feet north of DSB-04-SB, is dominated by very stiff, dark green to dark gray silt and clay-sized material (Figure 5-2). These fine-grained beds account for approximately 50 percent of the stratigraphy in this boring and range in thickness from 2 to 20 feet. Fine-grained beds are evenly distributed throughout this boring (Figure 5-2). The sands found in DSB-02-SB are fine- to very fine-grained, well-sorted to poorly sorted, and are predominantly green in color. The percentage of silt and clay in these sandy zones may be as high as 50 percent.

DSB-03-SB is located 9,849 feet north of DSB-02-SB. Dark green to dark gray silts and clays account for approximately 85 percent of the stratigraphy at this location. Very fine- to medium-grained dark green sands were found at three intervals within the upper 125 feet. These sands ranged in thickness from 1 to 15 feet and generally contained 10 to 30 percent silt and clay.

DSB-01-SB is the northernmost Phase I boring and is located 5,052 feet north of DSB-02-SB. Approximately 95 percent of the sediments encountered in this boring are very stiff, dark green and gray silts and clays. Beds of very fine, dark green sand about 1 to 2 feet thick were observed in the upper 125 feet. Perched water was found in the 0- to 20-foot interval.

Grain size distribution in the SIAD subsurface shows a distinct northward fining trend in the 0- to 250-foot interval (Figure 5-2). This trend is interpreted to represent a sedimentary facies change from a predominantly distal alluvial fan and eolian facies in

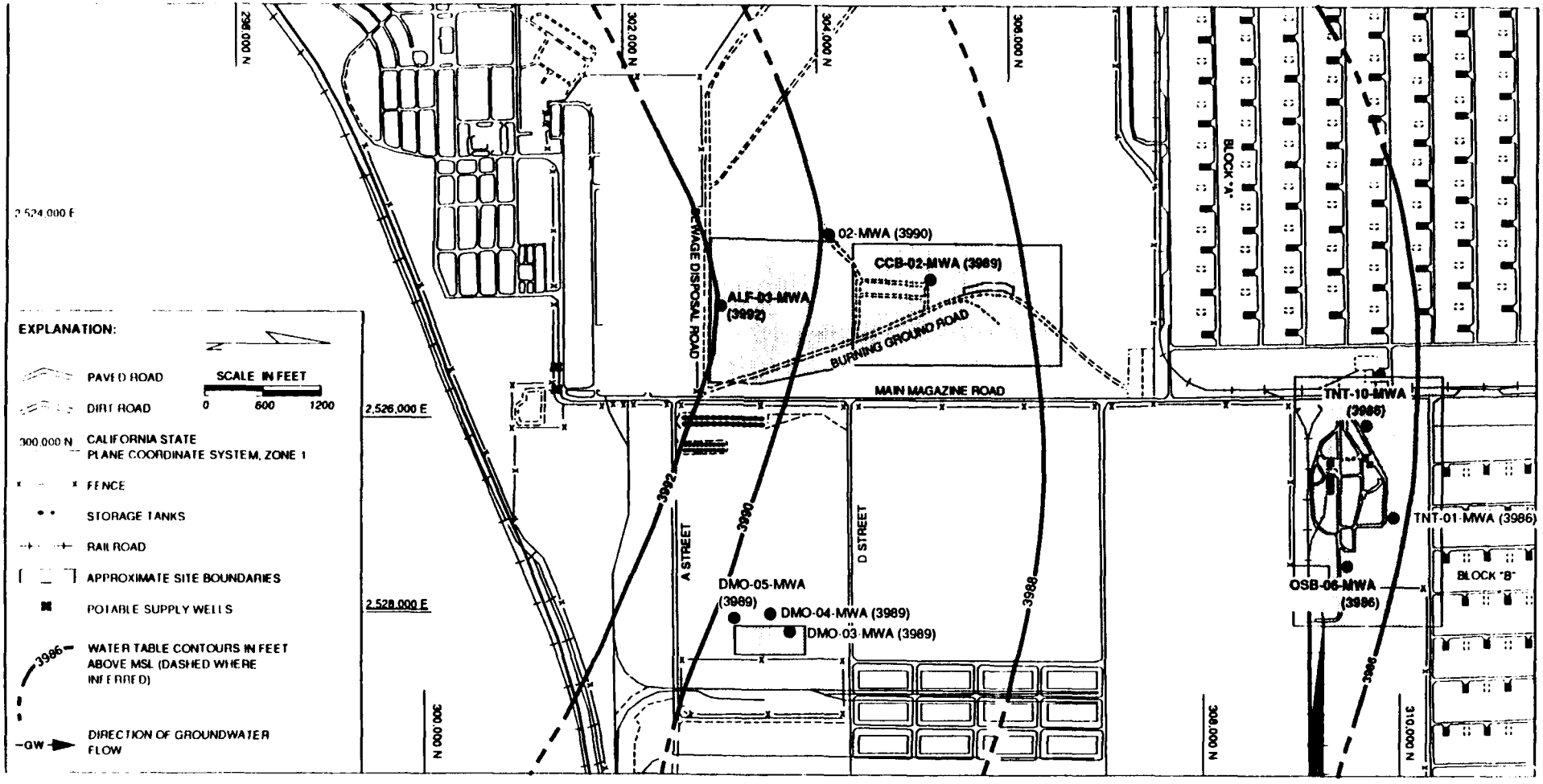
the southernmost portion of SIAD (DSB-05-SB), to a predominantly fluvial and near-shore transitional facies in the middle portion of SIAD (DSB-06-SB, DSB-04-SB, and DSB-02-SB), to a predominantly lacustrine facies in the northernmost portion of SIAD (DSB-03-SB and the Diamond Mountains) although minor amounts of coarse clastic sediments were probably derived from the Skedaddle and Amedee Mountains to the north.

The absence of significant fine-grained beds in the southernmost portion of SIAD suggests that Honey Lake did not cover this area in the recent geologic past. Therefore, it is expected that natural barriers that would retard downward groundwater and/or contaminant movement are not present in the southernmost portion of SIAD.

Fine-grained sediments interfinger with sands at semi-regular intervals in the upper 100 feet in the central portion of SIAD (Figure 5-2). This sediment distribution suggests that the ancestral Honey Lake shoreline migrated repeatedly across this area in the recent geologic past. These fine-grained shallow lacustrine sediments create natural barriers to downward groundwater and/or contaminant movement.

The northern portion of SIAD is dominated by silt and clay deposits interpreted to represent deposition in a relatively deep-water lacustrine environment. The permeability of these sediments is very low and the hydrogeologic gradient is essentially flat in this area (Figure 5-3). These two factors indicate that there is very slow horizontal and vertical groundwater movement within the upper 250-feet in this portion of SIAD.

Water table contour maps of the entire main depot (Figure 5-3) and the southern portion of the main depot (Figure 5-4) have been constructed. Water level measurements from each of the Phase I RI sites, the four piezometers installed near the DSB locations, and from monitoring wells LBG-1-MW and LBG-2-MW installed at the Active Landfill in the southwestern portion of SIAD were used to construct Figures 5-3 and 5-4. The groundwater gradient across the southern portion of SIAD generally trends to the north-northwest at about .0005 to .002 (Figure 5-4). The gradient in the northern portion of the site between DSB-02-MWA and DSB-01-MWA, the northernmost piezometers, is



SIERRA ARMY DEPOT

PIEZOMETRIC SURFACE
(JULY 1990)
PHASE I RI SITES

FIGURE 5-4

essentially flat (Figure 5-3). Table 5-1 lists water elevations from Phase I SIAD monitoring wells and piezometers. The basin-wide flow model of Honey Lake Valley is presented in Appendix K.

5.4 ABANDONED LANDFILL

Subsurface soils and hydrogeology at the Abandoned Landfill were characterized utilizing data collected from 11 tests pits, four soil borings, and three monitoring wells (Figures 4-8 and 5-5). Test pits were excavated to depths of 5 to 9 feet below grade. Soil borings and monitoring wells were installed to depths of 85 to 107 feet, respectively. A one-hour constant discharge test was conducted at each of the three wells installed at the Abandoned Landfill.

In general, the 0- to 1-foot interval coinciding with geophysical anomalies consist of ash and other burn debris (see Figure 4-8). The non-burned surface soils consist primarily of Amedee sandy loams in the southern section and Mottsville coarse-grained sandy loam in the northern section (Benioff, et al., 1988).

Well sorted, coarse- to fine-grained, light brown to brown sands and silty sand are the prevalent textural components in the 0- to 30-foot interval (Figures 5-6 and 5-7). A continuous silt and clay layer exists from approximately 28 to 38 feet below grade. This fine-grained layer ranges from 2 to 10 feet thick in the southern portion of the site, to 7 to 10 feet thick in the northern portion of the site (see Figure 5-6).

From approximately 38 to 60 feet below grade, light brown sands and silty sands interbedded with thin, discontinuous silt and clay zones, are the primary textural constituent (see Figures 5-6 and 5-7). A second silt and clay zone is present at this site from approximately 60 to 80 feet below grade. This fine-grained strata thickens northward. It is approximately 6 to 8 feet thick in the southern section and 20 feet thick in the northern portion of the site. From approximately 70 to 80 feet in depth to the terminus of each borehole, fine- to medium-grained sand is the primary constituent. Silty

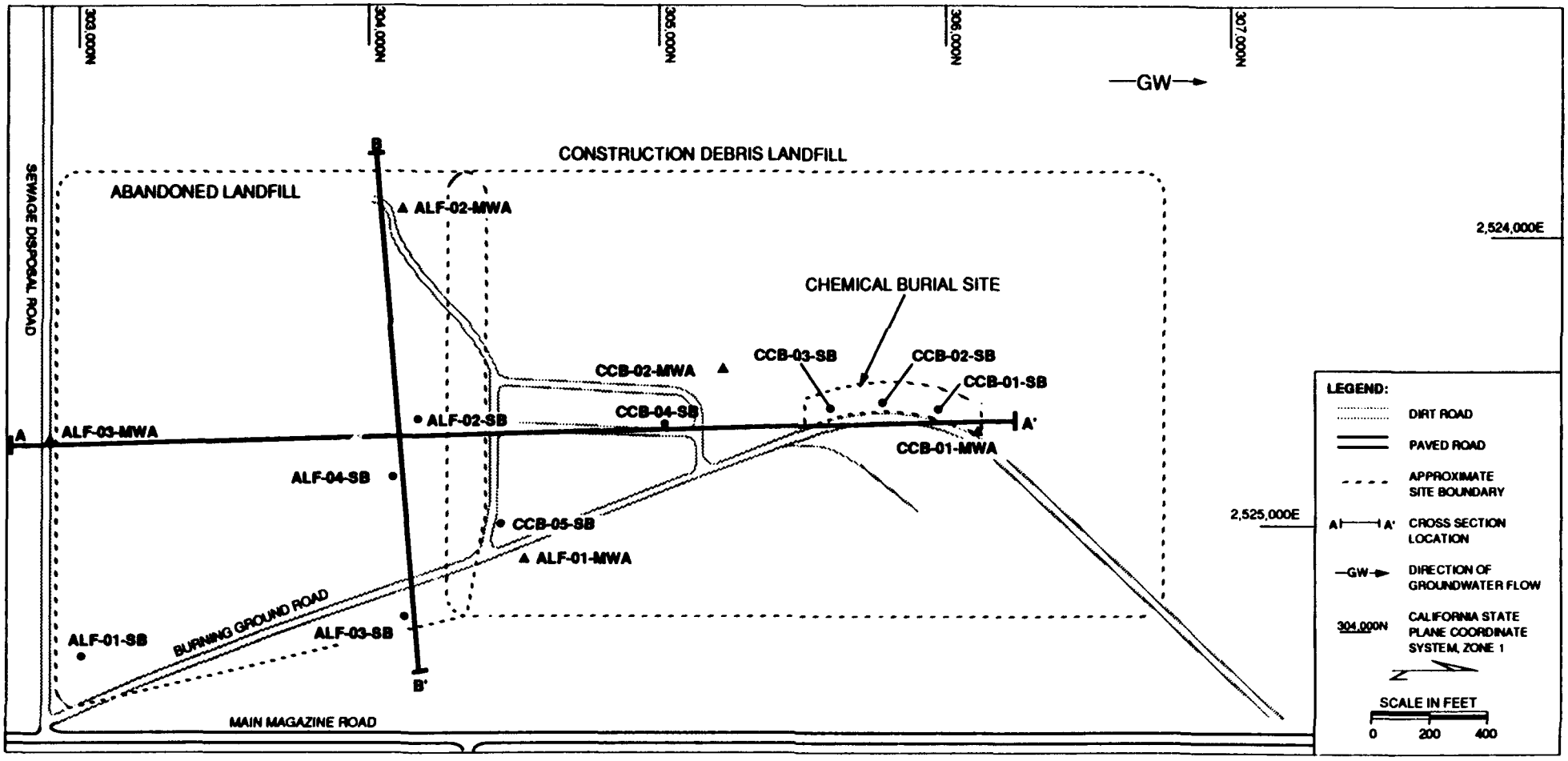
TABLE 5-1

MONITORING WELL PIEZOMETRIC ELEVATIONS

Well Number	Piezometric Elevation** March - April	(Date)	June	(Date)	July*	(Date)
ALF-01-MWA	3988.68	4/10	3988.19	6/7	3987.97	7/10
ALF-02-MWA	3990.67	4/11	3990.56	6/7	3990.47	7/10
ALF-03-MWA	3991.67	4/11	3991.56	6/7	3991.50	7/10
CCB-01-MWA	3988.48	4/9	3988.11	6/7	3988.01	7/10
CCB-02-MWA	3989.32	4/9	3988.65	6/7	3988.63	7/10
DMO-03-MWA	3989.27	4/12	3988.12	6/8	3989.02	7/10
DMO-04-MWA	3989.06	4/12	3989.93	6/8	3988.76	7/10
DMO-05-MWA	3988.97	4/19	3988.70	6/8	3988.67	7/10
TNT-01-MWA	3986.61	3/30	3988.42	6/7	3986.22	7/10
TNT-01-MWB	3986.22	4/2	3886.02	6/7	3985.42	7/10
TNT-01-MWC	3986.13	3/30	3985.70	6/7	3985.24	7/10
TNT-02-MWA	3986.71	4/21	3985.43	6/7	3986.38	7/10
TNT-02-MWB	3986.55	3/20	3986.27	6/7	3986.05	7/10
TNT-02-MWC	3986.22	3/27	3986.85	6/7	3985.42	7/10
TNT-03-MWA	3986.67	3/27	3985.52	6/7	3986.16	7/10
TNT-04-MWA	3986.90	3/27	3986.73	6/7	3986.72	7/10
TNT-05-MWA	3986.92	3/27	3986.70	6/7	3986.85	7/10
TNT-06-MWA	3986.76	4/5	3986.50	6/7	3985.43	7/10
TNT-07-MWA	3986.61	4/18	3986.26	6/7	3986.20	7/10
TNT-07-MWB	3986.41	3/30	3986.13	6/7	3985.88	7/10
TNT-07-MWC	3986.16	3/21	3986.79	6/7	3984.97	7/10
TNT-08-MWA	3987.11	3/30	3985.94	6/7	3986.95	7/10
TNT-09-MWA	3987.34	4/12	3986.26	6/7	3987.21	7/10
TNT-10-MWA	3987.00	4/5	3987.67	6/7	3986.52	7/10
TNT-10-MWB	3986.17	3/29	3986.80	6/7	3985.20	7/10
TNT-10-MWC	3985.90	3/26	3985.49	6/7	3984.77	7/10
TNT-11-MWA	3986.99	4/9	3985.75	6/7	3986.53	7/10
TNT-12-MWA	3986.67	4/25	3986.36	6/8	3986.21	7/10
TNT-13-MWA	3986.82	4/24	3986.82	6/7	3986.60	7/10
TNT-14-MWA	3986.43	4/24	3986.14	6/7	3985.76	7/10
TNT-15-MWA	3985.12	3/18	3984.92	6/7	3984.48	7/10
TNT-16-MWA	3986.41	3/21	3986.16	6/7	3986.03	7/10
DSB-01-MWA	3982.05	3/29	3981.87	6/7	3981.76	7/10
DSB-02-MWA	3981.97	3/29	3981.90	6/7	3981.86	7/10
DSB-04-MWA	3984.35	3/29	3984.54	6/7	3984.52	7/10
DSB-06-MWA	3986.47	3/30	3986.47	6/7	3986.30	7/10

* All measurements for July collected in one 10-hour period.

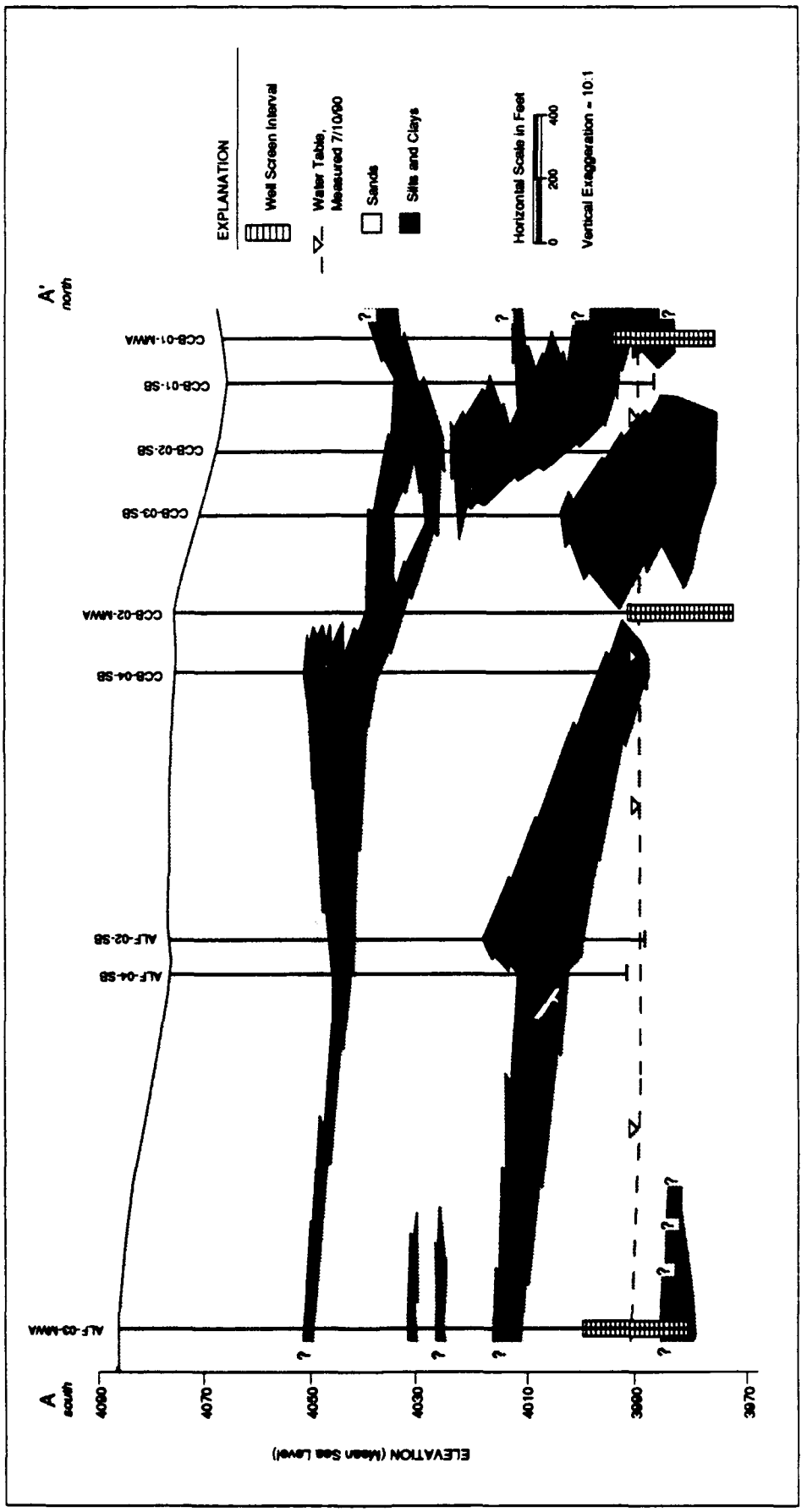
** Feet above mean sea level.



SIERRA ARMY DEPOT

CROSS SECTION LOCATIONS:
A-A' AND B-B': ABANDONED LANDFILL/
CHEMICAL BURIAL SITE/CONSTRUCTION DEBRIS LANDFILL

FIGURE 5-5

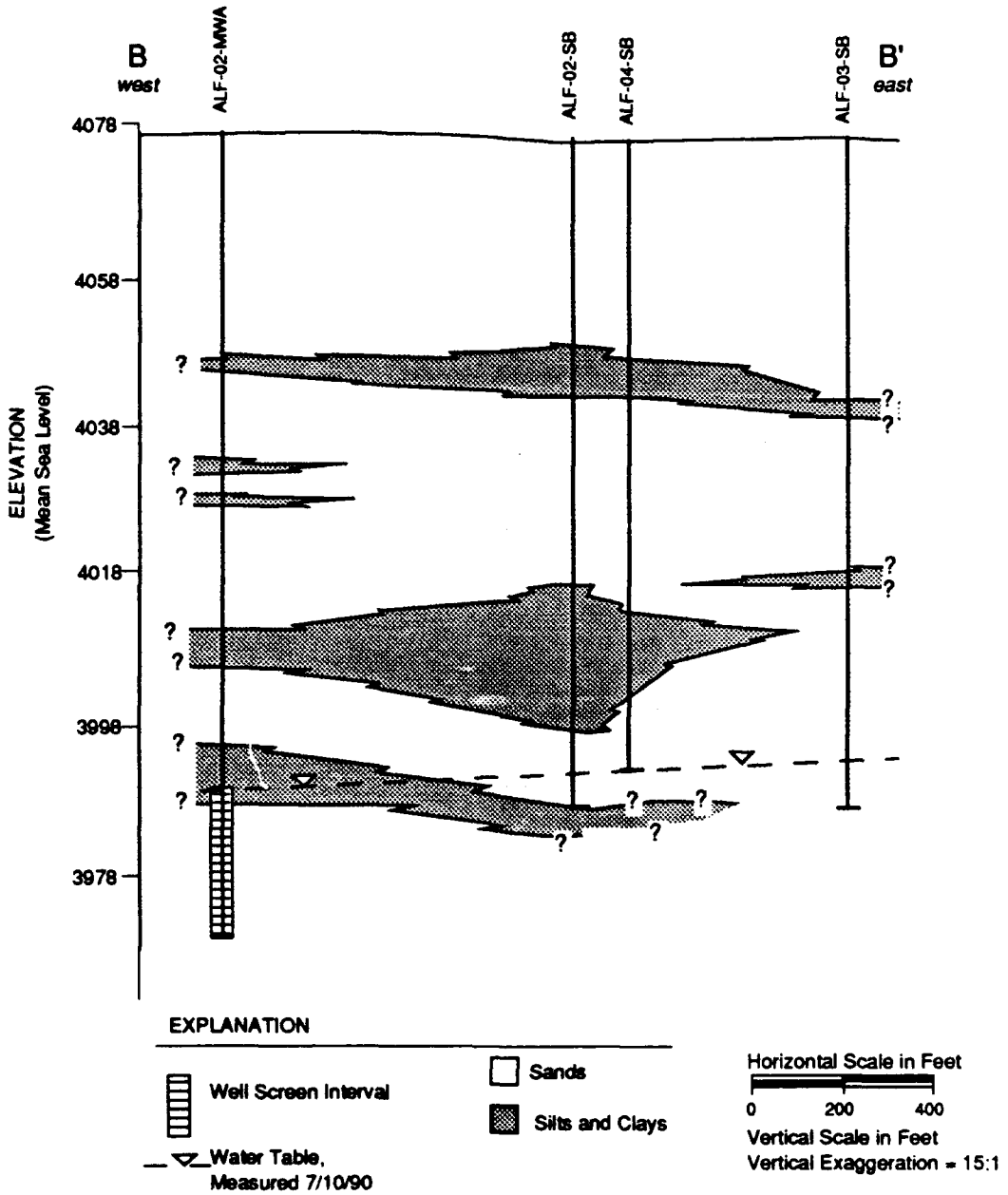


SIERRA ARMY DEPOT

CROSS SECTION A-A'

ABANDONED LANDFILL/CHEMICAL BURIAL SITE/ CONSTRUCTION DEBRIS LANDFILL

FIGURE 5-6



SIERRA ARMY DEPOT

CROSS SECTION B-B'
ABANDONED LANDFILL

FIGURE 5-7

clay was present in the bottom of borehole ALF-3-MWA at a depth of approximately 100 feet.

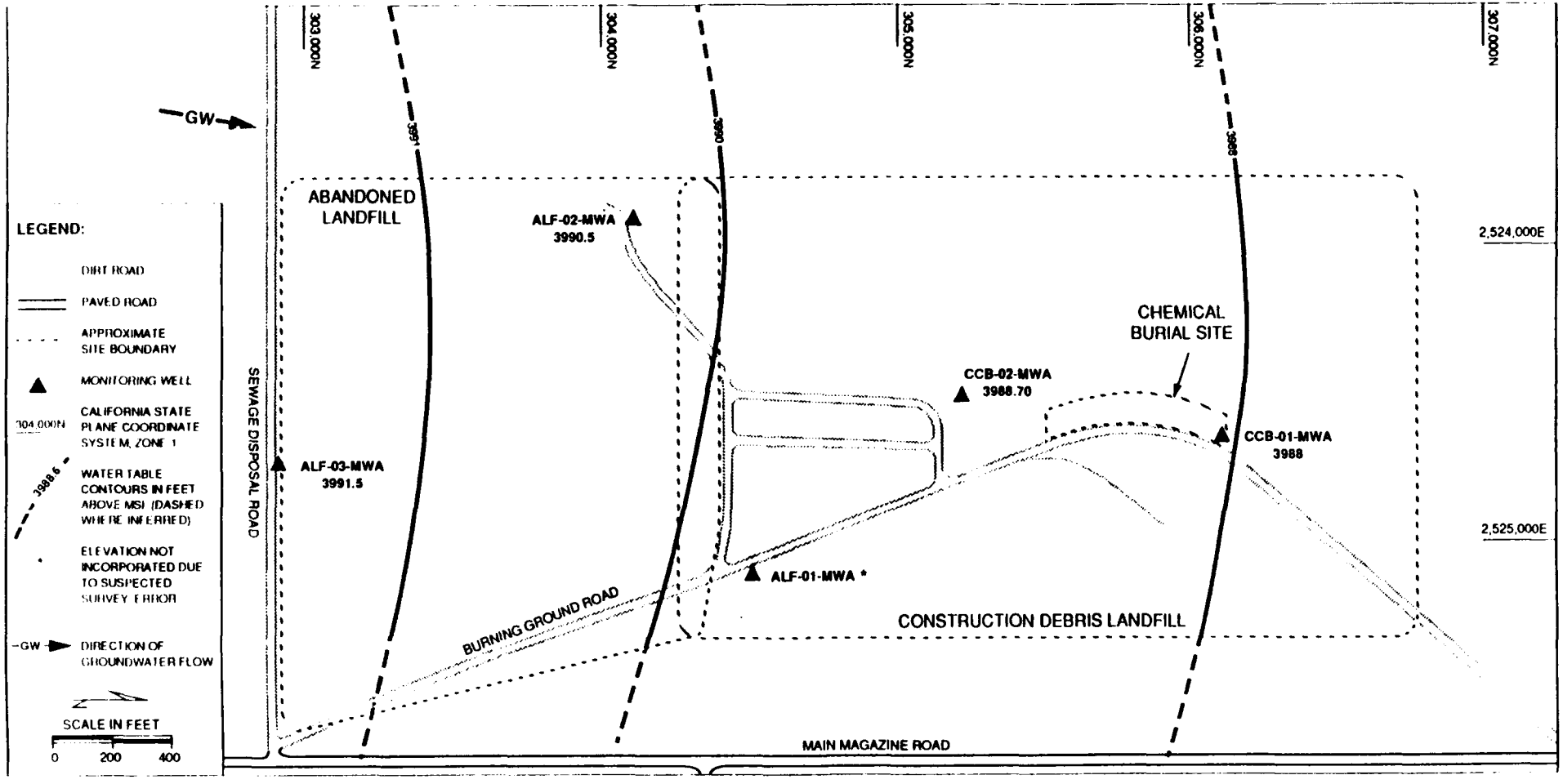
The stratigraphy of the 0- to 30-foot interval suggests a depositional environment similar to the present day environment. These sandy sediments represent distal alluvial fan and eolian sedimentation. Sediment distribution in the 0- to 100-foot interval suggests that these sediments were deposited in a nearshore ancestral Honey Lake environment. The fine-grained continuous strata may have been deposited during a time when the Honey Lake water levels were higher.

Soils were dry to a depth of approximately 35 feet. Moisture content increased above the fine-grained beds that exist at 35 and 60 feet. The water table was encountered at approximately 90 feet below grade at this site (Table 5-1). The groundwater gradient is .0021 to the north over much of this site as determined from July 1990 water level data (Figure 5-8). It should be noted that the groundwater level measurements from ALF-01-MWA do not correspond to the piezometric surface shown in Figure 5-8. This is due to a suspected survey error at ALF-01-MWA. Because of this suspected error, data from this well was not used to interpret the piezometric surface.

The hydraulic conductivity of the shallow aquifer was calculated from data collected during one-hour constant discharge tests that were performed on each monitoring well. The results of these tests show conductivities of 1,510 feet/day in ALF-01-MWA, 142.8 feet/day in ALF-02-MWA, and 65.8 feet/day in ALF-03-MWA. The wide range in values reflect the heterogeneity of the shallow aquifer.

5.5 CHEMICAL BURIAL SITE/CONSTRUCTION DEBRIS LANDFILL

Because the Chemical Burial Site is located within the boundary of the Construction Debris Landfill, these two sites have been considered as a single site for this discussion. Subsurface soils and hydrogeology were characterized utilizing data collected from four test pits, five soil borings, and two monitoring wells (see Figures 4-8 and 5-5). Test pits were excavated to a depth of 5 feet below grade. Soil borings and monitoring wells were



SIERRA ARMY DEPOT
PIEZOMETRIC SURFACE:
ABANDONED LANDFILL/CONSTRUCTION DEBRIS LANDFILL (JULY 1990)

FIGURE 5-8

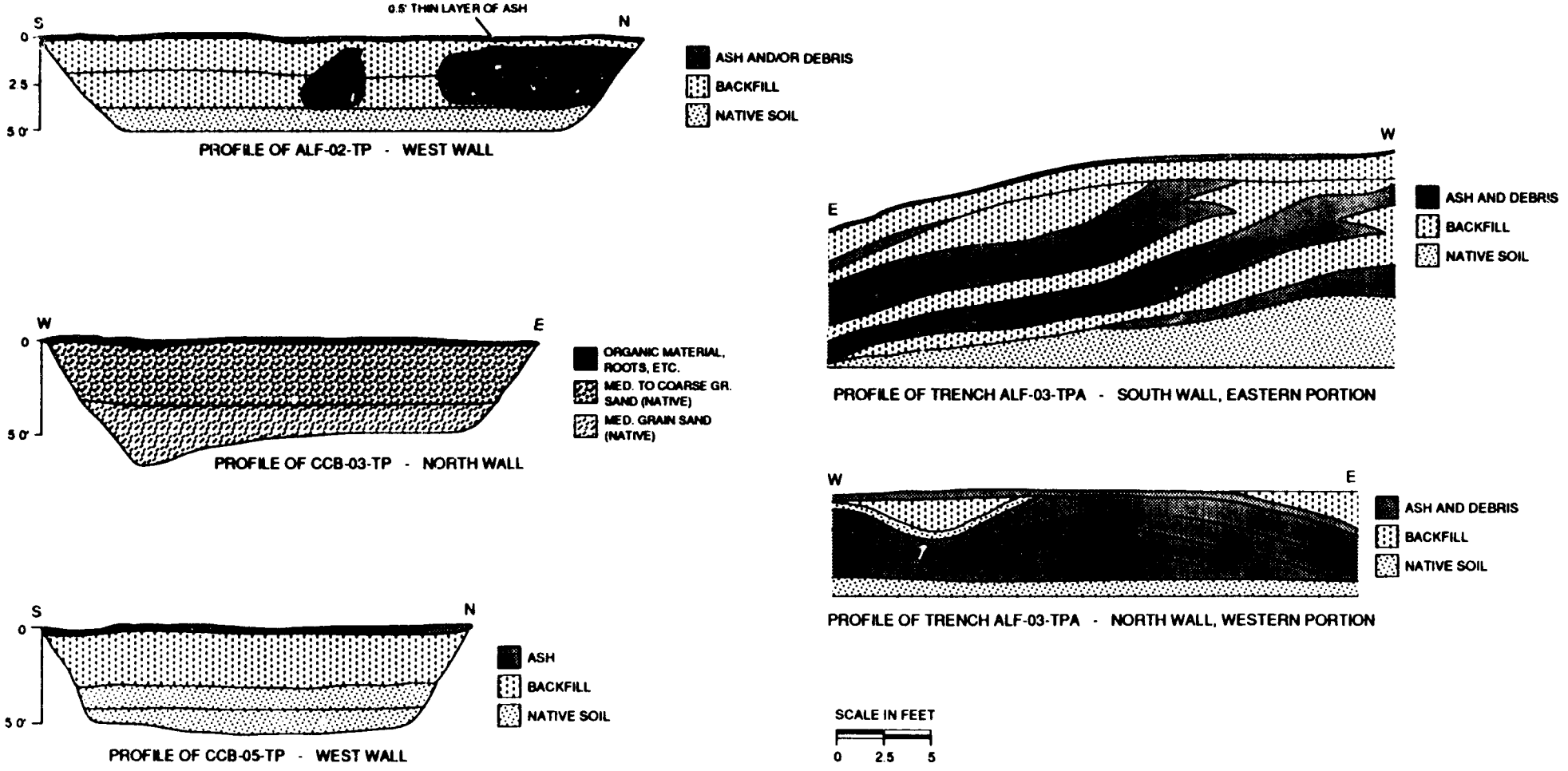
installed from depths of 80 feet to 104.5 feet. A one-hour constant discharge test was conducted on each of two monitoring wells installed at this site.

The 0- to 1-foot interval that coincide with geophysical anomalies generally consisted of ash and other burn debris (Figure 5-9). The native surface soils consisted mainly of Mottsville loamy coarse sand (Benioff, et al., 1988). These soils are typified by sands, gravel, or both and are well drained. The soils in this group have high infiltration and water transmission rates, even when thoroughly wetted. The USDA estimates that the permeabilities of this type of soil range from 5 to more than 10 inches/hour (Benioff, et al., 1988).

Subsurface sediments at this site are composed of sands, silts, and clays. The upper sediment unit from ground surface to depths approximately 24 to 35 feet is a fine- to coarse-grained, light brown sand that is moderately well-sorted, subangular to subround, and contains approximately 10 to 15 percent silt and clay. Below the upper sand unit to about 100 feet, silt and clay beds comprise approximately 35 to 40 percent of the stratigraphy. These beds are generally very thin and are interbedded with fine-grained sand that is stained red.

Subsurface soils were generally dry in the 0- to 10-foot interval. From 10 feet to the top of the saturated zone the soil was moist. Moisture content increased noticeably above silt and clay zones in the 40- to 70-foot interval.

Sediment distribution in this area suggests a depositional environment similar to that described in the Abandoned Landfill site (Section 5.4). The water table was encountered at about 80 feet below grade at this site and the groundwater gradient is generally .0021 to the north (see Figure 5-8). The hydraulic conductivity of the shallow aquifer was calculated from data collected during one-hour constant discharge tests that were conducted on the two monitoring wells. The hydraulic conductivity ranged from 4.5 ft./day in CCB-02-MWA to 64.3 ft./day in CCB-01-MWA. Aquifer test results are presented in Table 5-2.



SIERRA ARMY DEPOT

TEST PIT PROFILES OF ALF-02-TP, ALF-03-TPA, CCB-03-TP AND CCB-05-TP

FIGURE 5-9

TABLE 5-2

PUMP TEST RESULTS AT SIERRA ARMY DEPOT

Well	TD (ft)	b' (ft)	T (ft2/day)	Method*	k' (ft/day)	r (ft)	S
ALF-01-MWA	105	14	1,510	PT	108	NA	NA
ALF-02-MWA	101	14	142.8	PT	10.2	NA	NA
ALF-03-MWA	100	14	65.8	PT	4.7	NA	NA
CCB-01-MWA	93	14	899.5	PT	64.3	NA	NA
CCB-02-MWA	100	14	63.5	PT	4.5	NA	NA
DMO-03-MWA	110	14	2.94	R	0.21	NA	NA
DMO-04-MWA	110	14	22.9	PT	1.6	NA	NA
DMO-04-MWA	110	14	10.9	R	0.78	NA	NA
TNT-16-MWA	73	14	27.6	PT	2	NA	NA
TNT-16-MWA	73	14	17.2	R	1.2	NA	NA
TNT-1B-PROD	100	40.8	6.61	ST	016	10-NR	ND
TNT-1C-PROD	140	82	448.7	ST	5.47	10-NR	ND
TNT-2B-PROD	100	43.6	1,636.5	ST	37.5	--	NA
TNT-2B-OBS		43.6	703.7	ST	16.1	8	0.0808
TNT-7B-PROD	100	41.6	138	ST	3.32	--	NA
TNT-7B-OBS			2,647.5	ST	ND	10	ND
TNT-7C-PROD	140	81	22.9	ST	0.28	10-NR	ND
TNT-10B-PROD	100	41	53.3	ST	1.3	10-NR	ND
TNT-10C-PROD	140	82	ND	ST	ND	NA	ND

* PT: 1 hour pump test
ST: Step-drawdown test
ND: Not determined
TD: Total depth
b: Aquifer thickness
T: Transmissivity
k: Hydraulic conductivity
r: Distance from pumping well to obstruction well
S: Storage coefficient (dimensionless)
NA: Not applicable
NR: No response in observation well
PROD: Production well
OBS: Observation well
R: Recovery test

5.6 DRMO TRENCH AREA

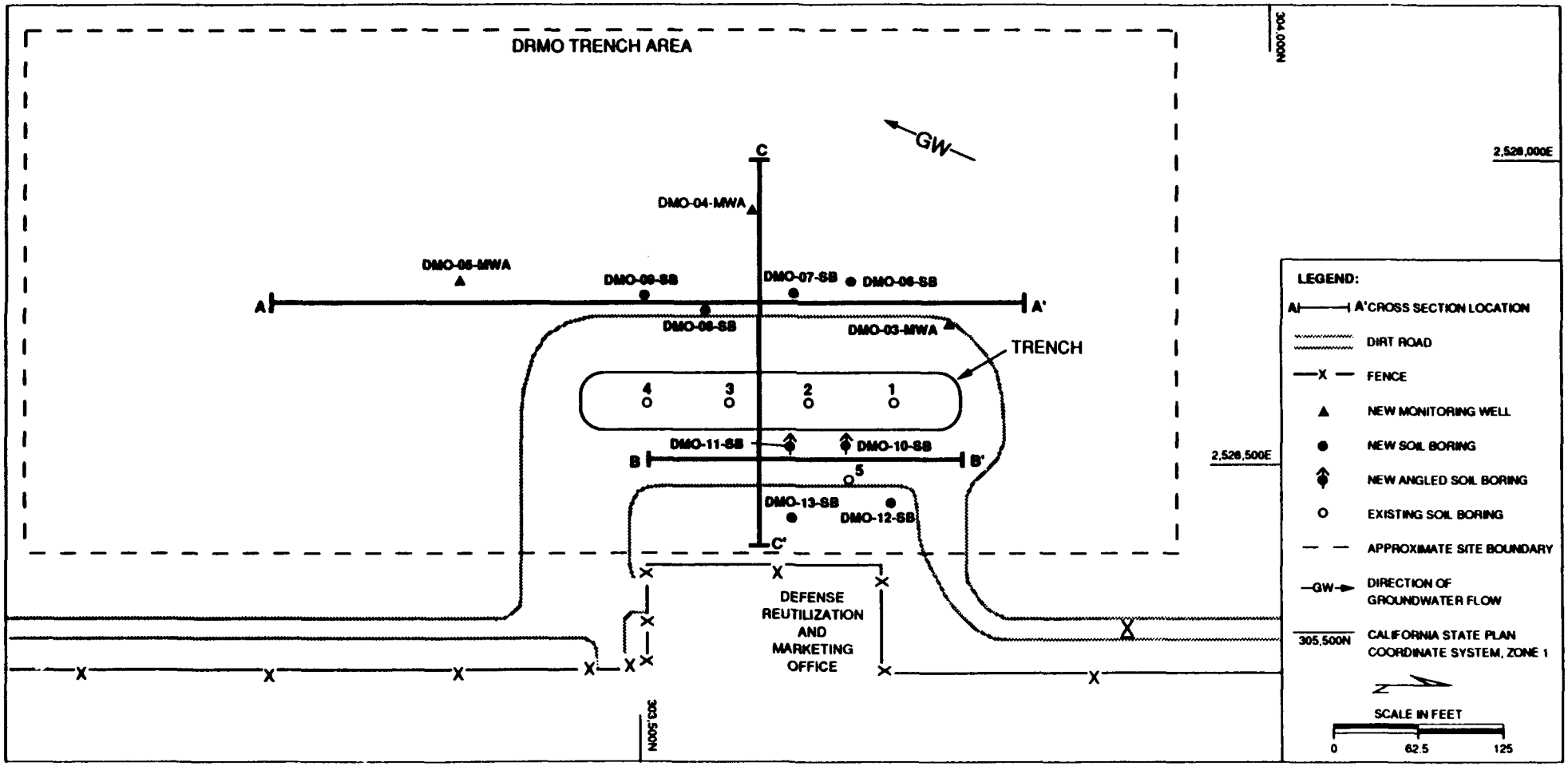
The geology and hydrogeology of the DRMO Trench Area subsurface soils were characterized using data from seven test pits (Figure 4-9), eight borings, and three monitoring wells installed during the Phase I RI (Figure 5-10). The test pits were excavated to 5 feet below ground surface. The total depths of the soil borings and monitoring wells were 90 and 110 feet, respectively. Three cross sections were constructed utilizing data from the soil borings and monitoring well boring logs (Figures 5-11 through 5-13). One-hour constant discharge pump tests were conducted on DMO-3-MWA and DMO-4-MWA. No aquifer test was performed on DMO-05-MWA because of a very low recharge rate.

Test pits were excavated in an area adjacent to the open trench existing at this site to sample and characterize the materials present in an historically reported buried trench (Benioff, et al., 1988). Excavation and geophysical investigations in this area did not locate this suspected buried trench (Appendix E).

A 20-foot by 150-foot burn and debris area was discovered approximately 120 feet to the southwest of the open trench (Figure 5-10). During Phase I RI activities, this area was tentatively identified as the covered trench. Four test pits were excavated to characterize this disturbed area. Upon excavation, it was discovered that this area was covered by a two- to four-inch thick ash layer mixed with miscellaneous surface metal debris. Native soil was encountered beneath this ash layer.

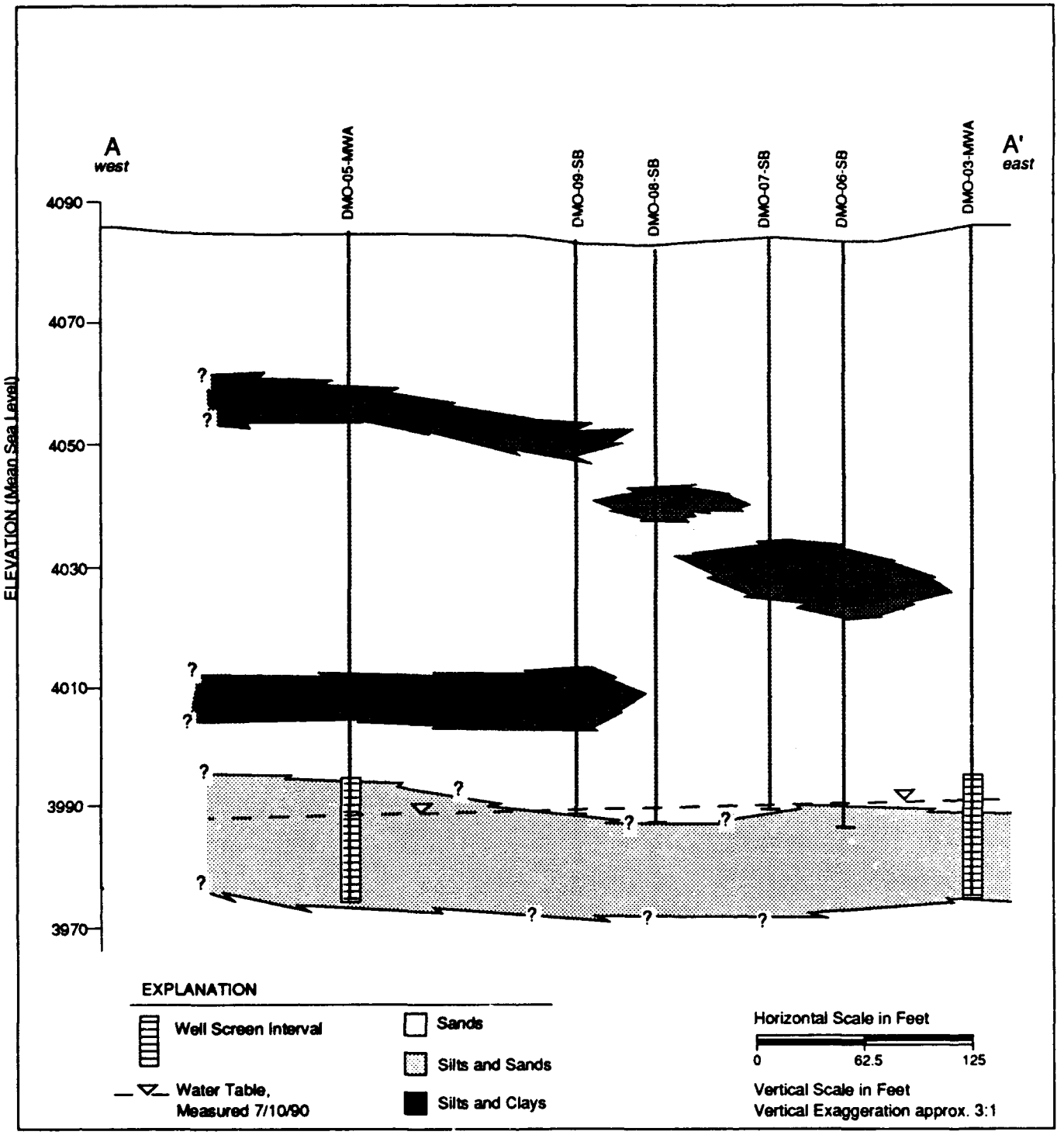
From 0 to 10 feet, the subsurface soils consist of light brown sands that are well sorted and subangular to subrounded. Interbedded and discontinuous silt, clay, and sand beds exist from about 10 feet to 100 feet. Silt and clay beds account for about 25 to 35 percent of the stratigraphy at this site.

Subsurface soils are dry to damp to the proximity of the water table, which is about 94 feet below ground surface at this site. The water table aquifer materials consist of fine-grained silty clay and silty sand material.



SIERRA ARMY DEPOT
CROSS SECTION LOCATIONS:
A-A', B-B', AND C-C'; DRMO TRENCH AREA

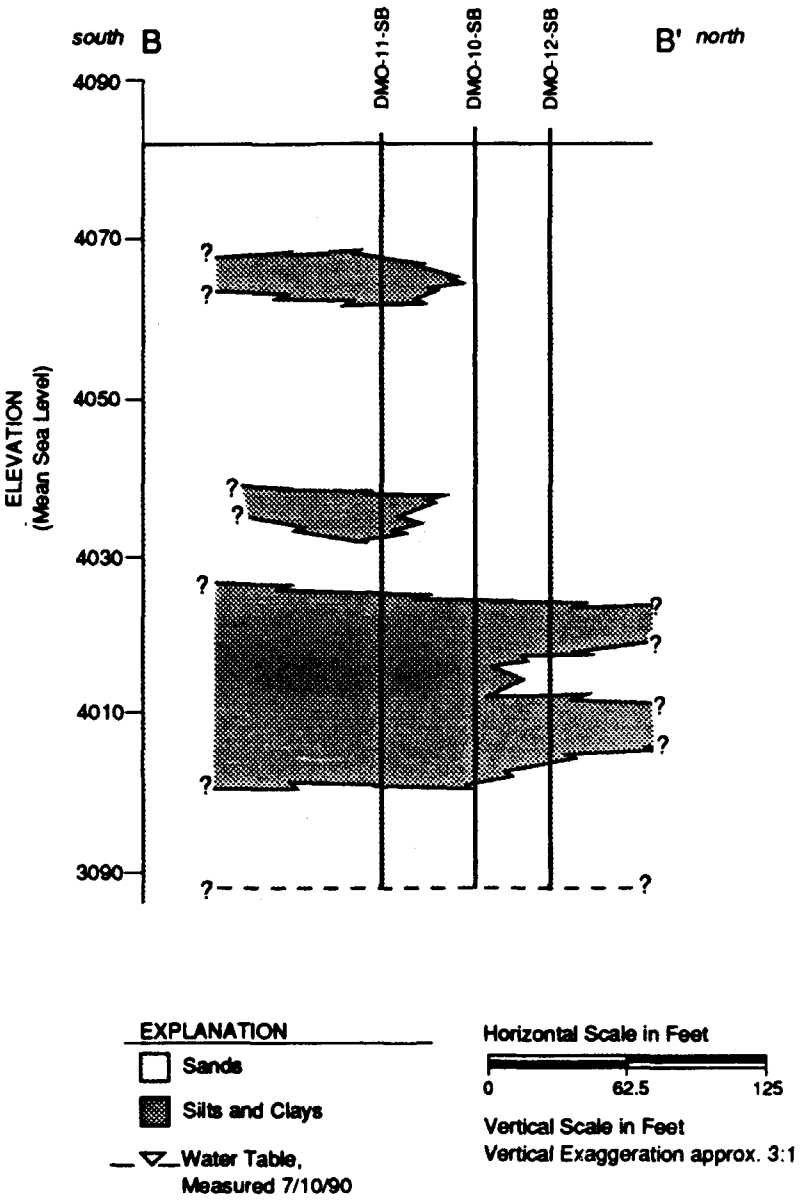
FIGURE 5-10



SIERRA ARMY DEPOT

CROSS SECTION A-A'
DRMO TRENCH AREA

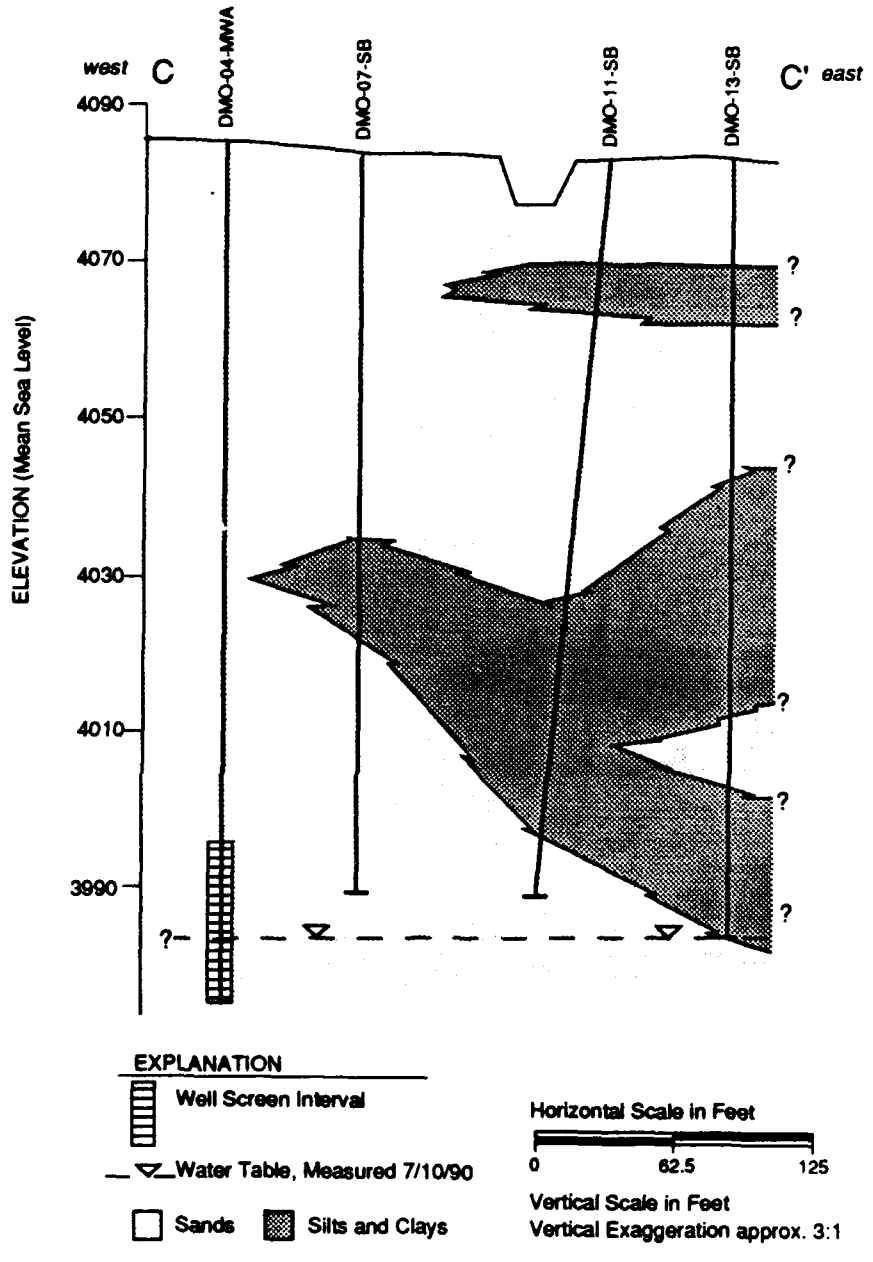
FIGURE 5-11



SIERRA ARMY DEPOT

CROSS SECTION B-B'
DRMO TRENCH AREA

FIGURE 5-12



SIERRA ARMY DEPOT

CROSS SECTION C-C'
DRMO TRENCH AREA

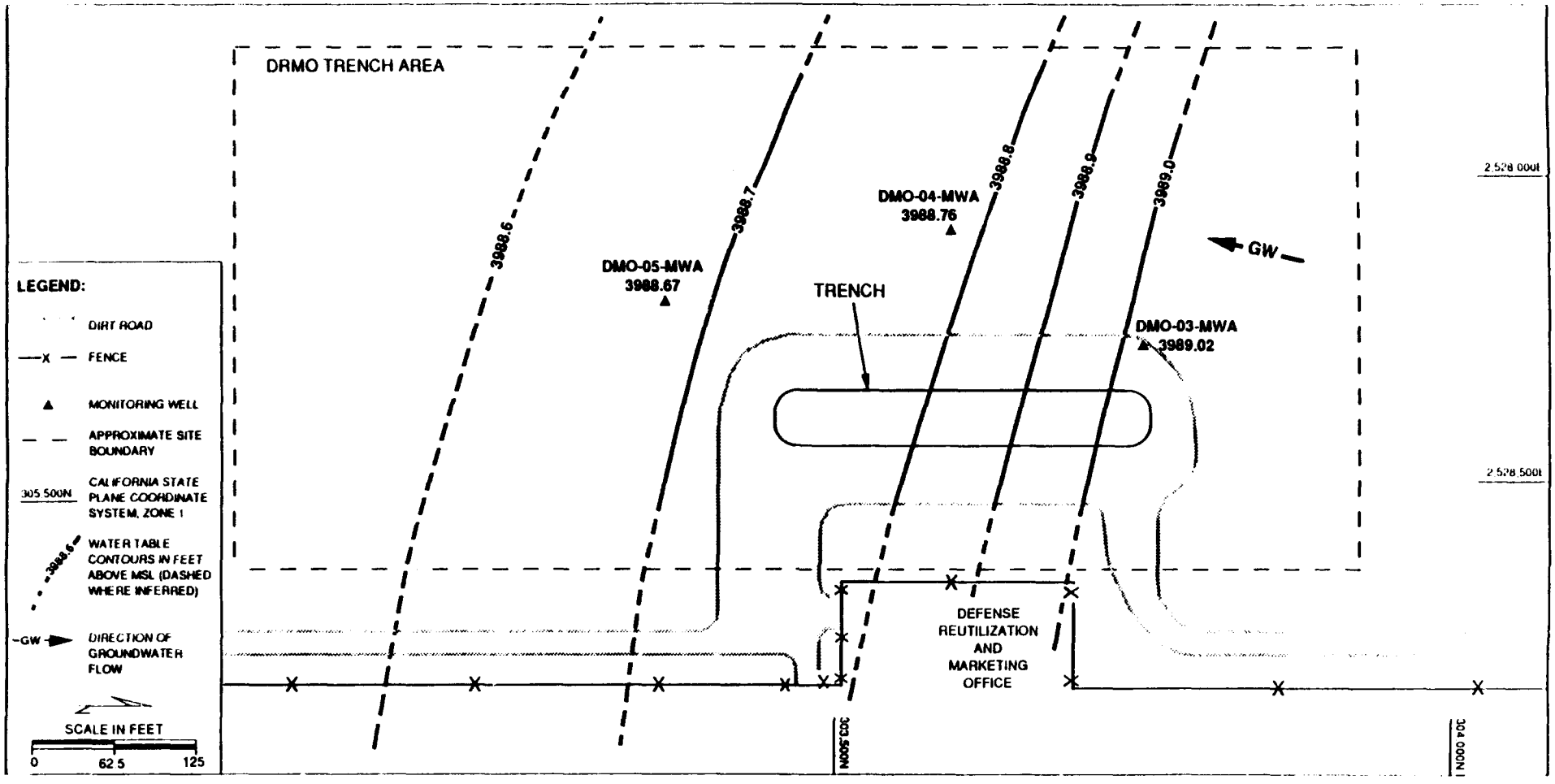
FIGURE 5-13

One-hour constant discharge tests were conducted on DMO-03-MWA and DMO-04-MWA. Aquifer test results are presented in Table 5-2 and Appendix L. Aquifer test results show low hydraulic conductivities in both wells: 1.6 feet/day in DMO-03-MWA and 0.78 feet/day in DMO-04-MWA. These hydraulic conductivity values reflect the fine-grained nature of the water table aquifer in this area. Recovery in DMO-05-MWA was too low to perform a meaningful pump test. Based on the stratigraphy encountered in deep soil borings within the southern portion of SIAD (Figure 5-3), this fine-grained low hydraulic conductivity zone is expected to be less than 20 to 30 feet thick.

Water level measurements taken in April, June, and July 1990 from the three wells installed during the Phase I RI indicate a groundwater gradient of .0016 to the southwest at this site (Figure 5-14). This groundwater gradient direction is opposite the north-northwest regional groundwater gradient (Figure 5-3). This change in gradient may be due to the proximity of the DRMO Trench Area to the Herlong potable supply wells. These supply wells are about 2,700 feet southwest of the DRMO Trench Area (Figure 5-4). It is suspected that pumping of the supply wells causes a broad depression of the water table to the south, thereby reversing the groundwater gradient in this area (Figure 5-4). A similar groundwater gradient reversal was not observed at the Abandoned Landfill. This may be due to an increased hydraulic conductivity to the northeast. It should also be noted that the well spacings at the DRMO Trench Area are much closer than those at the Abandoned Landfill. Because of this, a small groundwater gradient reversal that was detected at the DRMO Trench Area may not be detected in the Abandoned Landfill.

5.7 TNT LEACHING BEDS AREA

The geology and hydrogeology of the TNT Leaching Beds Area was characterized using data from 10 existing monitoring wells, 14 new monitoring wells, 13 soil borings drilled to the water table, eight surface soil samples, and one deep soil boring drilled to 250 feet (Figures 4-13, 4-14, and 4-19). Subsurface soils were characterized by observing and describing the continuous core collected from the 250-foot-deep soil boring (DSB-06-SB), split-spoon samples collected at 5-foot intervals from the soil borings, and cuttings from



SIERRA ARMY DEPOT
PIEZOMETRIC SURFACE:
DRMO TRENCH AREA (JULY 1990)

FIGURE 5-14

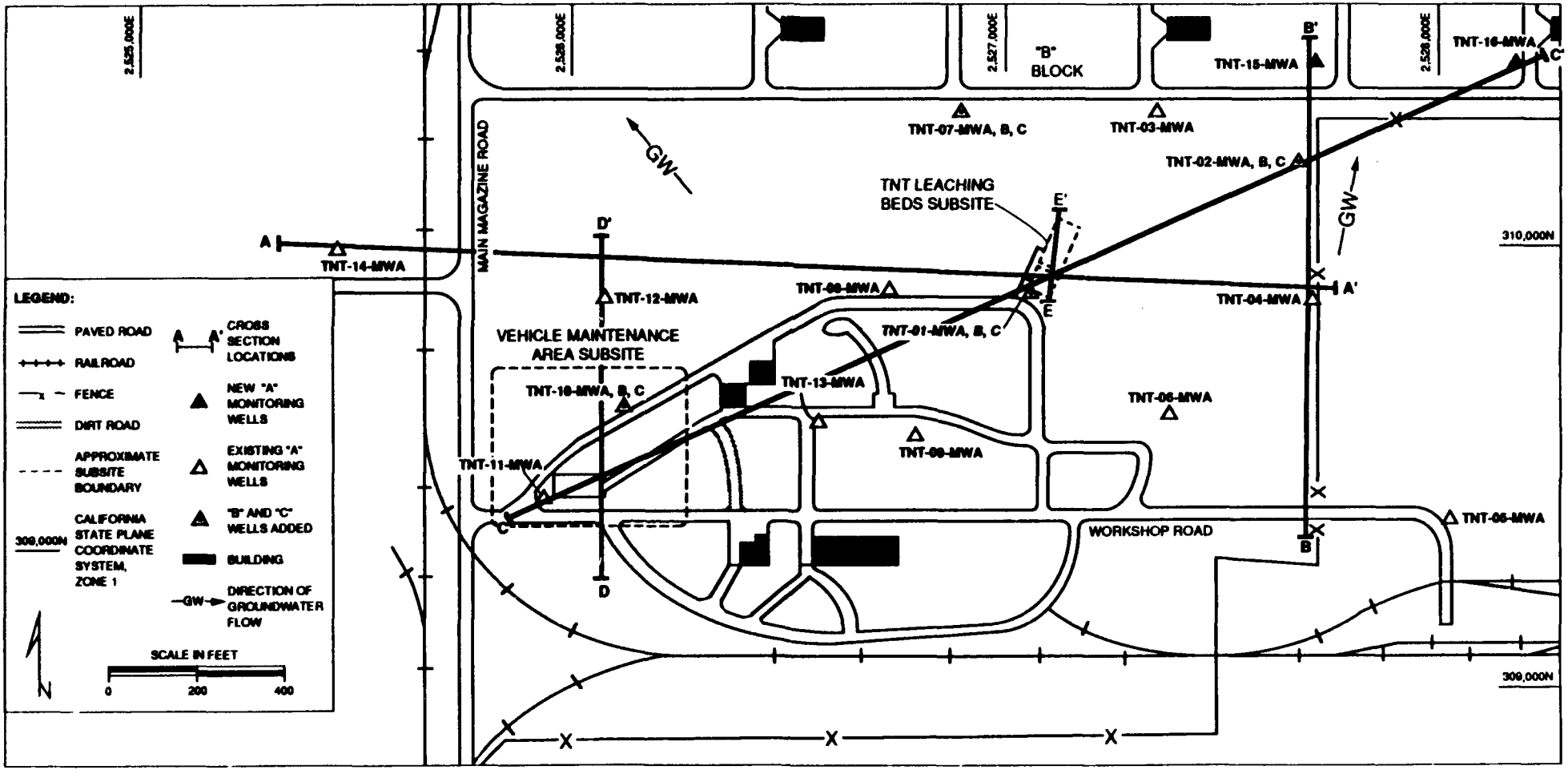
water table monitoring well borings. A series of cross sections, A to A' through E to E', were constructed from boring logs to show the correlation of the subsurface geology (Figures 5-15 through 5-21). The piezometric surface was measured during April, June, and July 1990 (Table 5-1). A water table contour map was constructed using water level data collected during July 1990 (Figure 5-22).

The surface soils in the area consist of the Amedee loamy sand series (Benioff, et al., 1988). From the ground surface to approximately 40 feet, the predominant soil type is generally light brown, fine- to medium-grained, and well-sorted sand (Figures 5-15 through 5-21). Silts and clays interbedded and interfingering with fine- to medium-grained sands were commonly observed from approximately 40 to 120 feet. Bed thickness in this interval ranged from about 2 to 15 feet. Approximately 50 percent of the soils in the 40- to 120-foot interval are comprised of these fine-grained beds.

From 120 to 250 feet, sand is the dominant textural constituent comprising approximately 90 percent of the stratigraphy as represented in DSB-06-SB. Sands in this zone are generally medium-grained, moderately well to well sorted, and subangular to subround. Laminar and low-angle cross bedding was observed in cores collected from the 120- to 250-foot interval.

The stratigraphy of the 0- to 40-foot interval suggests that the depositional environment of these sediments was similar to the present day environment, primarily an eolian/distal alluvial fan depositional environment. The 40- to 120-foot interval is distinguished by interbedded sands, silts, and clays that exhibit horizontal laminations. This interval probably represents near-shore Honey Lake deposits and a Honey Lake transgression. The 120- to 250-foot interval is dominated by sand which indicates a period of Honey Lake regression where the lake configuration and depositional environment in this area may have been similar to what is seen in the present day.

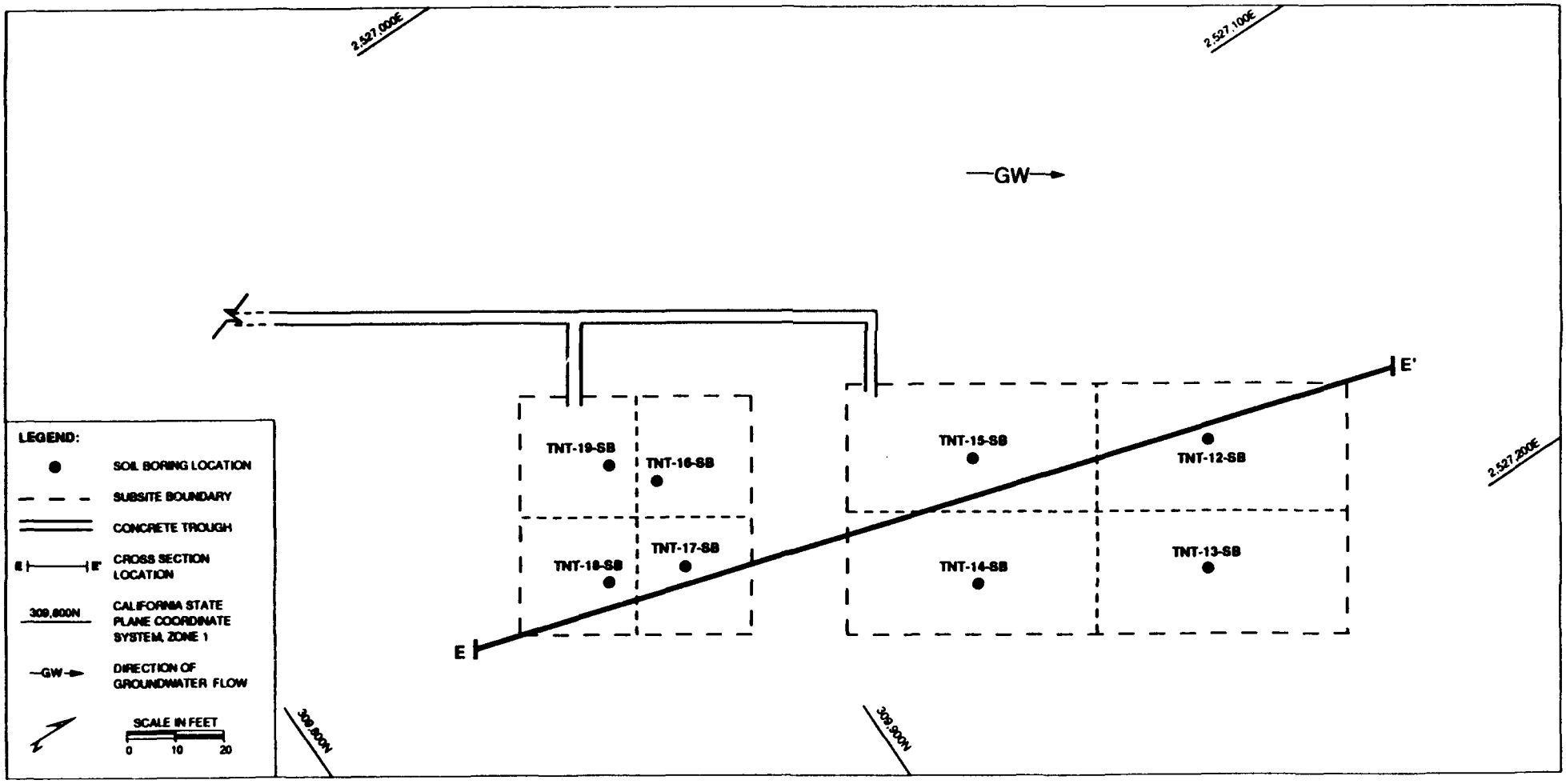
Groundwater level data collected from 16 water table wells at this site show that the groundwater gradient is generally oriented northward. The average gradient is about .0015 (Figure 5-22). In the western portion of the site, the groundwater orientation is



SIERRA ARMY DEPOT

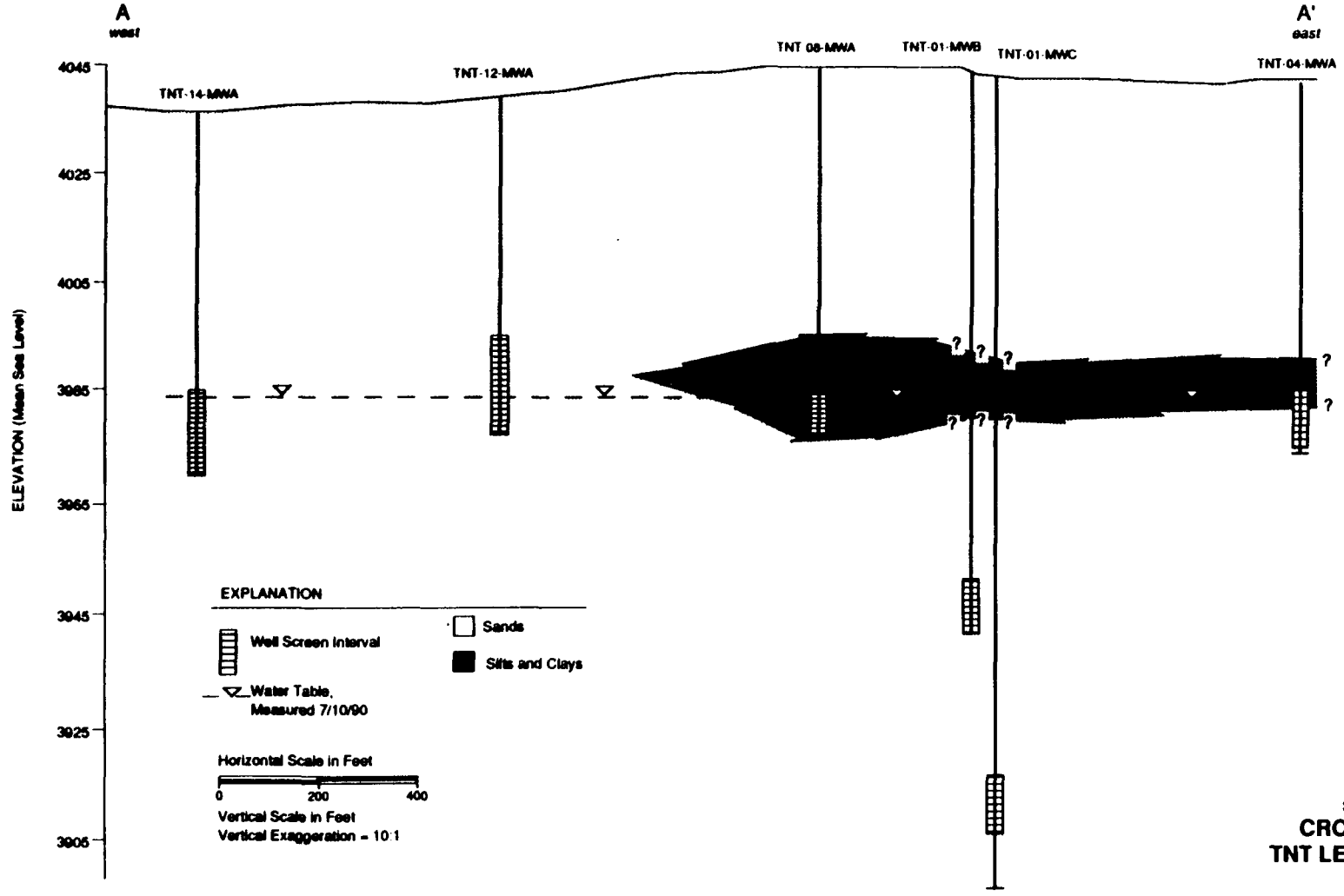
CROSS SECTION LOCATIONS A-A', B-B', C-C', D-D' & E-E':
TNT LEACHING BEDS AREA

FIGURE 5-15



SIERRA ARMY DEPOT
CROSS SECTION LOCATION E - E':
TNT LEACHING BEDS AREA

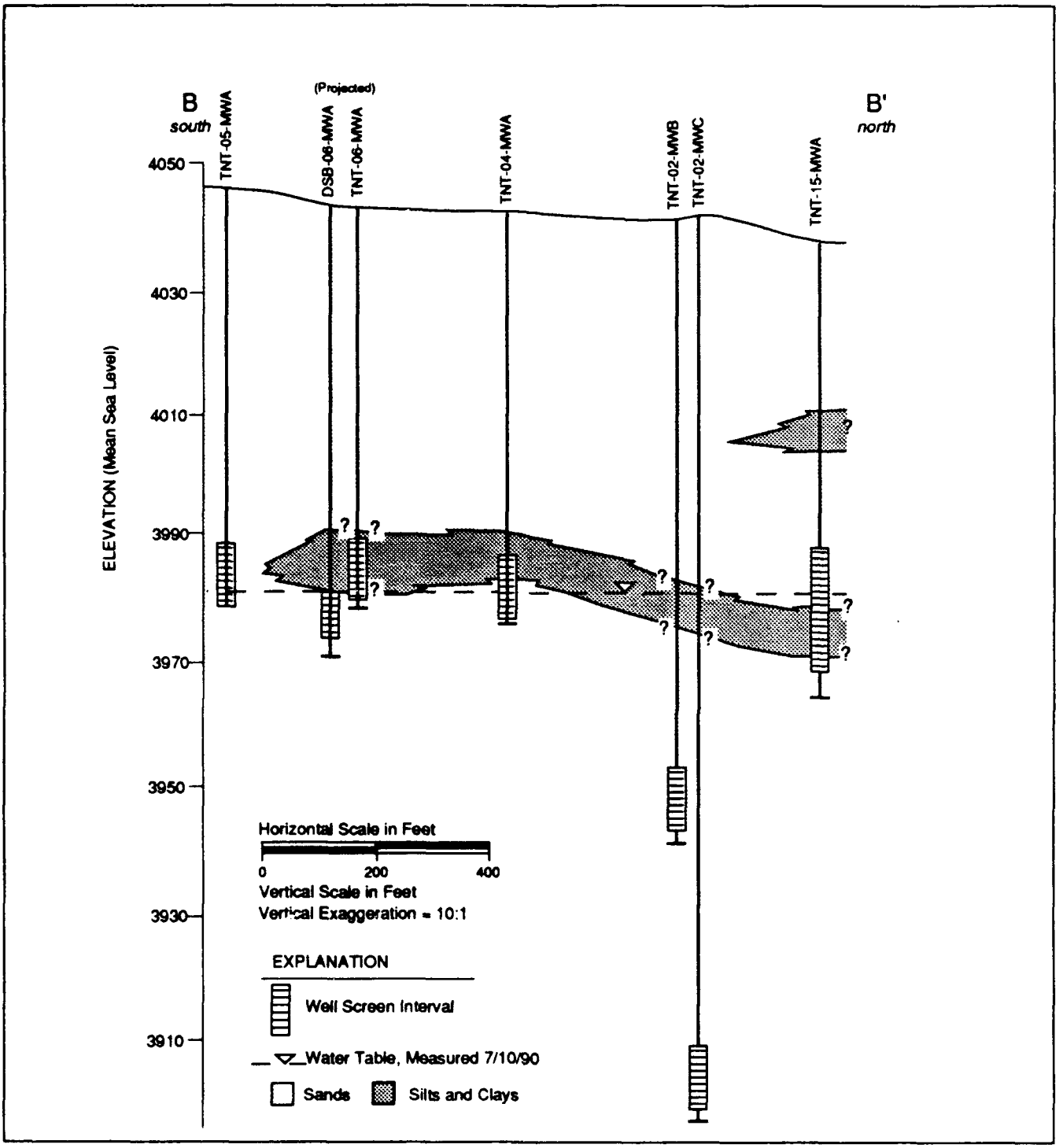
FIGURE 5-16



SIERRA ARMY DEPOT

CROSS SECTION A-A'
TNT LEACHING BEDS AREA

FIGURE 5-17



SIERRA ARMY DEPOT

CROSS SECTION B-B'
TNT LEACHING BEDS AREA

FIGURE 5-18

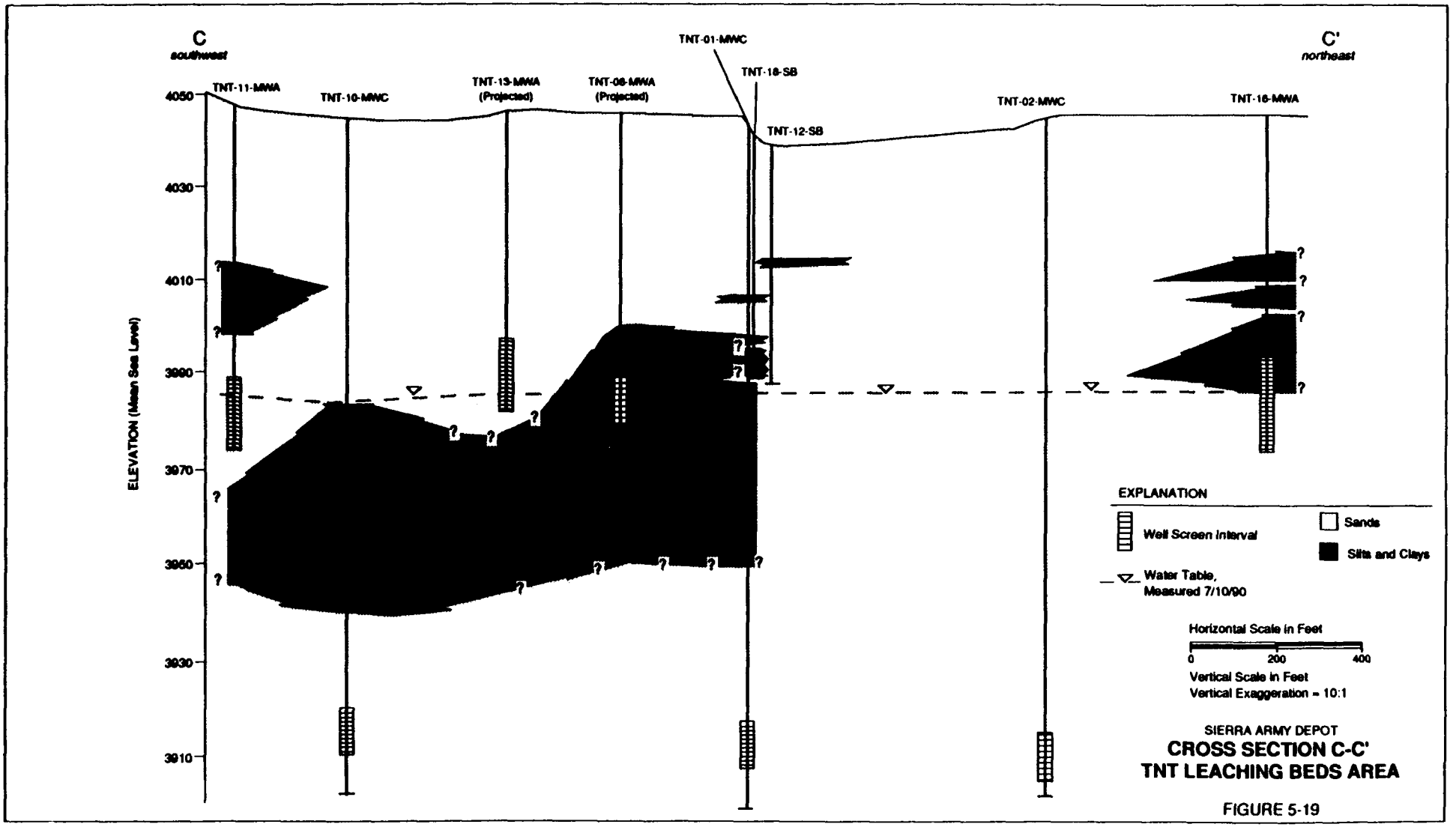
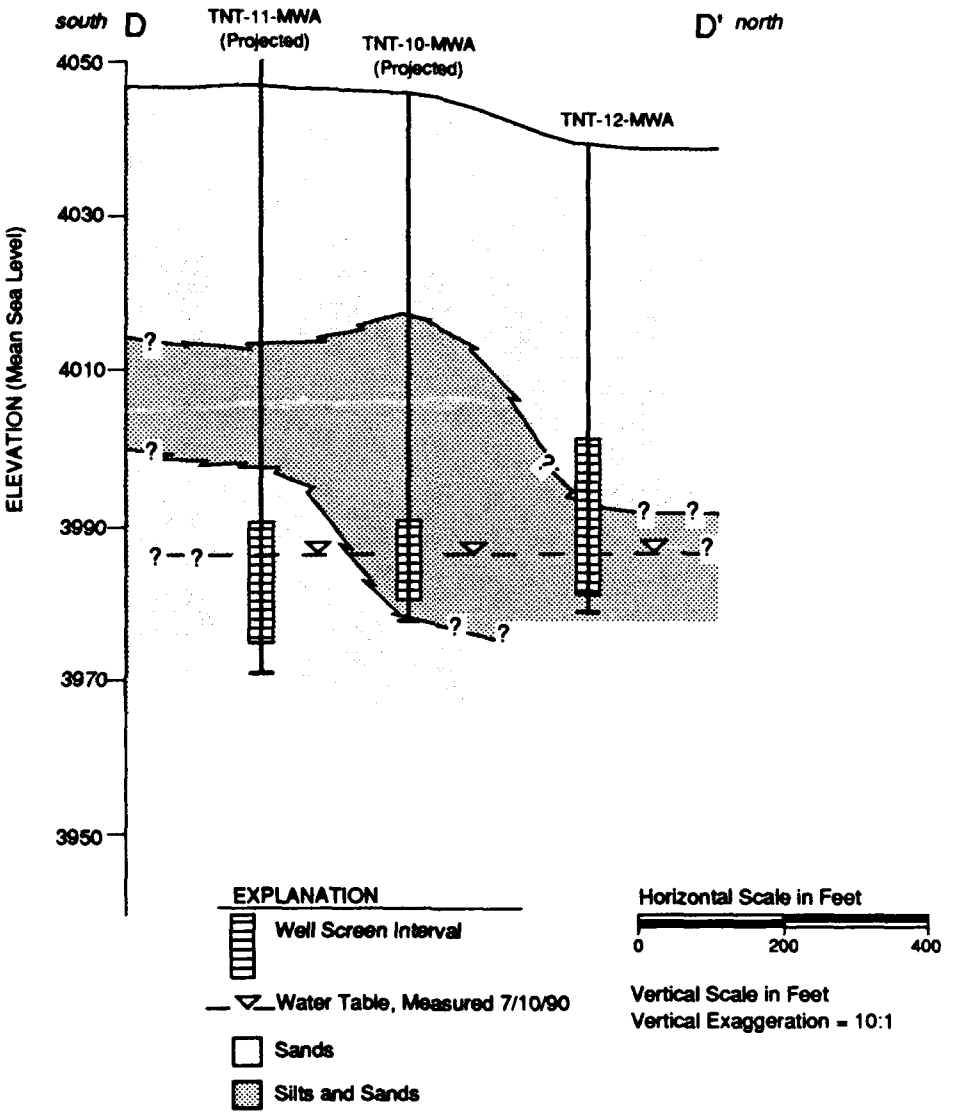

C
southwest
C'
northeast
TNT-11-MWA
TNT-10-MWC
TNT-13-MWA
(Projected)
TNT-08-MWA
(Projected)
TNT-01-MWC
TNT-18-SB
TNT-12-SB
TNT-02-MWC
TNT-16-MWA
ELEVATION (Mean Sea Level)
4050
4030
4010
3990
3970
3950
3930
3910
EXPLANATION
Well Screen Interval
Sands
Silts and Clays
Water Table,
Measured 7/10/90
Horizontal Scale in Feet
0
200
400
Vertical Scale in Feet
Vertical Exaggeration = 10:1
SIERRA ARMY DEPOT
CROSS SECTION C-C'
TNT LEACHING BEDS AREA

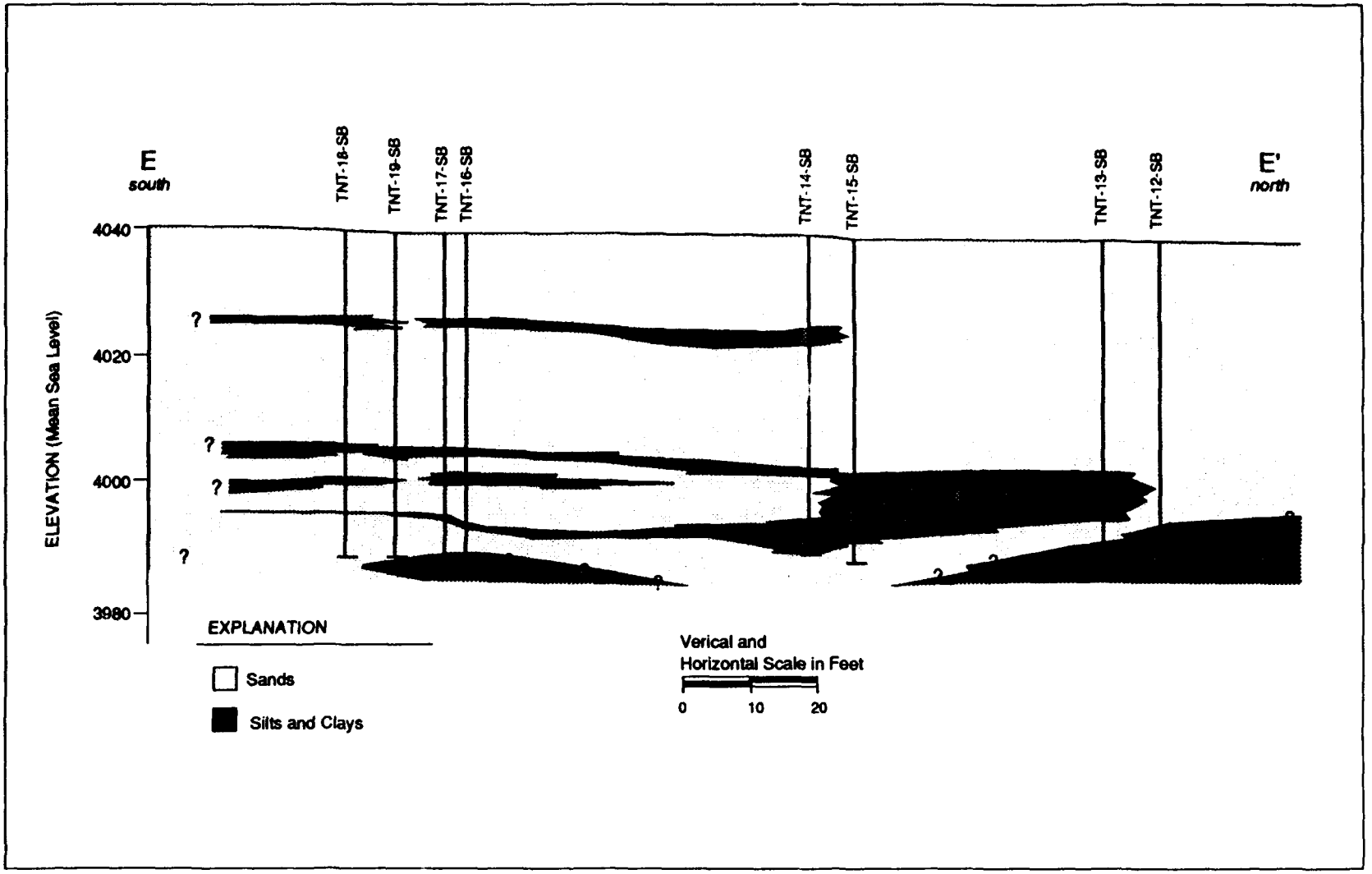
FIGURE 5-19



SIERRA ARMY DEPOT

CROSS SECTION D-D'
TNT LEACHING BEDS AREA

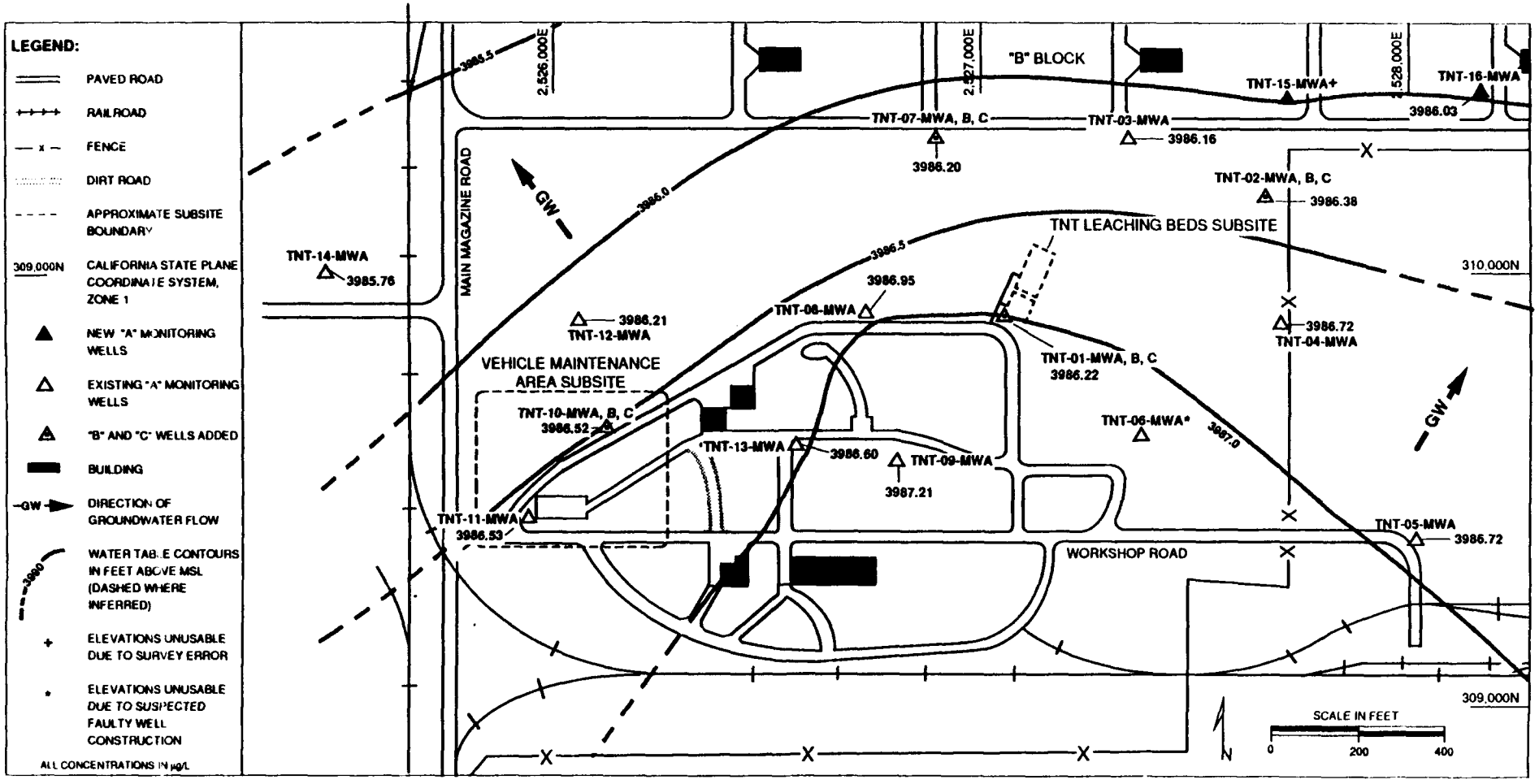
FIGURE 5-20



SIERRA ARMY DEPOT

CROSS SECTION E-E'
TNT LEACHING BEDS AREA

FIGURE 5-21



SIERRA ARMY DEPOT
PIEZOMETRIC SURFACE, "A" ZONE WELLS:
TNT LEACHING BEDS AREA (JULY 1990)

FIGURE 5-22

N 50 W. In the eastern portion the orientation is N 20 E (Figure 5-22). The groundwater in the vicinity of the Vehicle Maintenance Area Subsite is moving towards the northwest and the groundwater at the TNT Leaching Beds Subsite is moving towards the northeast (Figure 5-22).

A groundwater mound exists in the central portion of the site which is possibly due to a water line leak (AEHA, 1988). TNT-16-MWA and TNT-06-MWA were not used in the construction of the piezometric surface map due to suspected survey errors.

Aquifer tests were conducted in order to assess aquifer characteristics and to determine the degree of hydraulic connection between the upper and lower aquifer zones at this site. A one-hour constant discharge test was conducted on TNT-16-MWA. Four-hour aquifer tests were conducted on each of the "B"and "C"zone wells at the TNT-01-MWA, TNT-02-MWA, TNT-07-MWA, and TNT-10-MWA well-cluster locations. (See Section 4.12 for a discussion of aquifer test procedures.) Semi-log and log-log plots were made of the aquifer test results (Appendix K) and were used to calculate the hydraulic conductivities, transmissivities, and storage coefficients of groundwater beneath this site. Log-log plot curves were compared to standard curves to help interpret the nature of this aquifer.

Aquifer test results indicate that there is little to no hydraulic connection between the upper and lower zones at the TNT-01-MWA, TNT-07-MWA, and TNT-10-MWA well cluster locations and a minor hydraulic connection at the TNT-02-MWA well cluster location. A drawdown response of about 6 inches was registered in observation well TNT-02-MWA while pumping TNT-02-MWB at a rate of 20 gallons per minute (gpm).

The bottom of the screened interval in the "B" zone wells is about 40 feet below the bottom of the screened interval in the "A"zone wells. When plotted on log-log paper, the drawdown curve shape indicates that the aquifer at the TNT Leaching Beds Site is unconfined (Freeze and Cherry, 1979).

The very limited hydraulic connection between the upper and lower zones suggests that the intermittent fine-grained zones may inhibit downward contaminant migration at this site. Horizontal hydraulic conductivities at this site ranged from 0.16 feet/day (TNT-01-MWB) to 37.5 feet/day (TNT-02-MWB). Vertical hydraulic conductivities could not be determined because of the low response in the observation wells. Factors affecting the observation well response include the intermittent silt and clay zones in the 40- and 120-foot interval and the relatively short pump test durations. A greater response in observation wells in each cluster may occur with a longer aquifer test. The range in hydraulic conductivities reflects the heterogeneity of the stratigraphy at this site. Aquifer test results are presented in Table 5-2.

Observations made during the soil boring support the pump tests conclusions of very limited hydraulic connection between upper and lower zones. Stratigraphic data show that silt and clay zones are common and discontinuous at the TNT Leaching Beds Site. The uneven distribution of these low hydraulic conductivity zones may account for the increased hydraulic connection at the TNT-02-MWA well cluster location. It should be noted that these silt and clay zones are saturated when encountered below the water table, indicating no perched zones exist in the shallow aquifer.

5.8 SUMMARY

The geology of the SIAD shallow subsurface displays a transition from predominately coarse-grained distal alluvial fan and Long Valley Creek sediments in the south, to silt and clay lacustrine sediments in the north. Facies transitions from south to north are represented by interbedded fine- and coarse-grained sediments that are restricted in their distributions, resulting in heterogeneous sediment assemblages.

The hydrogeology of the five priority sites is marked by a nearly flat groundwater gradient, about .002, that generally trends northward. The gradient is essentially flat in the northern portion of SIAD. The groundwater gradient may be locally distorted in the southern portion of SIAD due to water withdrawal from the Herlong potable supply

wells, as reflected by the reversal of the groundwater gradient from north to south at the DRMO Trench Area site.

The heterogeneous nature of the sediments at each of the five priority sites is responsible for the wide range of hydraulic conductivities which ranged from 0.28 ft./day to 108 ft./day. Pump tests conducted on "B"and "C"zone wells at the TNT Leaching Beds show poor vertical hydraulic connection at this site.

Section 6

Contamination Assessment



6.0 CONTAMINATION ASSESSMENT

The purpose of the contamination assessment work element is to characterize distribution of contamination at each of the five SIAD Phase I RI sites. Additionally, the contamination assessment must evaluate the migration potential and fate of contaminants associated with these sites. It provides the interpretive link between the tabulated, validated chemical data, field observations, the interpreted hydrogeological and physical environment, and the characterization of human health risks and environmental impacts. The major outputs of the contamination assessment are the spatial distribution of chemical contaminants in each of the environmental matrices: identification, qualitative (and to the extent possible, quantitative) characterization of contaminant sources, and an assessment of contaminant migration potential.

Numeric fate and transport modeling of 1,3,5 trinitrobenzene (TNB) and TCE was conducted at the TNT Leaching Beds Area. No modeling was performed at the other Phase I sites due to either insufficient data sets or lack of contaminants found at the sites. For sites with insufficient data sets, recommendations for further study are presented in Section 9.0.

This section is divided into two parts. Section 6.1 discusses the quality of the data gathered during the Phase I RI. Section 6.2 discusses natural background metals expected to be found at SIAD, the distribution of contaminants in soil and groundwater at each site, and the water quality of the Herlong potable water supply wells. Included in this section are chemical data tables, figures and cross sections showing contaminant distribution in soil and groundwater, soil gas and groundwater plume maps, and vadose zone and groundwater modeling results.

6.1 CHEMICAL ANALYSES AND DATA QUALITY

6.1.1 Analytical Methods

Soil and groundwater samples collected as part of the SIAD Phase I RI/FS were analyzed for numerous organic compounds and inorganic analytes in accordance with the SIAD QA/QC Plan by Environmental Science and Engineering, Inc., Gainesville, Florida. Classes of

chemicals measured in project samples included volatile and semivolatile organic compounds, organochlorine pesticides, polychlorinated biphenyls, nitroaromatic compounds (explosives), metals, and miscellaneous chemical parameters, as listed in Table 6-1. A complete listing of analytical results is included in Appendix M.

6.1.2 Data Quality Assessment

A comparison of Phase I RI analytical results to project data quality objectives (DQOs) forms the basis for evaluating the generated analytical data quality. As described in the SIAD Phase I QA/QC Plan, analytical data must be of a known and acceptable quality in order to be used to evaluate site contamination at SIAD. Determination of data quality is based on evaluation of the precision, accuracy, representativeness, comparability, and completeness (PARCC) characteristics of the data. Once these characteristics have been evaluated, a determination may be made as to whether the data are appropriate for the intended uses. With the exception of a limited number of analytical results, SIAD Phase I analytical results met project data quality objectives and are appropriate for planned uses without qualification. The few exceptions, as discussed in the following sections, are limited in nature and do not result in substantial qualification of the contamination assessment. Quality control results discussed in the following sections are included in tabular form in Appendix N.

6.1.2.1 Precision

The reproducibility of measurements under a given set of conditions, or precision, was evaluated based on the analysis of two different types of QC samples: duplicate laboratory control samples and duplicate field samples. The first type, duplicate spiked QC samples, are required as part of the USATHAMA analytical program for non-GC/MS methods and provide ongoing information on the performance of each analytical method in a standard matrix. USATHAMA has reviewed and approved all duplicate laboratory control sample results related to the SIAD project.

The second type of QC sample, duplicate field samples, was included as part of the SIAD Phase I RI program in order to obtain additional information on sampling and analysis

TABLE 6-1

REFERENCED METHODS FOR SOIL AND AQUEOUS SAMPLES

Parameter	USATHAMA Method Soil	USATHAMA Method Aqueous	EPA Method Equivalent Soil	EPA Method Equivalent Aqueous	Method Description
Priority Pollutant Volatile Organic Compounds	LM19	UM20 & GC	8240	624	GC/MS
Priority Pollutant Base/Neutral/ Acid Extractable	LM18	UM18	8270	625	GC/MS
Priority Pollutant Metals					
Aluminum	JS11	SS10	6010	200.7	ICP
Antimony	JS11	SS10	7041	204.2	ICP
Arsenic	JD19	SD22	4060	206.2	GFAA
Barium	JS11	SS10	6010	200.7	ICP
Beryllium	JS11	SS10	6010	200.7	ICP
Cadmium	JS11	SS10	6010	200.7	ICP
Chromium	JS11	SS10	6010	200.7	ICP
Copper	JS11	SS10	6010	200.7	ICP
Lead	JS11	SD20	6010	239.2	ICP/GFAA
Mercury	JB01	SB01	7471	245.1	Cold Vapor AA
Nickel	JS11	SS10	6010	200.7	ICP
Selenium	JD15	SD21	7740	270.2	GFAA
Silver	JS11	SD23	6010	272.2	ICP/GFAA
Thallium	JS11	SD09	6010	200.7	GFAA
Zinc	JS11	SS10	6010	200.7	ICP
Additional California TTLC Metals					
Barium	JS11	(NS)	6010	(NS)	ICP
Hexavalent Chromium	(NA)	(NS)	7196	(NS)	Colorimetric
Cobalt	JS11	(NS)	6010	(NS)	ICP
Molybdenum	JS11	(NS)	6010	(NS)	ICP
Vanadium	JS11	(NS)	6010	(NS)	ICP

TABLE 6-1 (Continued)

REFERENCED METHODS FOR SOIL AND AQUEOUS SAMPLES

Parameter	USATHAMA Method Soil	USATHAMA Method Aqueous	EPA Method Equivalent Soil	EPA Method Equivalent Aqueous	Method Description
Priority Pollutant Pesticides/ PCB	LH10/LH16	UH13/UH02	8080	608	Gas Chromatography/ECD
Explosives	LW12	UW14	(NA)	(NA)	HPLC
Sulfate, Chloride	(NS)	TT10	(NS)	300.0	Ion Chromatography
Calcium, Sodium	(NS)	SS10	(NS)	200.7	ICP
Total Dissolved Solids	(NS)	(NA)	(NS)	160.2	Gravimetric
Total Cyanide	KY01	TF18	9012	335.3	Colorimetric
Total Phenols	(NA)	(H2)	420.1	420.1	Spectrophotometric
Asbestos	(NA)	(NS)	600/4-82-020	(NS)	Light Microscopy
Ignitability	(NA)	(NS)	1010	(NS)	Closed Cup
Reactivity	(NA)	(NS)	910/9030	(NS)	Cyanide/Sulfide
Bioassay	(NA)	(NS)	CA Dept. of Fish and Game	(NS)	Static Acute LC50
Dioxins/Furans	(NA)	(NS)	8280	(NS)	GC/MS

(NS) Indicates analysis not scheduled for this matrix
(NA) Indicates not applicable
ICP is inductively coupled plasma; GFAA is graphite furnace atomic absorption; GC/MS is gas chromatography/mass spectroscopy
HPLC is high pressure liquid chromatography
PCDD/PCDF are polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans

precision as expressed as the relative percent difference (RPD) between duplicate samples. With the exception of results for several inorganic and explosive compounds, the majority of duplicate field sample RPDs are within the performance objectives presented in the SIAD Phase I RI/FS QA/QC Plan. The most substantial trend for results outside objectives was for arsenic in soil samples: 13 of the 31 RPDs were outside objectives (RPDs for arsenic in soil ranged between 0.62 and 107 percent, with a mean RPD of 26 percent).

6.1.2.2 Accuracy

Accuracy, or the bias in a measurement system, was evaluated based on laboratory control and field samples spiked with target and surrogate compounds. Each type of spiked sample provides different information on the accuracy of the measurement system. Laboratory control samples are used as the primary control on accuracy of the laboratory system. As discussed in Section 6.1.2.1, laboratory control sample results met project and USATHAMA requirements.

Surrogate compounds spiked into field samples provide information of the efficiency of all steps of a GC/MS method in recovering these compounds from the individual environmental sample matrices. Under the USATHAMA analytical program, surrogate recoveries are not used to determine if an analytical method is in control. Instead they are used to obtain information on possible sample matrix effects. One out of three VOC surrogates were outside recovery objectives provided by the laboratory for approximately 20 soil samples. No problems were identified in the surrogate recoveries for the related laboratory control samples. These results suggest that limited matrix effects may have been encountered during VOC analysis of these samples.

The most substantial example of matrix effects in soil samples occurred during the analysis of soil sample DMO-11-SB for semivolatile compounds at a depth of 15 feet: six out of six semivolatile surrogate compounds were not recovered (0 percent recovery). Associated laboratory control sample results were acceptable.

Surrogate recoveries for groundwater samples that were outside recovery objectives were generally limited to one analyte per method per sample. The noticeable exceptions to this trend are the recoveries of acid extractable compounds (e.g., phenols) for the potable supply well samples: PSW-02, PSW-08, and PSW-09. Poor surrogate recoveries in these samples ranged from 0 to 6.7 percent. Similar recoveries were obtained from Round 2 water samples. These consistently low recoveries may be due to some environmental factor present in these wells. Due to low surrogate recoveries, the measurement of acid extractable semivolatile compounds in the potable supply wells requires qualification.

The final type of QC parameter used for assessing accuracy, field samples spiked with target analytes, were analyzed for almost all methods. Approximately five percent of the field samples were spiked to obtain information on sample matrix effects. In general, individual spike recoveries for soil samples were within recovery objectives presented in the SIAD QA/QC Plan for more than 85 percent of the spiked samples. Several organic compounds had recoveries within objectives for approximately 53 to 74 percent of the spiked samples. These organic compounds included phenol, pentachlorophenol, and 2,4-DNT according to the semivolatile analysis (Method LM18) and 2,4-DNT and 1,3,5-TNB according to the explosives method (Method LW12). These compounds generally have low recoveries when analyzed by these methods. The spike recoveries for one soil sample analyte (selenium), were consistently outside the 75 to 125 field duplicate sample recovery objectives. The spike recovery in the 50 spiked soil samples ranged between 24.7 and 72.9 percent. The low recoveries may be due to the volatilization of the analyte or matrix effects. Since the laboratory control sample results did not indicate a problem with this analysis, actual selenium results in soil may be slightly higher than reported. Regardless, these levels, when corrected for low recoveries, are substantially below the level of concern based on the on-site risk assessment.

In general, groundwater natural matrix target analyte recoveries are consistent with surrogate recoveries. No problems were associated with laboratory control sample recoveries. This suggests that matrix interferences may be the cause of low recoveries. Potable supply well sample PSW-02 had the largest number of recoveries that were outside suggested limits, consistent with surrogate recovery results.

6.1.2.3 Representativeness

Representativeness to actual site conditions is achieved through representative sample collection, handling, and analysis procedures. Several types of QC samples provide information on the representativeness of various parts of this system: method blanks, trip blanks, rinsate samples, and filter blanks.

Method blank results were below certified reporting limits (CRLs) for both soil and water lots. One exception was lead at 322 μg/g in the soil lot PZP. Six other samples included in this lot (samples ALF-01-SB at 90 and 95 feet, and ALF-02-SB at 10, 30, 70, and 80 feet) also contained lead at concentrations between 52.7 and 305 μg/g. The laboratory redigested and reanalyzed these six samples to determine if sample results should be considered false positives. Lead results from reanalyses performed in August 1990 were all less than the CRL (6.62 μg/g). Method blank results above CRLs for water lots include calcium, chromium, copper, sodium, and zinc in lot RUH and bis(2-ethylhexyl)phthalate in lots SAL and SAN. These positive method blank results do not affect results for field samples in the same lots because field sample results were blank corrected (in accordance with USATHAMA water sample protocols which were approved by DHS) by subtracting the method blank instrument response from the field and laboratory control sample responses for all samples within the same lot.

Trip blanks, the second type of QC sample used to assess representativeness, provide information on possible VOC contamination of field samples during handling and shipment. Thirty-one trip blanks were submitted with soil VOC samples. Only one contaminant was detected in a trip blank: Trip blank SISTB-3, shipped on March 13, 1990, contained trichloroethene (TCE) at 0.73 μg/L. One soil sample shipped with this trip blank, ALF-03-SB from the 5-foot interval, also contained TCE at 0.02 μg/g. However, significance of the positive trip blank sample is limited because: (1) matrices of trip blank and samples are different with correspondingly different detection limits, (2) the higher TCE concentration was found in the soil sample, and (3) none of the other soil samples shipped with the trip blank (sample ALF-01-SB, ALF-02-SB, and ALF-04-SB, all from the 5-foot interval) contained TCE.

Sixteen trip blanks were submitted to the laboratory during the first round of groundwater sampling. Two of these trip blanks associated with samples shipped on April 20 and May 7, contained below 1 μg/L of at least one of the following compounds: trans-1,3-dichloropropene, carbon tetrachloride (both based on GC analysis), and toluene (based on GC/MS analysis). These positive results do not indicate possible sample contamination because field samples shipped with these two trip blanks did not contain any of these compounds (samples TNT-01-MWB, TNT-01-MWC, and DMO-03-MWA were shipped on April 20; samples PSW-02, PSW-02DUP, PSW-08, and PSW-09 were shipped on May 7).

Rinsate samples, the third type of QC sample, were collected from each SIAD site for both soil and groundwater samples. Samples were obtained by collecting purified deionized water that has been poured over or through a decontaminated sample collection container. Rinsate samples were analyzed for all parameters of interest at a given site to provide a measurement of the cumulative contamination derived from field sampling equipment, rinse blank water, sample transit, storage, and analysis.

With the exception of dissolved residue and sodium, compounds detected in rinsate samples were not detected in groundwater samples from the corresponding site. Concentration of dissolved residue and sodium may be indicative of concentrations that are present in uncontaminated rinsate water. One rinsate sample from 4/17/90, ALF-GW-RB, contained eight VOCs as listed below:

1,1,1-Trichloroethane	87.1 μg/L
1,1-Dichloroethene	1.13 μg/L
Trichlorofluoromethane	3.01 μg/L
Carbon tetrachloride	1.52 μg/L
Carbon Disulfide	1.09 μg/L
Ethylbenzene	86.7 μg/L
Toluene	2.65 μg/L
Trichloroethene	52.4 μg/L

However, none of these compounds was detected in site samples. There is no ready explanation for the presence of these compounds in the rinsate blank.

The last type of QC sample, filter blanks, provides information on inorganics contamination during the filtration process. Three filter blank samples were collected during the first round of groundwater sampling. Calcium was detected in all three samples while copper and sodium were only detected in one sample. These results may be indicative of actual dissolved contaminant concentrations in the deionized water or due to contamination from the filter. Field sample results may require qualification based on these data. However, the significance of this qualification is limited because the majority of field samples contained approximately two orders of magnitude more calcium and sodium than the filter blanks. Further, copper was detected only sporadically in groundwater samples.

6.1.2.4 Comparability

The characteristic of comparability reflects the consistency of sample collection and handling procedures, analytical techniques, and expression of results in units consistent with other organizations reporting similar data. No substantial changes to planned procedures were made that would affect data comparability. However, it should be noted that several compounds of interest were detected by two separate methods. Comparison of these replicate results must take into account the strengths and weaknesses of each method. The following is a summary of replicate measurements of compounds and information on the analytical methods necessary to evaluate the results:

- Phenolic compounds were quantified according to two substantially different analytical methods: spectrophotometry and gas chromatography/ mass spectrometry (GC/MS). The former method is a nonspecific measurement of total phenolic compounds present in samples. Non-phenolic compounds with absorbance patterns similar to phenol interfere with this analysis. GC/MS analysis, on the other hand, is capable of identifying and quantifying numerous individual phenolic compounds with a high degree of certainty. Positive total phenol results, particularly for soil samples, should be considered false positives unless results are confirmed by GC/MS.

- All water samples were analyzed for four VOCs (vinyl chloride, cis- and trans-1,3-dichloropropene, and carbon-tetrachloride) by two methods: GC and GC/MS. All other VOCs were quantified based on GC/MS analysis. The GC analysis was used to quantify these select compounds because GC/MS CRLs are greater than MCLs. GC VOC results should only be used for results that are between the GC level of detection and the GC/MS CRLs.

- Organochlorine pesticides and select nitroaromatic compounds were measured according to two different methods. Both classes of compounds were quantified based on the semivolatile GC/MS method at relatively high limits of detection. In addition, pesticides and nitroaromatic compounds were measured to lower limits of detection based on GC and high performance liquid chromatography, respectively. Positive results from these different methods are comparable.

6.1.2.5 Completeness

The completeness measurement compares the amount of valid data obtained compared to the amount that was expected to be obtained under normal conditions. Two completeness objectives were established for this project: 100 percent for background samples and 90 percent for all other samples.

The objectives for background and other field sample results were met. All data planned for collection regarding background samples were obtained. Further, all analyses of SIAD soil and groundwater samples were performed within holding times. There are several gaps for the remaining field samples; however, the overall completeness of the data is substantially greater than 90 percent. The following is a summary of incomplete data:

- Chloride and sulfate were not analyzed in groundwater sample ALF-03-MWA due to the laboratory's lack of sample volume. However, this data loss is of minimal significance because chloride and sulfate results are available based on a duplicate sample collected at the same time and from the same well.
- Field measurement data (e.g., pH and temperature) for some groundwater samples were not obtained.

6.1.3 Data Quality and RI Objectives

Analytical data collected as part of the SIAD Phase I RI/FS is of a known and acceptable quality to be used to evaluate site contamination and potential risk to human health and the environment. Only a limited percentage of the data is qualified due to either unforeseen or inherent problems with the measurement system. The following QC results should be considered by data users:

- The recovery of surrogate and target analyte acid extractable compounds in samples from the potable supply wells (particularly wells PSW-02 and PSW-08) indicate that it may be difficult to quantify these compounds should they be present in the potable supply wells.

- Selenium measurements in soil samples may be biased low based on spike recoveries compared to recoveries in laboratory control samples, as discussed in Section 6.1.2.

6.2 CONTAMINANT DISTRIBUTION

6.2.1 Background Levels

Metals concentrations were assessed from soil samples collected in four of six deep soil borings collected outside of any area of known SIAD contamination. Metals concentrations for SIAD and typical desert soils are presented in Tables 6-2 and 6-3. Background groundwater results for Rounds 1 and 2 collected from monitoring well DSB-04-MWA, which was placed in an area upgradient of any known SIAD contamination, are presented in Table 6-4 and Table 6-5.

The range of metals values from background soil were: arsenic (2.010 μg/g to 16.000 μg/g), barium (72.300 μg/g to 630.000 μg/g), chromium (< 12.7 μg/g to 31.000 μg/g), lead (< 6.62 μg/g to 18.500 μg/g), molybdenum (< 1.15 μg/g to 4.030 μg/g), vanadium (30.200 μg/g to 130.000 μg/g) and zinc (< 30.2 μg/g to 84.200 μg/g). Background metals in Round 1 groundwater samples included arsenic (191.000 μg/L), barium (24.400 μg/L), cadmium (4.070 μg/L), copper (20.100 μg/L), and zinc (28.700 μg/L). Round 2 background groundwater results include arsenic (7.700 μg/L), barium (18.800 μg/L), selenium (7.700 μg/L), and silver (0.425 μg/L).

It is noted that selenium was detected at levels close to its MCL (10 μg/l) in the background monitoring well. Selenium was also found at levels above its MCL at various SIAD monitoring wells. However, because elevated selenium in groundwater is associated with agricultural activities, and because there is no agricultural activity on SIAD, the selenium found in the groundwater at SIAD may represent background conditions.

POSITIVE SOIL RESULTS - BACKGROUND SAMPLES

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
DSB-01-MWA	0.0	03-mar-1990	JD19	Arsenic	3.400	ug/g
	1.0	03-mar-1990	JS11	Barium	347.500	ug/g
		03-mar-1990	JS11	Lead	7.800	ug/g
		03-mar-1990	JS11	Vanadium	45.100	ug/g
	5.0	03-mar-1990	JD19	Arsenic	6.600	ug/g
		03-mar-1990	JS11	Barium	472.000	ug/g
		03-mar-1990	JS11	Vanadium	130.200	ug/g
		03-mar-1990	JS11	Zinc	73.500	ug/g
	13.0	03-mar-1990	JD19	Arsenic	17.800	ug/g
		03-mar-1990	JS11	Barium	373.400	ug/g
		03-mar-1990	JS11	Chromium	31.000	ug/g
		03-mar-1990	JS11	Molybdenum	4.000	ug/g
		03-mar-1990	JS11	Vanadium	100.900	ug/g
		03-mar-1990	JS11	Zinc	84.200	ug/g
DSB-02-MWA	1.0	04-mar-1990	JD19	Arsenic	2.100	ug/g
		04-mar-1990	JS11	Barium	436.700	ug/g
		04-mar-1990	JS11	Lead	8.500	ug/g
		04-mar-1990	JS11	Vanadium	54.500	ug/g
	5.0	04-mar-1990	JD19	Arsenic	2.300	ug/g
		04-mar-1990	JS11	Barium	198.300	ug/g
		04-mar-1990	JS11	Vanadium	42.400	ug/g
	35.0	04-mar-1990	JD19	Arsenic	3.200	ug/g
		04-mar-1990	JS11	Barium	72.900	ug/g
		04-mar-1990	JS11	Vanadium	44.900	ug/g
	40.0	04-mar-1990	JD19	Arsenic	12.500	ug/g
		04-mar-1990	JS11	Barium	626.300	ug/g
		04-mar-1990	JS11	Vanadium	115.800	ug/g
DSB-04-MWA	1.0	05-mar-1990	JD19	Arsenic	7.700	ug/g
		05-mar-1990	JS11	Barium	315.700	ug/g
		05-mar-1990	JS11	Lead	18.500	ug/g
		05-mar-1990	JS11	Vanadium	49.700	ug/g
		05-mar-1990	JS11	Zinc	79.900	ug/g
	5.0	05-mar-1990	JD19	Arsenic	2.600	ug/g
		05-mar-1990	JS11	Barium	72.300	ug/g
		05-mar-1990	JS11	Vanadium	30.200	ug/g
	20.0	05-mar-1990	JD19	Arsenic	5.200	ug/g
		05-mar-1990	JS11	Barium	146.000	ug/g
		05-mar-1990	JS11	Vanadium	51.000	ug/g

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

TABLE 6-3

NATIVE SOIL CONCENTRATIONS OF METALS

Element	Concentration (mg/kg) Typical Range[a] (Worldwide)	Typical Range[a] (Worldwide)	Typical Range[c] US Alluvial Soils	Typical Range[c] US Desert Soils
Silver	--	0.1 - 5.0	--	--
Aluminum	10,000 - 300,000	10,000 - 300,000	--	--
Arsenic	0.1 - 40	1.0 - 40	2.1 - 22	1.2 - 18
Beryllium	--	0.1 - 40	1 - 3	<1 - 7
Cadmium	0.01 - 2	0.01 - 7.0	0.41 - 0.57[d]	--
Chromium	5 - 1,500	5 - 3,000	15 - 100	10 - 200
Copper	2 - 250	2.0 - 100	5 - 50	5 - 100
Mercury	0.01 - 0.5	0.01 - 0.08	0.02 - 0.15	0.02 - 0.32
Nickel	2 - 750	5.0 - 1,000	7 - 50	7 - 150
Lead	2 - 300	2.0 - 200	10 - 30	10 - 70
Antimony	--	0.6 - 10	0.25 - 0.6[d]	--
Selenium	0.01 - 2	0.1 - 2.0	<0.1 - 2.0	<0.1 - 1.1
Thallium	--	0.1 - 12	0.02 - 2.8[d]	--
Zinc	1 - 900	10 - 300	20 - 108	25 - 150

[a] Mattigod and Page (1985)
[b] Dragun (1988)
[c] Kabata-Pendias and Pendias (1984)
[d] Various US soils

POSITIVE GROUNDWATER RESULTS - ROUND 1 - BACKGROUND SAMPLES

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
DSB-04-MWA	22.9	24-apr-1990	SD22	Arsenic	190.000	ug/l
		24-apr-1990	SS10	Barium	24.400	ug/l
		24-apr-1990	SS10	Calcium	220000.000	ug/l
		24-apr-1990	SS10	Cadmium	4.070	ug/l
		24-apr-1990	SS10	Copper	20.100	ug/l
		24-apr-1990	SS10	Sodium	2300000.000	ug/l
		24-apr-1990	SS10	Zinc	28.700	ug/l

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

POSITIVE GROUNDWATER RESULTS - *ROUND 2 - BACKGROUND SAMPLES*

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
DSB-04-MWA	22.9	08-jun-1990	SD21	Selenium	7.700	ug/l
		08-jun-1990	SD22	Arsenic	170.000	ug/l
		08-jun-1990	SD23	Silver	0.425	ug/l
		08-jun-1990	SS10	Barium	18.800	ug/l
		08-jun-1990	SS10	Calcium	220000.000	ug/l
		08-jun-1990	SS10	Sodium	2300000.000	ug/l

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

6.2.2 Abandoned Landfill

The distribution and extent of contamination at the Abandoned Landfill Site was assessed based on review of data collected as part of the following Phase I RI activities: soil gas and geophysical surveys, 11 test pits, four soil borings, and three monitoring wells.

6.2.2.1 Soil Gas Survey

Seventy-three soil gas samples were collected at this site to identify VOC soil sources and/or VOC plumes in the groundwater. Target compounds were TCA, TCE, PCE, methylene chloride, chloroform, carbon tetrachloride, benzene, ethylbenzene, toluene, and xylene (BETX), and total hydrocarbons (THC). Analytical procedures and results are presented in Appendix D.

Two areas of elevated organic compounds in shallow soil gas were detected at this site (Figures 6-1 and 6-2). Both areas are located near an access road in the extreme northern portion of the Abandoned Landfill Site. The smaller of the two areas located is in the northeastern portion of the site and is comprised primarily of TCE. The highest soil gas concentration of TCE was 2.0 μg/l at ALF-02-SG. Low levels of THC, 0.4 μg/l, were also detected in this area. ALF-03-SB and ALF-01-MWA were installed in the vicinity of this concentration of soil gas. Analytical results from samples collected from the monitoring wells and borings are discussed in Sections 6.2.2.3 and 6.2.2.4.

The larger of the two areas of elevated soil gas concentration is located in the northwestern portion of the Abandoned Landfill Site. Both TCE and carbon tetrachloride were detected in this area. The distribution of the soil gas, is oriented towards the north (Figure 6-1), which is coincident with the groundwater gradient. The highest TCE and carbon tetrachloride readings were 10.0 and 0.001 μg/l, respectively. ALF-02-MWA was installed in the vicinity of this area. Analytical results from this monitoring well are discussed in Section 6.2.2.4.

6.2.2.2 Test Pits

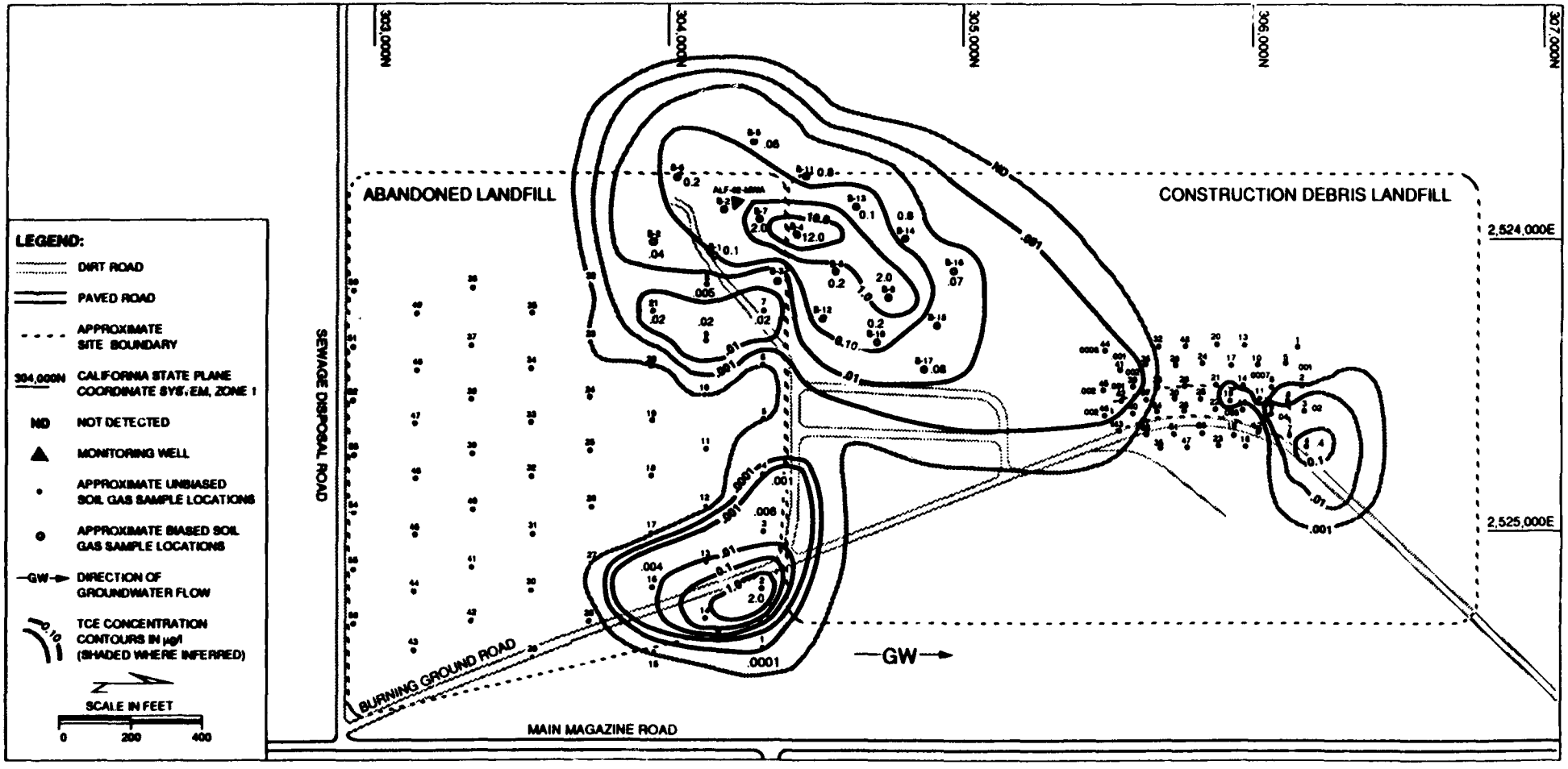
Eleven test pits (Figure 4-8) were excavated to characterize the Abandoned Landfill Site landfill material, clear the soil boring locations of landfill debris and possible ordnance, and to sample landfill material from four test pits at 5-foot intervals. The aerial extent of landfill debris was identified on the basis of geophysical anomalies (Figure 4-7 and Appendix C). Four of the 11 test pits were sampled and soil borings were installed in their centers. Table 4-3 lists each test pit location and characterization. Soil sample results are discussed in Section 6.2.2.3.

Surface scrap metal debris such as wire, bands, and lids were scattered throughout the Abandoned Landfill, account for many of the very high amplitude point-source geophysical anomalies, and therefore, were not excavated. Lower amplitude and more prevalent geophysical anomalies were investigated with test pits. Test pit characterization showed that these anomalies were typically related to ash and other burn debris. Disturbed thicknesses in these zones were about 6 inches.

Three old trenches were uncovered during the course of the test pit investigations. Two of the trenches were sampled at a depth of 5 feet and soil borings were placed in their centers. The depths of these trenches ranged from 6.5 feet to 9 feet. Household garbage associated with the odor of rotting organic matter was associated with these trenches.

6.2.2.3 Soil

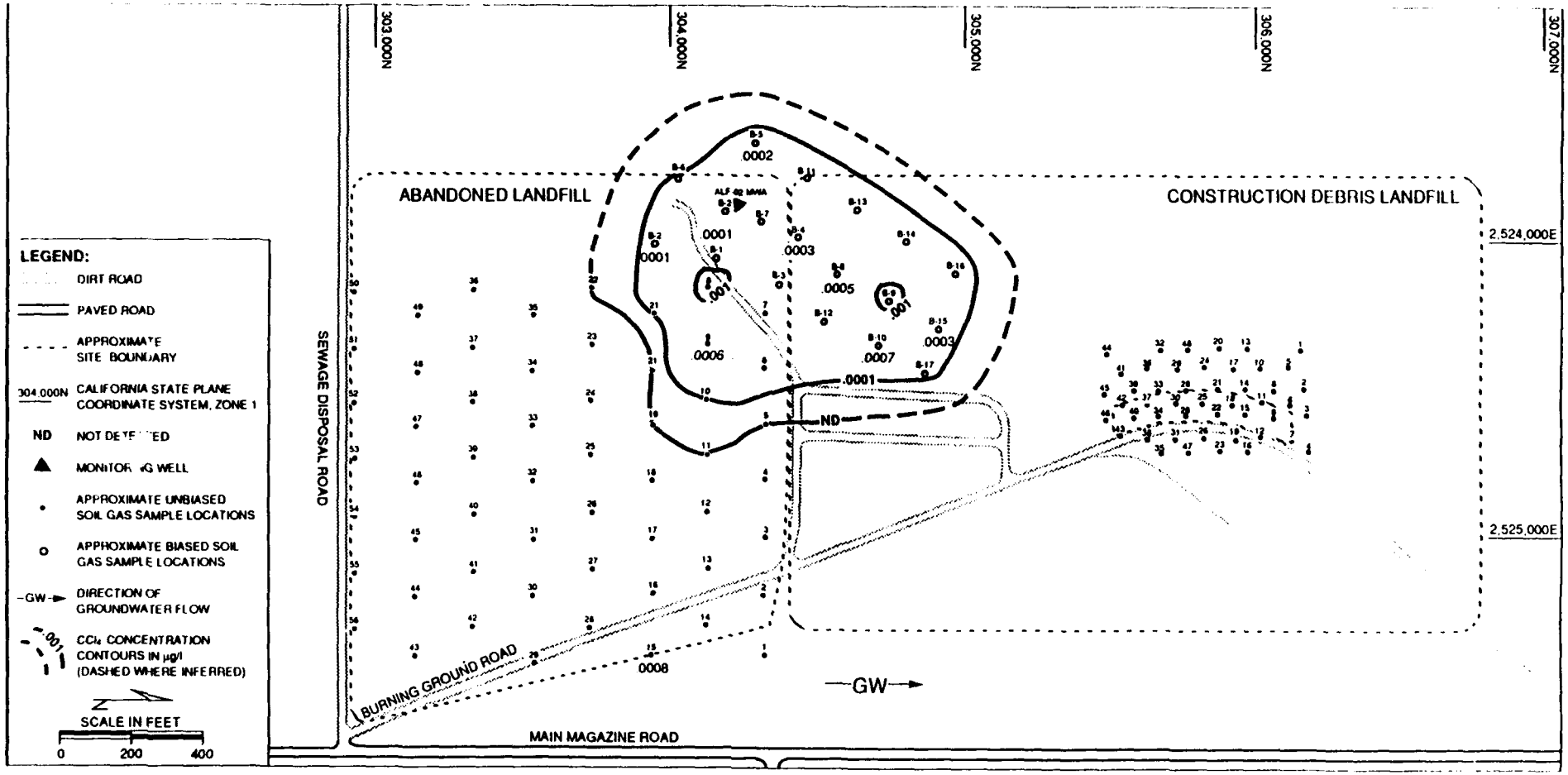
Four soil borings were installed to the water table (about 90 feet below grade) at this site. Fifty-three soil samples were collected at 5-foot intervals to 50 feet and at 10-foot intervals from 50 feet to the water table. Fifty-three soil samples collected from four soil borings were analyzed for inorganics (priority pollutant metals and cyanide), extractable organics (phenols, BNAs, and pesticides/PCBs), and VOCs. Four samples from each boring were analyzed for asbestos. A single sample from each boring, collected at a depth of 5 feet below ground surface, was analyzed for dioxin/furans. Analytical results are presented in Table 6-6 and Figures 6-3 through 6-5.



SIERRA ARMY DEPOT

TCE SOIL GAS PLUME:
ABANDONED LANDFILL/CHEMICAL BURIAL SITE/CONSTRUCTION DEBRIS LANDFILL

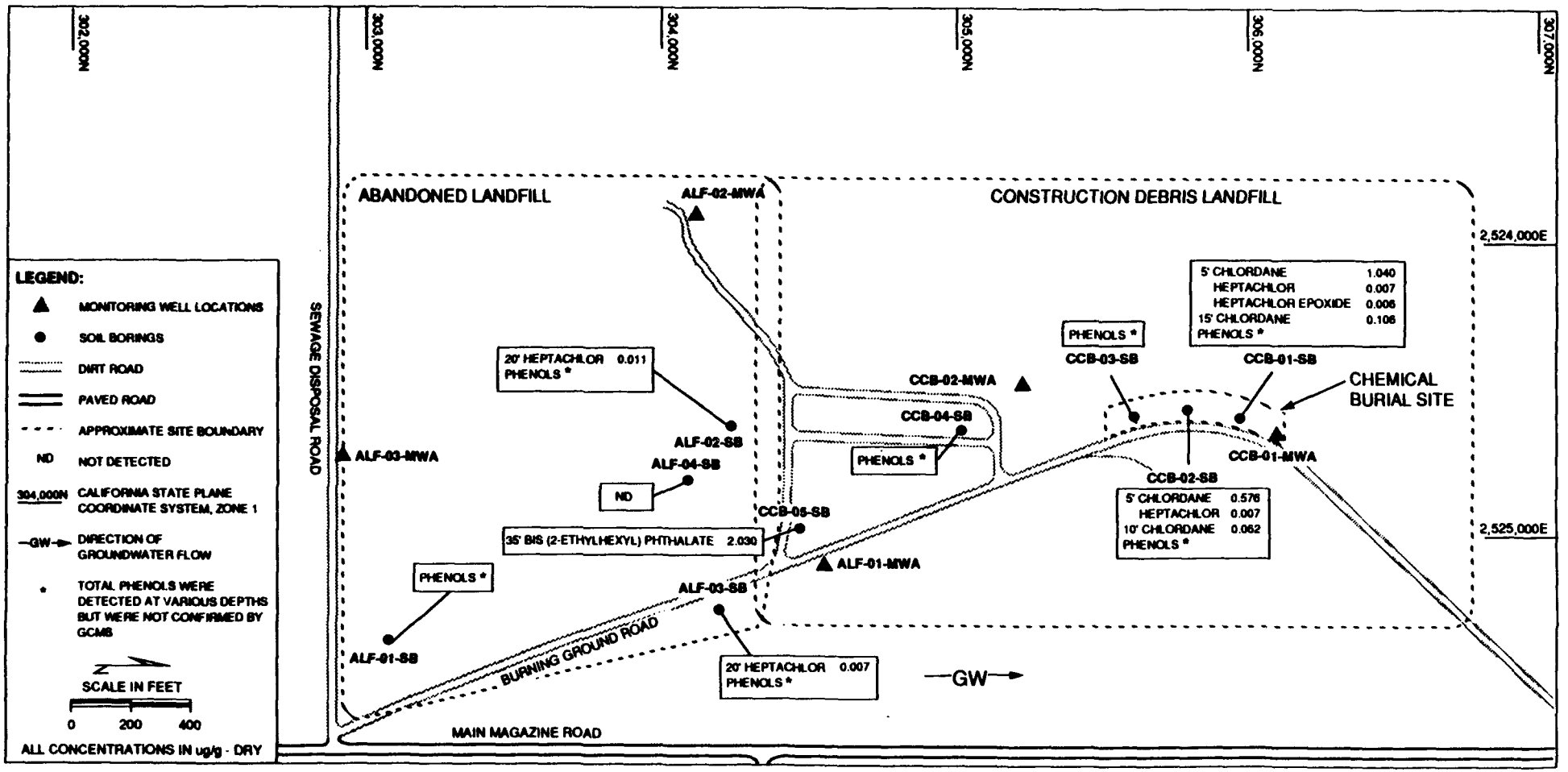
FIGURE 6-1



SIERRA ARMY DEPOT

CCl_4 SOIL GAS PLUME: ABANDONED LANDFILL/CHEMICAL BURIAL SITE/CONSTRUCTION DEBRIS LANDFILL

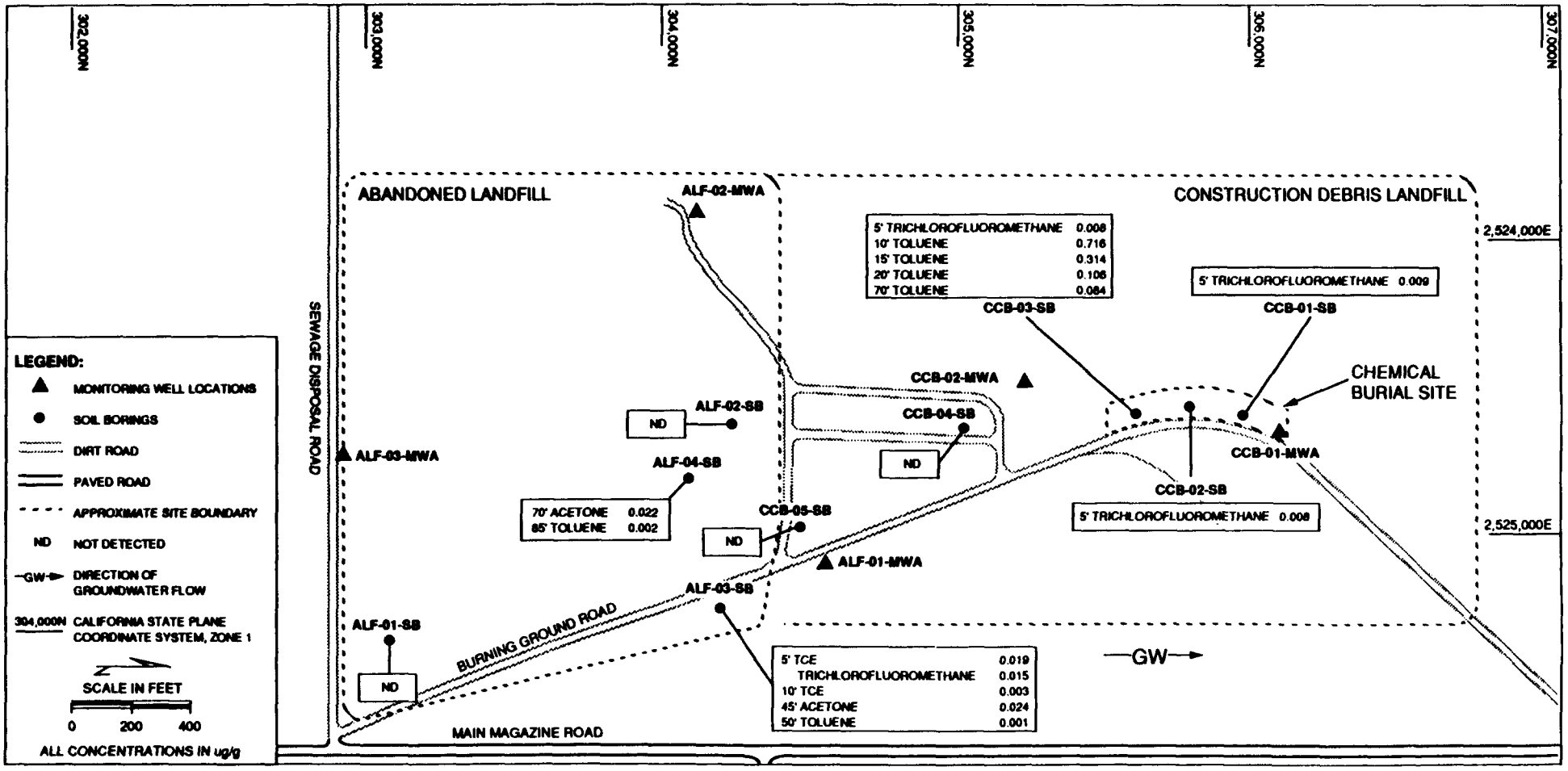
FIGURE 6-2



SIERRA ARMY DEPOT

EXTRACTABLE ORGANIC COMPOUND CONCENTRATIONS FROM SOIL BORINGS: ABANDONED LANDFILL/CHEMICAL BURIAL SITE/ CONSTRUCTION DEBRIS LANDFILL

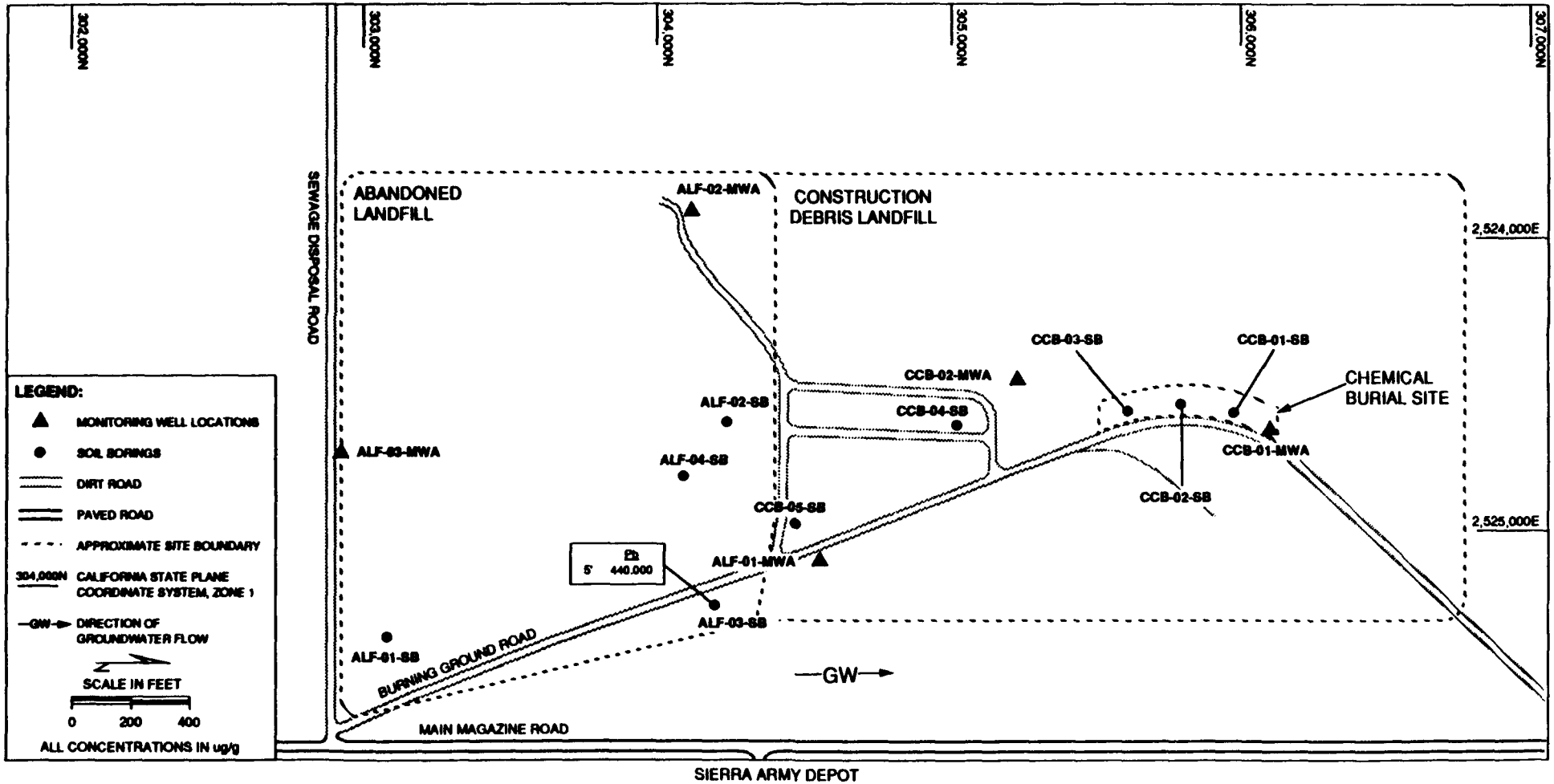
FIGURE 6-3



SIERRA ARMY DEPOT

VOC CONCENTRATIONS FROM SOIL BORINGS: ABANDONED LANDFILL/CHEMICAL BURIAL SITE/ CONSTRUCTION DEBRIS LANDFILL

FIGURE 6-4



SIERRA ARMY DEPOT

METALS CONCENTRATIONS ABOVE BACKGROUND: ABANDONED LANDFILL/ CHEMICAL BURIAL SITE/ CONSTRUCTION DEBRIS LANDFILL

FIGURE 6-5

POSITIVE SOIL RESULTS - ABANDONED LANDFILL SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
ALF-01-SB	5.0	13-mar-1990	99	Phenol	0.200	ug/g
		13-mar-1990	JD19	Arsenic	7.100	ug/g
		13-mar-1990	JS11	Zinc	56.300	ug/g
	10.0	17-mar-1990	99	Phenol	0.190	ug/g
		17-mar-1990	JD19	Arsenic	9.500	ug/g
		17-mar-1990	JS11	Zinc	95.800	ug/g
	15.0	17-mar-1990	JD19	Arsenic	6.600	ug/g
		17-mar-1990	JS11	Chromium	38.300	ug/g
		17-mar-1990	JS11	Nickel	36.700	ug/g
		17-mar-1990	JS11	Zinc	145.800	ug/g
	20.0	16-mar-1990	LM18	Unknown 613 (TIC)	0.250	ug/g
		17-mar-1990	99	Phenol	0.240	ug/g
		17-mar-1990	JD19	Arsenic	8.900	ug/g
		17-mar-1990	JS11	Zinc	109.500	ug/g
	25.0	17-mar-1990	99	Phenol	1.850	ug/g
		17-mar-1990	JD19	Arsenic	3.800	ug/g
	30.0	16-mar-1990	LM18	Unknown 512 (TIC)	0.310	ug/g
		17-mar-1990	JD19	Arsenic	8.100	ug/g
	35.0	17-mar-1990	99	Phenol	0.130	ug/g
		17-mar-1990	JD19	Arsenic	10.300	ug/g
	40.0	17-mar-1990	JD19	Arsenic	3.700	ug/g
		17-mar-1990	JS11	Lead	23.000	ug/g
	45.0	17-mar-1990	JD19	Arsenic	1.300	ug/g
		17-mar-1990	JS11	Lead	10.300	ug/g
	50.0	17-mar-1990	99	Phenol	0.450	ug/g
		17-mar-1990	JD19	Arsenic	1.400	ug/g
		17-mar-1990	JD19	Arsenic	1.400	ug/g
	60.0	17-mar-1990	JD19	Arsenic	6.100	ug/g
	70.0	17-mar-1990	99	Phenol	0.380	ug/g
		17-mar-1990	JD19	Arsenic	3.100	ug/g
	80.0	17-mar-1990	99	Phenol	0.110	ug/g
		17-mar-1990	JD19	Arsenic	3.600	ug/g
	90.0	17-mar-1990	99	Phenol	0.640	ug/g
		17-mar-1990	JD19	Arsenic	4.300	ug/g
		17-mar-1990	JS11	Lead	134.200	ug/g
		17-mar-1990	JS11	Zinc	98.200	ug/g

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

POSITIVE SOIL RESULTS - ABANDONED LANDFILL SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
ALF-01-SB	95.0	16-mar-1990	LM18	Diacetone alcohol (TIC)	0.480	ug/g
		17-mar-1990	99	Phenol	0.130	ug/g
		17-mar-1990	JD19	Arsenic	2.900	ug/g
		17-mar-1990	JS11	Lead	320.100	ug/g
ALF-02-SB	5.0	13-mar-1990	99	Phenol	0.110	ug/g
		13-mar-1990	99	Total heptachlorodibenzo-p-dioxins	0.00038	ug/g
		13-mar-1990	99	Total octochlorodibenzo-p-dioxins	0.0013	ug/g
		13-mar-1990	JD19	Arsenic	9.900	ug/g
		13-mar-1990	JS11	Chromium	24.400	ug/g
		13-mar-1990	JS11	Lead	84.800	ug/g
		13-mar-1990	JS11	Zinc	140.700	ug/g
	10.0	18-mar-1990	99	Phenol	0.280	ug/g
		18-mar-1990	JD19	Arsenic	3.600	ug/g
		18-mar-1990	JS11	Lead	55.400	ug/g
	15.0	18-mar-1990	JD19	Arsenic	4.600	ug/g
		18-mar-1990	JS11	Lead	7.100	ug/g
	20.0	18-mar-1990	JD19	Arsenic	3.700	ug/g
		18-mar-1990	LH10	Heptachlor	0.010	ug/g
	25.0	18-mar-1990	JD19	Arsenic	2.700	ug/g
	30.0	18-mar-1990	99	Phenol	0.250	ug/g
		18-mar-1990	JD15	Selenium	0.500	ug/g
		18-mar-1990	JD19	Arsenic	14.600	ug/g
		18-mar-1990	JS11	Lead	87.300	ug/g
		18-mar-1990	JS11	Zinc	111.300	ug/g
	35.0	18-mar-1990	99	Phenol	0.190	ug/g
		18-mar-1990	JD19	Arsenic	3.500	ug/g
		18-mar-1990	JS11	Lead	33.000	ug/g
	40.0	18-mar-1990	99	Phenol	0.150	ug/g
		18-mar-1990	JD19	Arsenic	4.800	ug/g
		18-mar-1990	JS11	Lead	15.700	ug/g
	45.0	18-mar-1990	99	Phenol	0.110	ug/g
		18-mar-1990	JD19	Arsenic	1.500	ug/g
	50.0	18-mar-1990	JD19	Arsenic	2.500	ug/g
		18-mar-1990	JD19	Arsenic	1.600	ug/g
		18-mar-1990	JS11	Lead	12.200	ug/g
		18-mar-1990	LM19	Toluene	0.000	ug/g
		18-mar-1990	LM19	Unknown 071 (TIC)	0.320	ug/g
		18-mar-1990	LM19	Unknown 076 (TIC)	0.020	ug/g
	60.0	18-mar-1990	JD19	Arsenic	6.700	ug/g
		18-mar-1990	JS11	Lead	23.800	ug/g

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

POSITIVE SOIL RESULTS - ABANDONED LANDFILL SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
ALF-02-SB	60.0	18-mar-1990	LM18	4-Hydroxy-3-methoxybenzaldehyde (TIC)	0.790	ug/g
	70.0	18-mar-1990	99	Phenol	0.180	ug/g
		18-mar-1990	JD19	Arsenic	4.500	ug/g
		18-mar-1990	JS11	Lead	134.200	ug/g
		18-mar-1990	JS11	Zinc	85.200	ug/g
		18-mar-1990	LM18	4-Hydroxy-3-methoxybenzaldehyde (TIC)	0.830	ug/g
	80.0	18-mar-1990	99	Phenol	0.200	ug/g
		18-mar-1990	JD19	Arsenic	4.000	ug/g
		18-mar-1990	JS11	Lead	62.900	ug/g
		18-mar-1990	JS11	Zinc	82.700	ug/g
	89.0	18-mar-1990	99	Phenol	0.240	ug/g
		18-mar-1990	JD19	Arsenic	2.700	ug/g
ALF-03-SB	5.0	13-mar-1990	99	Phenol	0.260	ug/g
		13-mar-1990	99	2,3,7,8-Tetrachlorodibenzo-p-dioxin (Dioxin)	0.000035	ug/g
		13-mar-1990	99	2,3,7,8-Tetrachlorodibenzofuran	0.00032	ug/g
		13-mar-1990	99	Total hexachlorodibenzofurans	0.000082	ug/g
		13-mar-1990	99	Total heptachlorodibenzo-p-dioxins	0.00017	ug/g
		13-mar-1990	99	Total heptachlorodibenzofurans	0.00013	ug/g
		13-mar-1990	99	Total octochlorodibenzo-p-dioxins	0.00022	ug/g
		13-mar-1990	99	Total pentachlorodibenzofurans	0.000021	ug/g
		13-mar-1990	JD15	Selenium	0.400	ug/g
		13-mar-1990	JD19	Arsenic	11.200	ug/g
		13-mar-1990	JS11	Cadmium	6.200	ug/g
		13-mar-1990	JS11	Chromium	48.400	ug/g
		13-mar-1990	JS11	Copper	446.500	ug/g
		13-mar-1990	JS11	Nickel	43.600	ug/g
		13-mar-1990	JS11	Lead	440.200	ug/g
		13-mar-1990	JS11	Zinc	1091.200	ug/g
		13-mar-1990	LM19	Trichlorofluoromethane	0.020	ug/g
		13-mar-1990	LM19	Trichloroethene	0.020	ug/g
	10.0	19-mar-1990	99	Phenol	0.300	ug/g
		19-mar-1990	JD19	Arsenic	3.900	ug/g
		19-mar-1990	JS11	Lead	37.800	ug/g
		19-mar-1990	JS11	Zinc	132.000	ug/g
		19-mar-1990	LM19	Trichloroethene	0.000	ug/g
	15.0	19-mar-1990	99	Phenol	0.120	ug/g
		19-mar-1990	JD19	Arsenic	3.000	ug/g
	20.0	19-mar-1990	99	Phenol	0.160	ug/g
		19-mar-1990	JD19	Arsenic	3.400	ug/g
		19-mar-1990	LH10	Heptachlor	0.010	ug/g
	25.0	19-mar-1990	99	Phenol	0.110	ug/g
		19-mar-1990	JD19	Arsenic	4.700	ug/g
	30.0	19-mar-1990	JD15	Selenium	0.600	ug/g

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

POSITIVE SOIL RESULTS - ABANDONED LANDFILL SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
ALF-03-SB	30.0	19-mar-1990	JD19	Arsenic	15.600	ug/g
		19-mar-1990	JS11	Zinc	92.800	ug/g
	35.0	19-mar-1990	JD19	Arsenic	9.800	ug/g
	40.0	19-mar-1990	99	Phenol	0.120	ug/g
		19-mar-1990	JD19	Arsenic	5.500	ug/g
	45.0	19-mar-1990	JD19	Arsenic	3.400	ug/g
		19-mar-1990	LM19	Acetone	0.020	ug/g
	50.0	19-mar-1990	JD19	Arsenic	1.300	ug/g
		19-mar-1990	JD19	Arsenic	0.800	ug/g
		19-mar-1990	LM19	Toluene	0.000	ug/g
		19-mar-1990	LM19	Unknown 071 (TIC)	0.210	ug/g
		19-mar-1990	LM19	Unknown 076 (TIC)	0.020	ug/g
	60.0	19-mar-1990	JD19	Arsenic	4.000	ug/g
	70.0	19-mar-1990	JD19	Arsenic	2.200	ug/g
	80.0	19-mar-1990	JD19	Arsenic	4.200	ug/g
	90.0	19-mar-1990	99	Phenol	0.140	ug/g
		19-mar-1990	JD19	Arsenic	5.300	ug/g
ALF-04-SB	5.0	13-mar-1990	JD19	Arsenic	23.100	ug/g
		13-mar-1990	LM19	Unknown 070 (TIC)	0.010	ug/g
	10.0	18-mar-1990	JD19	Arsenic	4.800	ug/g
	15.0	18-mar-1990	JD19	Arsenic	3.100	ug/g
	20.0	18-mar-1990	JD19	Arsenic	4.200	ug/g
		18-mar-1990	LM18	Unknown 529 (TIC)	0.310	ug/g
	25.0	18-mar-1990	JD19	Arsenic	4.900	ug/g
	30.0	18-mar-1990	JD15	Selenium	0.500	ug/g
		18-mar-1990	JD19	Arsenic	14.000	ug/g
		18-mar-1990	JS11	Zinc	91.700	ug/g
	35.0	18-mar-1990	JD19	Arsenic	3.900	ug/g
	40.0	18-mar-1990	JD19	Arsenic	2.300	ug/g
	45.0	18-mar-1990	JD19	Arsenic	1.800	ug/g
		18-mar-1990	LM18	Unknown 592 (TIC)	0.310	ug/g
	50.0	19-mar-1990	JD19	Arsenic	2.600	ug/g
		19-mar-1990	JD19	Arsenic	1.400	ug/g

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

POSITIVE SOIL RESULTS - ABANDONED LANDFILL SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
ALF-04-SB	60.0	19-mar-1990	JD19	Arsenic	6.000	ug/g
	70.0	19-mar-1990	JD19	Arsenic	9.000	ug/g
		19-mar-1990	LM19	Acetone	0.020	ug/g
	80.0	19-mar-1990	JD19	Arsenic	4.900	ug/g
	85.0	19-mar-1990	JD19	Arsenic	6.100	ug/g
		19-mar-1990	JS11	Zinc	60.300	ug/g
		19-mar-1990	LM19	Toluene	0.000	ug/g
		19-mar-1990	LM19	Unknown 071 (TIC)	0.220	ug/g
		19-mar-1990	LM19	Unknown 076 (TIC)	0.030	ug/g

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

Dioxin/Furans

Of four dioxin/furans measured, levels exceeding detection limits were observed in one sample, collected at ALF-03-SB. This sample was comprised of trench fill material. Detected values are shown in Table 6-6. The total concentration of all the dioxin/furan compounds detected in this interval was 0.000978 μg/g. This was comprised of tetra-, hept-, penta- and hexa-chlorodibenzofurans, and tetra-, hepta-, and octa-chlorodibenzo-p-dioxins.

Extractable Organic Compounds

Of 53 samples that measured extractable organic compounds, heptachlor levels exceeding detection limits were observed in only two samples. Detected values are shown in Table 6-6. Heptachlor was found in the 20-foot interval from both ALF-02-SB and ALF-03-SB, at 0.011 μg/g and 0.007 μg/g, respectively (Table 6-6 and Figure 6-3). Because of the low concentrations, the low frequency of occurrence, and the distance of heptachlor from the groundwater (70 feet) heptachlor is not considered a likely source of groundwater contamination. No correlation between site stratigraphy and extractable organic compound distribution was observed.

Total phenols, as determined by the spectrophotometric method, were detected at sampling intervals from the 5-foot interval to the water table in ALF-01-SB and ALF-02-SB, and to the 40-foot interval in ALF-03-SB. Total phenol concentrations found above detection limits (0.10 μg/g) ranged from 0.112 μg/g to 1.840 μg/g. The highest total phenols values were found in the ALF-01-SB 25-foot interval. Total phenols were detected in 71 percent of the samples from ALF-01-SB, 64 percent of the samples from ALF-02-SB, and 40 percent of the samples from ALF-03-SB.

The presence of phenols was not confirmed by GC/MS analysis in any of these samples (Method LM18). This could be due to poor recoveries of phenols in the GC/MS extraction or to a positive interference in the spectrophotometric method.

VOCs

Of 53 VOCs measured, levels exceeding detection limits were observed in only 11 percent of the samples. Detected values are shown in Table 6-6 and Figure 6-4. TCE was detected in ALF-03-SB in the 5- and 10-foot interval at 0.019 μg/g and 0.003 μg/g, respectively. TCE was not found in soils deeper than 15 feet at this site. Because TCE is restricted to soils approximately 80 feet above the water table, it is considered unlikely that the TCE detected in soil is a source of groundwater contamination. Trichlorofluoromethane (0.015 μg/g) was also found in the 5-foot sample at ALF-03-SB.

Acetone and toluene were the only other VOCs detected in the soil from the Abandoned Landfill Site. These compounds were found in three samples. Acetone (0.024 μg/g) was detected in the 45-foot sample from ALF-03-SB and in the 70-foot sample from ALF-04-SB (0.022 μg/g). Toluene (0.002 μg/g) was found in the 85-foot sampling interval at ALF-04-SB. No correlation between site stratigraphy and VOC distribution was observed.

Inorganics

Of 53 inorganics measured, levels exceeding background were observed in only one sample. An elevated lead concentration (440.000 μg/g) was detected in the 5-foot sample from ALF-03-SB. This sample was collected from trench fill material. All other inorganic constituent concentrations are believed to represent native soil conditions. Detected values are shown in Table 6-6 and Figure 6-5. The elevated lead value is apparently associated with trench fill material. Lead has not migrated into native soils at this site.

6.2.2.4 Groundwater

Groundwater from the three monitoring wells installed during the Phase I RI was sampled and analyzed on successive months for extractable organics (phenols, BNAs, and pesticides/PCBs), VOCs and inorganics (priority metals and cyanide). Results for both rounds 1 and 2 are presented in Tables 6-7 and 6-8.

POSITIVE GROUNDWATER RESULTS - ROUND 1 - ABANDONED LANDFILL SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
ALF-01-MWA	90.4	17-apr-1990	99	Total dissolved solids	762000.000	ug/l
		17-apr-1990	SB01	Mercury	0.488	ug/l
		17-apr-1990	SD21	Selenium	16.300	ug/l
		17-apr-1990	SD22	Arsenic	3.730	ug/l
		17-apr-1990	SS10	Barium	19.900	ug/l
		17-apr-1990	SS10	Calcium	110000.000	ug/l
		17-apr-1990	SS10	Copper	8.710	ug/l
		17-apr-1990	SS10	Sodium	50500.000	ug/l
		17-apr-1990	SS10	Zinc	62.500	ug/l
		17-apr-1990	TT10	Chloride	100000.000	ug/l
		17-apr-1990	TT10	Sulfate	300000.000	ug/l
		17-apr-1990	UM18	Unknown 600 (TIC)	10.000	ug/l
ALF-02-MWA	85.5	17-apr-1990	99	Total dissolved solids	4060000.000	ug/l
		17-apr-1990	SD21	Selenium	6.070	ug/l
		17-apr-1990	SD22	Arsenic	7.460	ug/l
		17-apr-1990	SS10	Barium	16.200	ug/l
		17-apr-1990	SS10	Calcium	130000.000	ug/l
		17-apr-1990	SS10	Sodium	78000.000	ug/l
		17-apr-1990	SS10	Zinc	38.000	ug/l
		17-apr-1990	TT10	Chloride	67000.000	ug/l
		17-apr-1990	TT10	Sulfate	450000.000	ug/l
		17-apr-1990	UM18	Unknown 576 (TIC)	5.000	ug/l
		17-apr-1990	UM18	Unknown 600 (TIC)	5.000	ug/l
		17-apr-1990	UM20	Trichloroethene	41.000	ug/l
ALF-03-MWA	83.3	17-apr-1990	99	Total dissolved solids	1250000.000	ug/l
		17-apr-1990	99	Total dissolved solids	1300000.000	ug/l
		17-apr-1990	SD21	Selenium	14.900	ug/l
		17-apr-1990	SD21	Selenium	15.300	ug/l
		17-apr-1990	SD22	Arsenic	3.940	ug/l
		17-apr-1990	SD22	Arsenic	4.800	ug/l
		17-apr-1990	SS10	Barium	53.500	ug/l
		17-apr-1990	SS10	Barium	54.700	ug/l
		17-apr-1990	SS10	Calcium	200000.000	ug/l
		17-apr-1990	SS10	Calcium	180000.000	ug/l
		17-apr-1990	SS10	Sodium	49200.000	ug/l
		17-apr-1990	SS10	Sodium	48000.000	ug/l
		17-apr-1990	SS10	Zinc	47.200	ug/l
		17-apr-1990	SS10	Zinc	43.100	ug/l
		17-apr-1990	TT10	Chloride	270000.000	ug/l
		17-apr-1990	TT10	Sulfate	260000.000	ug/l
		17-apr-1990	UM18	Unknown 600 (TIC)	4.000	ug/l
		17-apr-1990	UM18	Unknown 600 (TIC)	5.000	ug/l
		17-apr-1990	UM18	Unknown 648 (TIC)	9.000	ug/l
		17-apr-1990	UM20	Chloroform	1.130	ug/l
		17-apr-1990	UM20	Chloroform	1.030	ug/l

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

POSITIVE GROUNDWATER RESULTS - ROUND 2 - ABANDONED LANDFILL SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
ALF-01-MWA	90.4	31-may-1990	99	Total dissolved solids	900000.000	ug/l
		31-may-1990	99	Total dissolved solids	884000.000	ug/l
		31-may-1990	SD20	Lead	2.600	ug/l
		31-may-1990	SD20	Lead	2.930	ug/l
		31-may-1990	SD21	Selenium	18.600	ug/l
		31-may-1990	SD21	Selenium	18.300	ug/l
		31-may-1990	SD22	Arsenic	3.410	ug/l
		31-may-1990	SS10	Barium	19.900	ug/l
		31-may-1990	SS10	Barium	20.200	ug/l
		31-may-1990	SS10	Calcium	120000.000	ug/l
		31-may-1990	SS10	Calcium	110000.000	ug/l
		31-may-1990	SS10	Sodium	50900.000	ug/l
		31-may-1990	SS10	Sodium	53000.000	ug/l
		31-may-1990	TT10	Chloride	100000.000	ug/l
		31-may-1990	TT10	Chloride	100000.000	ug/l
		31-may-1990	TT10	Sulfate	320000.000	ug/l
		31-may-1990	TT10	Sulfate	310000.000	ug/l
ALF-02-MWA	85.5	01-jun-1990	99	Total dissolved solids	1100000.000	ug/l
		01-jun-1990	SD20	Lead	2.170	ug/l
		01-jun-1990	SD21	Selenium	6.790	ug/l
		01-jun-1990	SD22	Arsenic	6.720	ug/l
		01-jun-1990	SS10	Barium	16.100	ug/l
		01-jun-1990	SS10	Calcium	130000.000	ug/l
		01-jun-1990	SS10	Sodium	130000.000	ug/l
		01-jun-1990	TF18	Cyanide	3.310	ug/l
		01-jun-1990	TT10	Chloride	66000.000	ug/l
		01-jun-1990	TT10	Sulfate	440000.000	ug/l
		01-jun-1990	UM20	1,2-Dichloroethenes (cis and trans isomers)	0.621	ug/l
		01-jun-1990	UM20	Trichloroethene	70.500	ug/l
ALF-03-MWA	83.3	01-jun-1990	99	Total dissolved solids	1250000.000	ug/l
		01-jun-1990	SD20	Lead	3.360	ug/l
		01-jun-1990	SD21	Selenium	16.600	ug/l
		01-jun-1990	SD22	Arsenic	4.160	ug/l
		01-jun-1990	SS10	Barium	52.300	ug/l
		01-jun-1990	SS10	Calcium	170000.000	ug/l
		01-jun-1990	SS10	Sodium	57000.000	ug/l
		01-jun-1990	TT10	Chloride	270000.000	ug/l
		01-jun-1990	TT10	Sulfate	260000.000	ug/l
		01-jun-1990	UM18	Bis (2-ethylhexyl) phthalate	6.090	ug/l
		01-jun-1990	UM18	1,1,2,2-Tetrachloroethane	9.000	ug/l
		01-jun-1990	UM20	Chloroform	0.985	ug/l

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

Extractable Organic Compounds

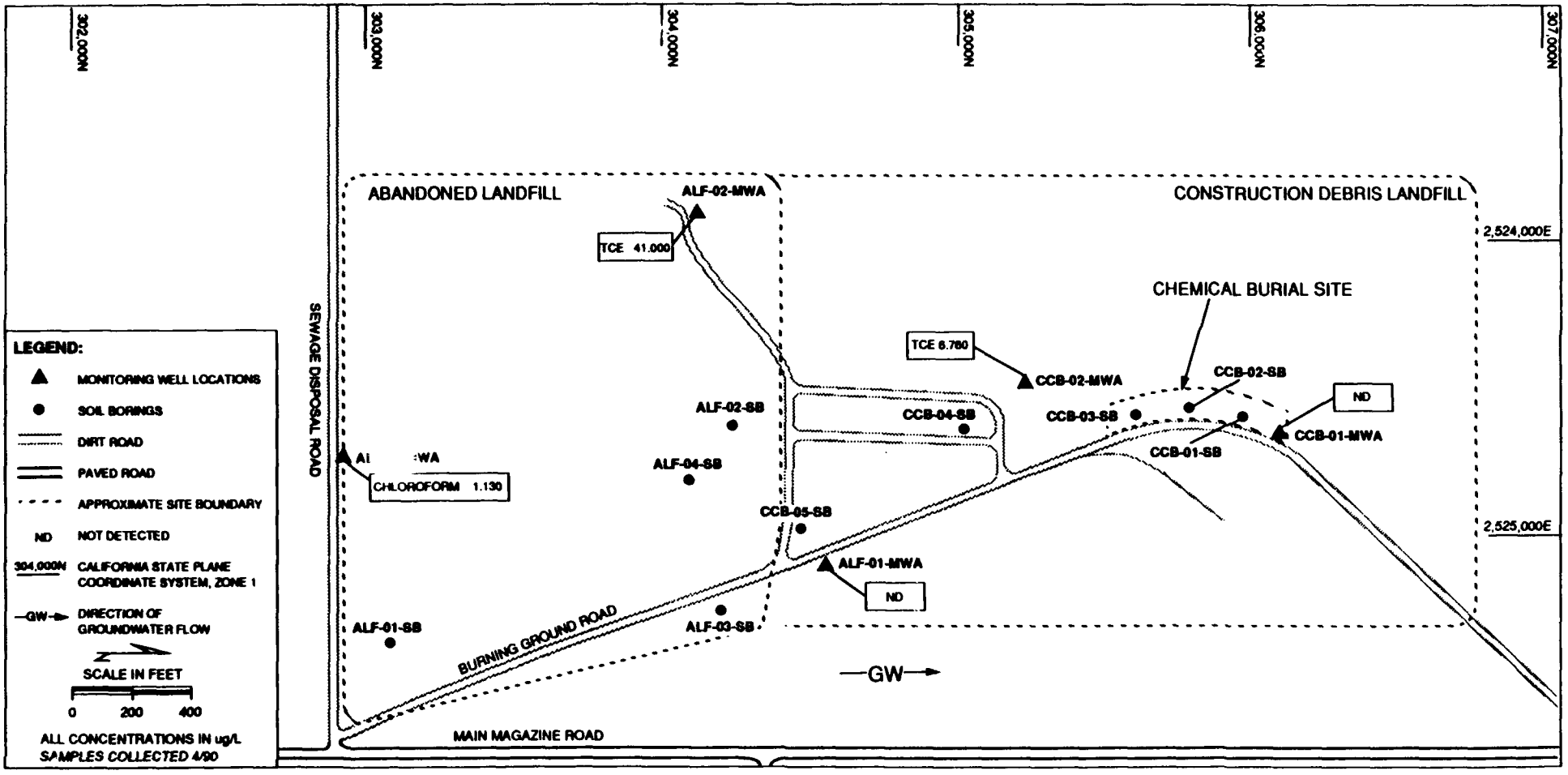
No extractable organic compounds were identified at levels above detection limits in the groundwater at this site.

VOCs

TCE (41.000 μg/L) was detected in Round 1 groundwater samples collected from ALF-02-MWA (Table 6-7 and Figure 6-6) above the California MCL (5.000 μg/L). The presence of TCE (70.500 μg/L) in groundwater was verified in Round 2 samples collected from ALF-02-MWA. Although no soil samples were collected in the vicinity of ALF-02-MWA and a TCE soil source was not identified, soil gas data (see Section 6.2.2.1) suggest that a TCE source exists in the vicinity of ALF-02-MWA. Because elevated levels of the soil gas is coincident with TCE in groundwater, the silt and clay layers under this site are not considered a significant barrier to vertical migration of TCE.

TCE was also detected in CCB-02-MWA (see Section 6.2.3) located approximately 1,600 feet northeast (downgradient) of ALF-02-MWA. The presence of TCE in this downgradient well suggests that a single TCE plume may exist in this area, a conclusion supported by the distribution of TCE in the vadose zone as determined from soil gas (Figure 6-1). However, a groundwater plume map could not be constructed due to the limited amount of groundwater data available at this site. The distribution of TCE in the groundwater in this area can not be fully determined until additional groundwater data is acquired.

Chloroform was detected at this site in Round 1 (1.130 μg/L) and Round 2 (0.985 μg/L) groundwater samples taken from ALF-03-MWA. Additional VOCs detected only in Round 2 samples include 1,2-Dichloroethenes (AFL-02-MWA; 0.621 μg/L) and 1,1,2,2-Tetrachloroethane (ALF-03-MWA; 9.000 μg/L). No VOCs were detected in ALF-01-MWA although this well is located downgradient of a 9-foot-deep covered trench and is in the vicinity of a low level TCE soil gas plume (Figure 6-1).



SIERRA ARMY DEPOT

VOC CONCENTRATIONS FROM "A" ZONE WELLS:
ABANDONED LANDFILL/CHEMICAL BURIAL SITE/
CONSTRUCTION DEBRIS LANDFILL

FIGURE 6-6

Inorganics

Groundwater was analyzed for priority pollutant metals and cyanide. With the exception of selenium, priority pollutant metals detected were present in concentrations consistent with the concentrations found in the background groundwater samples (Tables 6-7 and 6-8). Round 1 selenium concentrations above California MCLs (10 μg/L), were 15.300 μg/L and 14.900 μg/L in ALF-01-MWA and ALF-03-MWA, respectively (Figure 6-7). Round 2 selenium concentrations above California MCLs were 18.600 μg/L and 16.600 μg/L in ALF-01-MWA and ALF-03-MWA, respectively. A selenium soil source was not identified. Therefore, the selenium found at this site is interpreted as representing natural conditions.

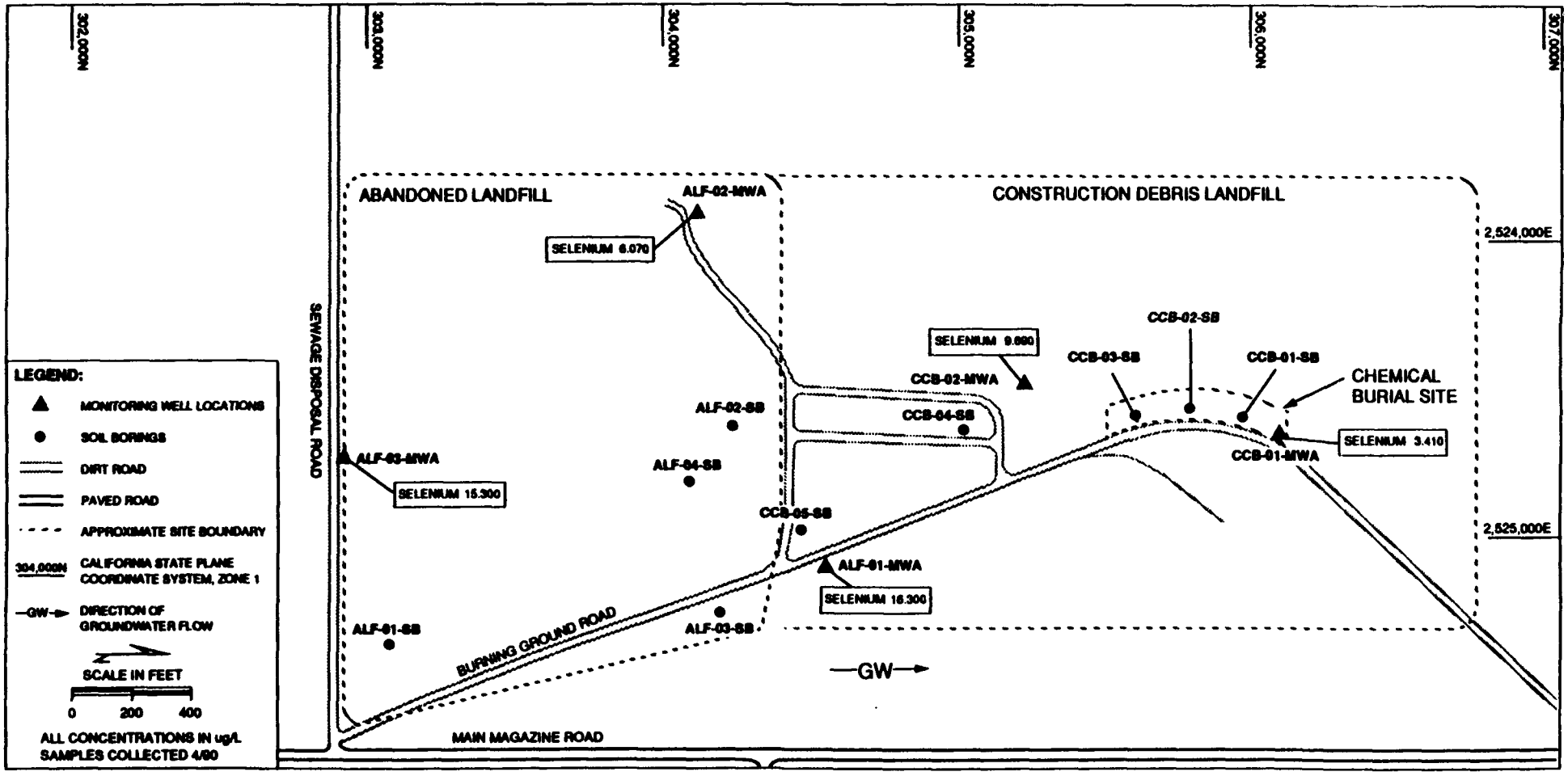
6.2.2.5 Abandoned Landfill Summary

Extractable organic compounds are not considered a likely source of groundwater contamination at this site. Heptachlor was detected at low concentrations in two samples from the 20-foot interval, approximately 70 feet above the water table.

Only one priority pollutant metal, lead, was detected; this occurred at the 5-foot sample interval at ALF-03-SB. No other inorganic constituents were detected at levels above what is considered to be background. Inorganics in soil are not considered a likely source of groundwater contamination at this site.

VOCs were detected in only 6 percent of the soil samples collected. TCE was detected in two of these samples in the 5- and 10-foot interval at ALF-03-SB. Monitoring well ALF-01-MWA is located about 50 feet downgradient of ALF-03-SB. No VOCs were present in that well, suggesting the low levels of TCE in the shallow soil do not influence the groundwater in the northeastern portion of the Abandoned Landfill Site.

Soil contaminants were generally restricted to the sandy zones in the shallow substrate. Subsurface contaminant distribution appears to be independent of the stratigraphy at this site. It is suspected that a TCE groundwater plume exists in the northwestern portion of the site because of the presence of TCE soil gas in this area, and groundwater contamination. TCE



SIERRA ARMY DEPOT
SELENIUM CONCENTRATIONS FROM "A" ZONE WELLS:
ABANDONED LANDFILL/CHEMICAL BURIAL SITE/CONSTRUCTION DEBRIS LANDFILL

FIGURE 6-7

concentrations of 41.000 μg/L (Round 1) and 70.500 μg/l (Round 2) were found in ALF-02-MWA, located within the soil gas plume. The long axis of the soil gas plume is oriented in a northeasterly direction, similar to the direction of groundwater flow. TCE was also detected in groundwater and soil gas from the vicinity of monitoring well CCB-02-MWA. This well is located about 1,600 feet downgradient of ALF-02-MWA.

Due to limited VOC groundwater data, a TCE groundwater plume map cannot be constructed at this time. In addition, a soil source could not be identified because no soil samples have been collected in the vicinity of the contaminated groundwater and soil gas plume. Installation and sampling of additional soil borings and monitoring wells at this site will be necessary to fully characterize the quantity, distribution, fate, and transport of TCE in soil and groundwater.

6.2.3 Chemical Burial Site/Construction Debris Landfill

Because the Chemical Burial Site is fully enclosed by the Construction Debris Landfill, these sites will be characterized jointly. Distribution and extent of contamination at this site was assessed based on data gathered as a result of the following Phase I RI activities: soil gas survey, geophysical survey, seven test pits, five soil borings, and two water table monitoring wells.

6.2.3.1 Soil Gas Survey

Soil gas samples were collected and analyzed from 48 locations at the Chemical Burial Site to identify VOC soil sources and/or VOC plumes in the groundwater. Target compounds were TCA, TCE, PCE, methylene chloride, chloroform, carbon tetrachloride, and 1,2-DCA, BETX, and THC. Analytical procedures and results are presented in Appendix D. No soil gas survey was conducted at the Construction Debris Landfill Site.

Low levels of TCE were detected in soil gas from the southwest portion of the Chemical Burial Site (Figure 6-1). The TCE detected in this area is believed to be the northeastern extension of the elevated TCE soil gas concentrations associated with the northwestern

portion of the Abandoned Landfill Site (discussed in Section 6.2.2.1). Low levels of TCE were also detected in the northeastern portion of the Chemical Burial Site along Burning Ground Road (Figure 6-1). No other significant levels of VOCs were detected during the soil gas survey at this site.

6.2.3.2 Test Pits

Seven test pits were excavated to depths of 5 feet at the Chemical Burial Site/Construction Debris Landfill Site (Figure 4-8) to identify the source of geophysical anomalies, search for possible buried drums, characterize landfill material, clear the soil boring locations of any possible explosive ordnance, and to sample the landfill material at 5-foot intervals. Landfill material distribution was identified on the basis of geophysical anomalies (Figure 4-7 and Appendix E). Four of the seven test pits were sampled and soil borings were installed in their centers. Table 4-3 lists each test pit location and characterization. Soil sample results are discussed in Section 6.2.3.3.

Three test pits were located in the Chemical Burial Site and sampled at a depth of 5 feet. Three to 4 feet of fill material was uncovered in each of these test pits consisting of clean sand that was similar in character to the native soil of the area. A small geophysical anomaly was uncovered in Test Pit No. 3 and was found to be a piece of asphalt approximately 2 feet below the ground surface. Soil borings were placed near the center of each test pit and were sampled to the water table.

Three additional test pits were excavated in the southwest portion of the Construction Debris Landfill to uncover and identify a geophysical anomaly discovered in this area. Excavation revealed 6 to 12 inches of burn material at the surface overlying native soil. One soil boring was drilled and sampled in this area.

6.2.3.3 Soil

Five soil borings were installed to the water table at this site and soil samples were collected at the 5-foot interval to 50 feet and at the 10-foot interval from 50 feet to the water table.

Sixty-one soil samples, collected from four soil borings, were analyzed for extractable organic compounds (phenols, pesticides/PCBs, BNAs), VOCs, and inorganics (priority pollutant metals and cyanide). The 5-foot sample from each boring was analyzed for dioxin/furans. Analytical results are presented on Table 6-9 and Figures 6-3 through 6-5.

Dioxin/Furans

Of the five dioxin/furan samples collected, levels exceeding detection limits were observed in three samples. Total octachlorodibenzo-p-dioxins (TOCDD) was found in CCB-02-SB and CCB-03-SB (Table 6-9) at 0.000062 μg/g and 0.000064 μg/g, respectively. TOCDD was also detected at a concentration of 0.001 μg/g in the 5-foot sample collected from CCB-05-SB.

Extractable Organic Compounds

Of 61 samples analyzed for extractable organic compounds, contaminant concentrations exceeding detection limits were observed in only 7 percent of the samples. Detected values are shown in Table 6-9 and Figure 6-3.

Bis(2-ethylhexyl)phthalate was detected in CCB-05-SB at the 35-foot interval (2.030 μg/g). Chlordane concentrations ranged from 0.062 μg/g in CCB-02-SB (10 feet) to 1.040 μg/g in CCB-01-SB (5 feet). Low frequency of occurrence, the distance to groundwater (45 to 65 feet), and low concentrations detected, suggest that these compounds are not a likely source of groundwater contamination.

Total phenol concentrations, above the detection limit (0.10 μg/g), ranged from 0.103 to 4.600 μg/g (Table 6-9). The highest total phenol values were detected in CCB-01-SB at 60 feet and 70 feet, and in CCB-03-SB at 10 feet.

The presence of phenols was not confirmed by GC/MS analysis. This could be due to poor recoveries of phenols in the GC/MS extraction or to a positive interference in the spectrophotometric method.

POSITIVE SOIL RESULTS - CONSTRUCTION DEBRIS LANDFILL/CHEMICAL BURIAL SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
CCB-01-SB	5.0	14-mar-1990	JD19	Arsenic	3.500	ug/g
		14-mar-1990	LH10	Chlordane	1.040	ug/g
		14-mar-1990	LH10	Heptachlor	0.010	ug/g
		14-mar-1990	LH10	Heptachlor epoxide	0.010	ug/g
		14-mar-1990	LM19	Trichlorofluoromethane	0.010	ug/g
	10.0	13-apr-1990	JD19	Arsenic	4.900	ug/g
		13-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.100	ug/g
		13-apr-1990	LM18	2-Cyclohexen-1-ol (TIC)	0.050	ug/g
		13-apr-1990	LM18	2-Cyclohexen-1-one (TIC)	0.050	ug/g
		13-apr-1990	LM18	Unknown 539 (TIC)	0.060	ug/g
	15.0	13-apr-1990	99	Phenol	0.180	ug/g
		13-apr-1990	JD19	Arsenic	4.700	ug/g
		13-apr-1990	LH10	Chlordane	0.110	ug/g
		13-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.100	ug/g
	20.0	13-apr-1990	JD19	Arsenic	2.700	ug/g
		13-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.100	ug/g
	25.0	13-apr-1990	99	Phenol	0.110	ug/g
		13-apr-1990	JD19	Arsenic	10.200	ug/g
		13-apr-1990	JS11	Zinc	69.600	ug/g
		13-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.110	ug/g
		13-apr-1990	LM18	Unknown 585 (TIC)	0.320	ug/g
		13-apr-1990	LM19	Unknown 170 (TIC)	0.010	ug/g
	30.0	13-apr-1990	JD19	Arsenic	8.400	ug/g
		13-apr-1990	JS11	Zinc	76.800	ug/g
		13-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.130	ug/g
		13-apr-1990	LM18	2-Cyclohexen-1-ol (TIC)	0.130	ug/g
		13-apr-1990	LM18	2-Cyclohexen-1-one (TIC)	0.080	ug/g
		13-apr-1990	LM19	Unknown 170 (TIC)	0.010	ug/g
	35.0	13-apr-1990	JD19	Arsenic	2.200	ug/g
		13-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.110	ug/g
		13-apr-1990	LM19	Unknown 170 (TIC)	0.010	ug/g
		13-apr-1990	LM19	Unknown 175 (TIC)	0.010	ug/g
	40.0	13-apr-1990	JD19	Arsenic	2.100	ug/g
		13-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.100	ug/g
		13-apr-1990	LM19	Unknown 170 (TIC)	0.010	ug/g
	45.0	13-apr-1990	JD19	Arsenic	2.900	ug/g
		13-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.110	ug/g
		13-apr-1990	LM19	Unknown 170 (TIC)	0.010	ug/g
	50.0	13-apr-1990	JD19	Arsenic	3.100	ug/g
		13-apr-1990	JD19	Arsenic	3.500	ug/g
		13-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.100	ug/g

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

POSITIVE SOIL RESULTS - CONSTRUCTION DEBRIS LANDFILL/CHEMICAL BURIAL SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
CCB-01-SB	60.0	13-apr-1990	99	Phenol	4.540	ug/g
		13-apr-1990	JD19	Arsenic	4.800	ug/g
		13-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.120	ug/g
		13-apr-1990	LM18	Unknown 533 (TIC)	0.110	ug/g
	70.0	13-apr-1990	99	Phenol	4.700	ug/g
		13-apr-1990	JD19	Arsenic	13.300	ug/g
		13-apr-1990	JS11	Zinc	92.500	ug/g
		13-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.120	ug/g
		13-apr-1990	LM19	Unknown 170 (TIC)	0.010	ug/g
	88.0	13-apr-1990	JD19	Arsenic	3.700	ug/g
		13-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.230	ug/g
		13-apr-1990	LM18	Unknown 533 (TIC)	0.110	ug/g
		13-apr-1990	LM19	Unknown 171 (TIC)	0.010	ug/g
CCB-02-SB	5.0	14-mar-1990	JD19	Arsenic	2.600	ug/g
		14-mar-1990	LH10	Chlordane	0.580	ug/g
		14-mar-1990	LH10	Heptachlor	0.010	ug/g
		14-mar-1990	LM19	Trichlorofluoromethane	0.010	ug/g
	10.0	12-apr-1990	99	Phenol	0.220	ug/g
		12-apr-1990	JD19	Arsenic	4.300	ug/g
		12-apr-1990	LH10	Chlordane	0.060	ug/g
	15.0	12-apr-1990	99	Phenol	0.110	ug/g
		12-apr-1990	JD19	Arsenic	4.700	ug/g
	20.0	12-apr-1990	99	Phenol	0.100	ug/g
		12-apr-1990	JD19	Arsenic	4.800	ug/g
		12-apr-1990	JD19	Arsenic	4.900	ug/g
		12-apr-1990	JS11	Zinc	56.700	ug/g
	25.0	12-apr-1990	99	Phenol	0.110	ug/g
		12-apr-1990	JD19	Arsenic	7.700	ug/g
		12-apr-1990	JS11	Chromium	22.500	ug/g
		12-apr-1990	JS11	Nickel	27.400	ug/g
		12-apr-1990	JS11	Zinc	87.400	ug/g
	30.0	12-apr-1990	JD19	Arsenic	12.200	ug/g
		12-apr-1990	JS11	Zinc	107.800	ug/g
	35.0	12-apr-1990	JD19	Arsenic	2.300	ug/g
		12-apr-1990	JS11	Chromium	31.100	ug/g
		12-apr-1990	JS11	Nickel	30.400	ug/g
		12-apr-1990	JS11	Zinc	57.000	ug/g
	40.0	12-apr-1990	JD19	Arsenic	1.900	ug/g
	45.0	12-apr-1990	JD19	Arsenic	21.500	ug/g
		12-apr-1990	JS11	Zinc	91.100	ug/g

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

POSITIVE SOIL RESULTS - CONSTRUCTION DEBRIS LANDFILL/CHEMICAL BURIAL SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
CCB-02-SB	50.0	12-apr-1990	JD19	Arsenic	37.100	ug/g
		12-apr-1990	JS11	Zinc	73.300	ug/g
	60.0	12-apr-1990	99	Phenol	0.120	ug/g
		12-apr-1990	JD19	Arsenic	3.200	ug/g
		12-apr-1990	JS11	Zinc	75.100	ug/g
	70.0	13-apr-1990	99	Phenol	0.210	ug/g
		13-apr-1990	JD19	Arsenic	3.000	ug/g
		13-apr-1990	LM19	Unknown 171 (TIC)	0.010	ug/g
	80.0	13-apr-1990	99	Phenol	0.160	ug/g
		13-apr-1990	JD19	Arsenic	5.100	ug/g
		13-apr-1990	JD19	Arsenic	3.600	ug/g
		13-apr-1990	JS11	Lead	6.700	ug/g
		13-apr-1990	JS11	Zinc	109.400	ug/g
		13-apr-1990	JS11	Zinc	74.600	ug/g
		13-apr-1990	LM19	Unknown 170 (TIC)	0.010	ug/g
		13-apr-1990	LM19	Unknown 170 (TIC)	0.010	ug/g
		13-apr-1990	LM19	Unknown 176 (TIC)	0.010	ug/g
CCB-03-SB	5.0	14-mar-1990	99	Total octochlorodibenzo-p-dioxins	0.000064	ug/g
		14-mar-1990	JD19	Arsenic	2.800	ug/g
		14-mar-1990	LM19	Trichlorofluoromethane	0.010	ug/g
	10.0	12-apr-1990	99	Phenol	2.190	ug/g
		12-apr-1990	JD19	Arsenic	15.100	ug/g
		12-apr-1990	LM18	Toluene	0.720	ug/g
	15.0	12-apr-1990	JD19	Arsenic	15.700	ug/g
		12-apr-1990	JS11	Zinc	69.000	ug/g
		12-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.100	ug/g
		12-apr-1990	LM18	Toluene	0.310	ug/g
	20.0	12-apr-1990	JD19	Arsenic	6.400	ug/g
		12-apr-1990	JS11	Zinc	95.900	ug/g
		12-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.110	ug/g
		12-apr-1990	LM18	Toluene	0.110	ug/g
	25.0	12-apr-1990	JD19	Arsenic	6.000	ug/g
		12-apr-1990	JS11	Zinc	64.500	ug/g
		12-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.110	ug/g
	30.0	12-apr-1990	JD19	Arsenic	19.000	ug/g
		12-apr-1990	JS11	Zinc	97.300	ug/g
		12-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.240	ug/g
	35.0	12-apr-1990	JD19	Arsenic	2.900	ug/g
		12-apr-1990	JD19	Arsenic	2.000	ug/g
		12-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.120	ug/g
		12-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.110	ug/g

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

POSITIVE SOIL RESULTS - CONSTRUCTION DEBRIS LANDFILL/CHEMICAL BURIAL SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
CCB-03-SB	40.0	12-apr-1990	JD19	Arsenic	3.400	ug/g
		12-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.110	ug/g
	45.0	12-apr-1990	JD19	Arsenic	2.000	ug/g
		12-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.110	ug/g
	50.0	12-apr-1990	99	Phenol	0.210	ug/g
		12-apr-1990	JD19	Arsenic	16.300	ug/g
		12-apr-1990	JS11	Zinc	127.700	ug/g
	60.0	12-apr-1990	99	Phenol	0.270	ug/g
		12-apr-1990	JD19	Arsenic	6.400	ug/g
		12-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.230	ug/g
	70.0	12-apr-1990	99	Phenol	0.130	ug/g
		12-apr-1990	JD19	Arsenic	8.000	ug/g
		12-apr-1990	JS11	Zinc	73.100	ug/g
		12-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.240	ug/g
		12-apr-1990	LM18	Toluene	0.080	ug/g
	80.0	12-apr-1990	99	Phenol	0.150	ug/g
		12-apr-1990	JD19	Arsenic	4.200	ug/g
		12-apr-1990	JS11	Zinc	108.400	ug/g
		12-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.240	ug/g
	88.0	12-apr-1990	JD19	Arsenic	5.700	ug/g
		12-apr-1990	JS11	Zinc	102.000	ug/g
CCB-04-SB	5.0	11-apr-1990	JD19	Arsenic	13.300	ug/g
		11-apr-1990	JD19	Arsenic	10.200	ug/g
		11-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.100	ug/g
	10.0	11-apr-1990	JD19	Arsenic	6.500	ug/g
	15.0	11-apr-1990	JD19	Arsenic	3.700	ug/g
	20.0	11-apr-1990	JD19	Arsenic	5.100	ug/g
		11-apr-1990	JS11	Zinc	130.200	ug/g
	25.0	11-apr-1990	JD19	Arsenic	5.700	ug/g
		11-apr-1990	JS11	Zinc	139.400	ug/g
	30.0	11-apr-1990	JD19	Arsenic	13.800	ug/g
		11-apr-1990	JS11	Zinc	107.000	ug/g
	35.0	11-apr-1990	JD19	Arsenic	6.000	ug/g
		11-apr-1990	JS11	Zinc	104.700	ug/g
	40.0	11-apr-1990	JD19	Arsenic	3.400	ug/g
	45.0	11-apr-1990	JD19	Arsenic	1.900	ug/g

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

POSITIVE SOIL RESULTS - CONSTRUCTION DEBRIS LANDFILL/CHEMICAL BURIAL SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
CCB-04-SB	50.0	11-apr-1990	JD19	Arsenic	2.100	ug/g
		11-apr-1990	JD19	Arsenic	2.200	ug/g
		11-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.090	ug/g
	60.0	11-apr-1990	JD19	Arsenic	2.300	ug/g
	70.0	12-apr-1990	JD19	Arsenic	5.200	ug/g
		12-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.110	ug/g
		12-apr-1990	LM18	5-Methyl-2-hexanone (TIC)	0.860	ug/g
	80.0	12-apr-1990	JD19	Arsenic	2.700	ug/g
		12-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.120	ug/g
		12-apr-1990	LM18	5-Methyl-2-hexanone (TIC)	0.820	ug/g
	90.0	12-apr-1990	99	Phenol	0.150	ug/g
		12-apr-1990	JD19	Arsenic	5.700	ug/g
		12-apr-1990	JS11	Zinc	77.200	ug/g
		12-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.130	ug/g
CCB-05-SB	5.0	15-mar-1990	99	Total octochlorodibenzo-p-dioxins	0.001	ug/g
		15-mar-1990	JD19	Arsenic	6.400	ug/g
	10.0	11-apr-1990	JD19	Arsenic	2.800	ug/g
	15.0	11-apr-1990	JD19	Arsenic	3.300	ug/g
	20.0	11-apr-1990	JD19	Arsenic	3.100	ug/g
		11-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.080	ug/g
	25.0	11-apr-1990	JD19	Arsenic	1.800	ug/g
		11-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.200	ug/g
		11-apr-1990	LM18	5-Methyl-2-hexanone (TIC)	0.200	ug/g
	30.0	11-apr-1990	99	Phenol	0.270	ug/g
		11-apr-1990	JD19	Arsenic	15.600	ug/g
		11-apr-1990	JD19	Arsenic	16.000	ug/g
		11-apr-1990	JS11	Zinc	72.700	ug/g
		11-apr-1990	JS11	Zinc	66.900	ug/g
		11-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.240	ug/g
		11-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.220	ug/g
		11-apr-1990	LM18	5-Methyl-2-hexanone (TIC)	0.240	ug/g
		11-apr-1990	LM18	5-Methyl-2-hexanone (TIC)	0.220	ug/g
	35.0	11-apr-1990	JD19	Arsenic	4.900	ug/g
		11-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.210	ug/g
		11-apr-1990	LM18	Bis (2-ethylhexyl) phthalate	2.030	ug/g
		11-apr-1990	LM18	Hexadecanoic acid, butyl ester (TIC)	0.520	ug/g
		11-apr-1990	LM18	Octadecanoic acid, butyl ester (TIC)	0.310	ug/g
	40.0	11-apr-1990	JD19	Arsenic	3.100	ug/g
		11-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.220	ug/g

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

POSITIVE SOIL RESULTS - CONSTRUCTION DEBRIS LANDFILL/CHEMICAL BURIAL SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
CCB-05-SB	40.0	11-apr-1990	LM18	5-Methyl-2-hexanone (TIC)	0.110	ug/g
	45.0	11-apr-1990	JD19	Arsenic	1.200	ug/g
		11-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.310	ug/g
		11-apr-1990	LM18	5-Methyl-2-hexanone (TIC)	0.210	ug/g
	50.0	11-apr-1990	JD19	Arsenic	2.200	ug/g
		11-apr-1990	JS11	Zinc	63.000	ug/g
		11-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.220	ug/g
		11-apr-1990	LM18	5-Methyl-2-hexanone (TIC)	0.220	ug/g
	60.0	11-apr-1990	JD19	Arsenic	2.900	ug/g
		11-apr-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.210	ug/g

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

VOCs

Of 61 VOCs measured, levels exceeding detection limits were observed in only 5 percent of the samples. Detected values are shown in Table 6-9 and Figure 6-4. Trichlorofluoromethane was detected in soils at CCB-01-SB (0.009 μg/g), CCB-02-SB (0.008 μg/g) and CCB-03-SB (0.008 μg/g) in the 5-foot interval. Toluene was detected in the 10-, 15-, 20-, and 70-foot samples from CCB-03-SB at 0.716 μg/L, 0.314 μg/L, 0.106 μg/L, and 0.084 μg/L, respectively. No other VOCs were detected in soils at this site. Low frequency of occurrence, distance of this contaminant from the groundwater (about 80 feet), and the low concentrations detected suggest that these compounds are not likely a source of groundwater contamination.

Inorganics

No inorganic constituents were detected above what are considered background soil levels at this site.

6.2.3.4 Groundwater

The two monitoring wells installed as part of the Phase I RI were sampled and analyzed on successive months for extractable organics (phenols, BNAs, pesticides/PCBs), VOCs, and inorganics (priority pollutant metals and cyanide). Rounds 1 and 2 results are presented in Tables 6-10 and 6-11.

Extractable Organic Compounds

No extractable organic compounds were identified above detection limits in the groundwater at this site.

POSITIVE GROUNDWATER RESULTS - ROUND 1 - CONSTRUCTION DEBRIS LANDFILL/CHEMICAL BURIAL SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
CCB-01-MWA	77.1	16-apr-1990	99	Total dissolved solids	516000.000	ug/l
		16-apr-1990	SD21	Selenium	3.410	ug/l
		16-apr-1990	SD22	Arsenic	9.380	ug/l
		16-apr-1990	SS10	Barium	38.300	ug/l
		16-apr-1990	SS10	Calcium	63000.000	ug/l
		16-apr-1990	SS10	Copper	8.710	ug/l
		16-apr-1990	SS10	Sodium	41400.000	ug/l
		16-apr-1990	TT10	Chloride	33000.000	ug/l
		16-apr-1990	TT10	Sulfate	116000.000	ug/l
CCB-02-MWA	82.3	16-apr-1990	99	Total dissolved solids	740000.000	ug/l
		16-apr-1990	SB01	Mercury	0.488	ug/l
		16-apr-1990	SD21	Selenium	9.690	ug/l
		16-apr-1990	SD22	Arsenic	7.250	ug/l
		16-apr-1990	SS10	Barium	24.700	ug/l
		16-apr-1990	SS10	Calcium	88000.000	ug/l
		16-apr-1990	SS10	Sodium	48000.000	ug/l
		16-apr-1990	SS10	Zinc	48.700	ug/l
		16-apr-1990	TT10	Chloride	100000.000	ug/l
		16-apr-1990	TT10	Sulfate	260000.000	ug/l
		16-apr-1990	UM18	Unknown 600 (TIC)	7.000	ug/l
		16-apr-1990	UM20	Trichloroethene	6.760	ug/l

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

POSITIVE GROUNDWATER RESULTS - ROUND 2 - CONSTRUCTION DEBRIS LANDFILL/CHEMICAL BURIAL SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
CCB-01-MWA	77.1	01-jun-1990	99	Total dissolved solids	564000.000	ug/l
		01-jun-1990	SD20	Lead	2.490	ug/l
		01-jun-1990	SD21	Selenium	3.330	ug/l
		01-jun-1990	SD22	Arsenic	8.640	ug/l
		01-jun-1990	SS10	Barium	53.900	ug/l
		01-jun-1990	SS10	Calcium	72000.000	ug/l
		01-jun-1990	SS10	Copper	25.100	ug/l
		01-jun-1990	SS10	Sodium	37300.000	ug/l
		01-jun-1990	TT10	Chloride	32200.000	ug/l
		01-jun-1990	TT10	Sulfate	111000.000	ug/l
CCB-02-MWA	85.2	02-jun-1990	99	Total dissolved solids	808000.000	ug/l
		02-jun-1990	SD20	Lead	2.930	ug/l
		02-jun-1990	SD21	Selenium	10.600	ug/l
		02-jun-1990	SD22	Arsenic	7.140	ug/l
		02-jun-1990	SS10	Barium	31.200	ug/l
		02-jun-1990	SS10	Calcium	110000.000	ug/l
		02-jun-1990	SS10	Copper	8.270	ug/l
		02-jun-1990	SS10	Sodium	51600.000	ug/l
		02-jun-1990	TT10	Chloride	97000.000	ug/l
		02-jun-1990	TT10	Sulfate	238000.000	ug/l
		02-jun-1990	UM20	Trichloroethene	4.670	ug/l

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

VOCs

TCE was detected above the California MCL (5.0 μg/L) in the Round 1 groundwater sample collected from CCB-02-MWA at 6.760 μg/L (Table 6-10 and Figure 6-6). TCE was detected in the Round 2 sample at 4.670 μg/L (Table 6-11). No soil samples were collected in the vicinity of CCB-02-MWA and geophysical data did not suggest the presence of a trench or any other anomaly that could be considered a potential TCE source. However, this well is located downgradient of ALF-02-MWA which registered 41.000 μg/L (Round 1) and 70.500 μg/L (Round 2) in the groundwater. Soil gas data suggests that this well may be part of a TCE plume originating in the northwestern portion of the Abandoned Landfill (Figure 6-1 and Section 6.2.2).

Inorganics

All inorganic contaminant concentrations detected were below MCLs and represented values consistent with the concentrations found in background groundwater samples (Tables 6-10 and 6-11 and Figure 6-7).

6.2.3.5 Chemical Burial Site/Construction Debris Landfill Summary

Although this site housed buried drums containing pesticides in 1974, chlordane was detected in only two of 63 samples at levels ranging from 0.062 μg/g (10 feet) to 1.040 μg/g (5 feet). Trichlorofluoromethane was also detected in only three samples in the 5-foot interval, approximately 80 feet above the water table. No inorganics were found above what are considered background levels at this site. Therefore, vertical contaminant migration through the vadose zone is not considered a likely groundwater contamination source at this site. There is no apparent correlation between the chemical distribution in the substrate and the stratigraphy at this site.

TCE was detected above the California MCL (5.000 μg/L) in groundwater from the southernmost monitoring well, CCB-02-MWA, at a concentration of 6.760 μg/L (Round 1). This well is upgradient of the Chemical Burial Site, but downgradient of the Abandoned

Landfill site. Groundwater and soil gas data suggest that the TCE found in both ALF-02-MWA and CCB-02-MWA may represent part of a single plume. However, existing data is insufficient to confirm this. Data required to more fully define the extent of TCE in groundwater at this site is discussed in Sections 6.2.2.5 and 9.0.

6.2.4 DRMO Trench Area

Distribution and extent of contamination at the DRMO Trench Area site was assessed from geophysical data, seven test pits, eight soil borings, and three monitoring wells. In addition, five soil gas samples were collected and analyzed.

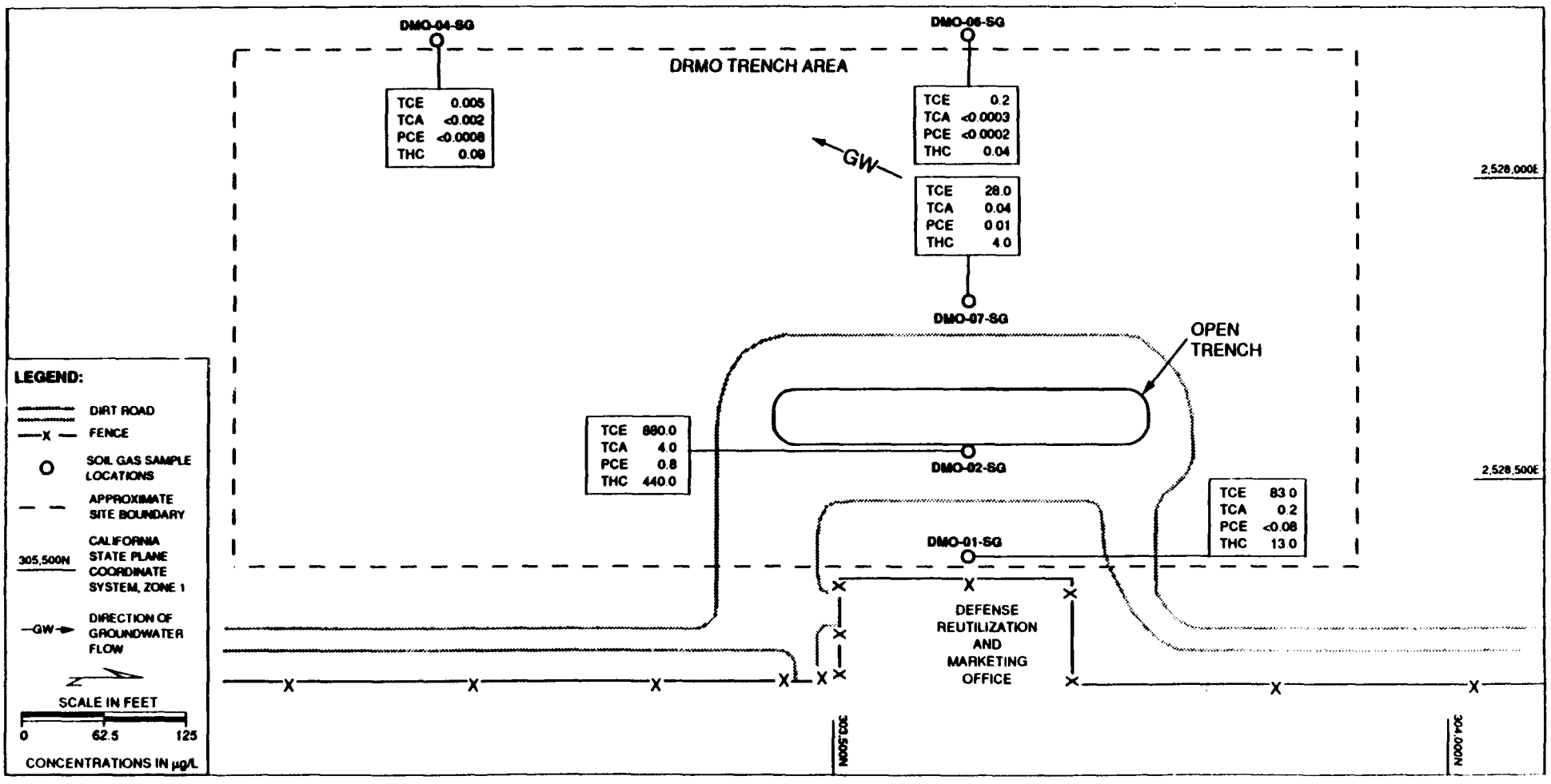
6.2.4.1 Soil Gas

Five soil gas samples were collected and analyzed at this site. Elevated levels of VOCs (TCE, TCA, PCE, THC) were found in the vicinity of the open trench (Figure 6-8). Insufficient data was collected to construct a soil gas plume map.

6.2.4.2 Test Pits

Seven test pits (Figure 4-8) were excavated to locate and characterize the buried trench reportly located 50 feet to the west of the open trench, clear the soil boring locations of trench debris and possible explosive ordnance, and sample landfill material at 5-foot intervals. The buried trench location was estimated using historical data. Three of the seven test pits were located approximately 50 feet west of the open trench; soil borings were installed in their centers, and each was sampled at a depth of 5 feet. Table 4-4 lists each test pit location and character. No evidence of a buried trench was found either during geophysical or test pit investigations.

Approximately 120 feet southwest of the open DRMO trench a geophysical disturbance was registered and was investigated with four test pits excavated to a depth of 5 feet (Figure 4-8). The surface of this area was covered with ash and miscellaneous metal debris. Upon



SIERRA ARMY DEPOT

SOIL GAS VOC CONCENTRATIONS: DRMO TRENCH AREA

FIGURE 6-8

excavation it was discovered that this ash zone was only 2 to 4 inches thick over native soil. No samples were collected from this burn area.

6.2.4.3 Soil

Eight soil borings were installed to the water table at this site. Soil samples were collected at 5-foot intervals to 50 feet and at 10-foot intervals from 50 feet to the water table.

One-hundred and thirteen soil samples collected from eight soil borings were analyzed for extractable organic compounds (BNAs and pesticides/PCBs), VOCs, and inorganics (TTLC metals). Analytical results are presented on Table 6-12 and Figures 6-9 and 6-10.

Extractable Organic Compounds

Levels exceeding detection limits were observed in only 10 percent of the 113 samples collected for extractable organic compounds. Detected values are shown in Table 6-12 and Figure 6-9. Highest concentrations of pesticides and phenol were detected in the 15-foot interval sample of DMO-11-SB. DMO-11-SB was an angled boring and the 15-foot interval corresponds to a depth of approximately 5 feet beneath the open trench. Compounds found in this interval included: aldrin (0.058 μg/g), DDD, PP' (2.2000 μg/g), DDE, PP' (0.024 μg/g) and DDT, PP' (2.530 μg/g). DDT, PP' (0.014 μg/g) was also found in the 20-foot interval in this boring. Extractable organic compound detects in soils deeper than 15 feet were restricted to low levels of phenol, heptachlor, bis(2-ethylhexyl)phthalate, and bis(z-chloroethyl)ether (Table 6-12 and Figure 6-9).

Pesticide compounds are primarily restricted to the interval 5 feet below the trench bottom. Higher concentrations were generally observed in this interval compared to the 0- to 3-foot interval (see Section 2.3.1). The physiochemical properties of these compounds helps explain their subsurface distribution.

Pesticide compounds detected in DMO-11-SB have a strong affinity for soil material (DOE, 1989) which may contribute to their distribution pattern in the vadose zone. Photolysis

POSITIVE SOIL RESULTS - DRMO TRENCH AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
DMO-06-SB	10.0	26-mar-1990	JD19	Arsenic	5.100	ug/g
		26-mar-1990	JS11	Barium	82.300	ug/g
		26-mar-1990	JS11	Vanadium	23.100	ug/g
	15.0	26-mar-1990	JD19	Arsenic	17.100	ug/g
		26-mar-1990	JS11	Barium	399.800	ug/g
		26-mar-1990	JS11	Cobalt	29.200	ug/g
		26-mar-1990	JS11	Molybdenum	2.600	ug/g
		26-mar-1990	JS11	Lead	9.000	ug/g
		26-mar-1990	JS11	Vanadium	120.500	ug/g
		26-mar-1990	JS11	Zinc	157.900	ug/g
		26-mar-1990	LM18	Bis (2-ethylhexyl) phthalate	1.550	ug/g
	20.0	26-mar-1990	JD19	Arsenic	5.800	ug/g
		26-mar-1990	JS11	Barium	57.000	ug/g
	25.0	26-mar-1990	JD19	Arsenic	3.500	ug/g
		26-mar-1990	JS11	Barium	117.900	ug/g
		26-mar-1990	JS11	Vanadium	43.100	ug/g
	30.0	26-mar-1990	JD19	Arsenic	1.500	ug/g
		26-mar-1990	JS11	Barium	56.000	ug/g
	35.0	26-mar-1990	JD19	Arsenic	1.100	ug/g
		26-mar-1990	LM18	Unknown 573 (TIC)	0.100	ug/g
	40.0	26-mar-1990	JD19	Arsenic	6.300	ug/g
		26-mar-1990	JS11	Barium	111.600	ug/g
		26-mar-1990	JS11	Vanadium	41.000	ug/g
		26-mar-1990	LM18	Bis (2-ethylhexyl) phthalate	1.800	ug/g
		26-mar-1990	LM18	Unknown 614 (TIC)	0.110	ug/g
	45.0	26-mar-1990	JD19	Arsenic	2.500	ug/g
		26-mar-1990	JS11	Barium	133.200	ug/g
		26-mar-1990	JS11	Vanadium	38.700	ug/g
	50.0	26-mar-1990	JD19	Arsenic	4.200	ug/g
		26-mar-1990	JD19	Arsenic	6.900	ug/g
		26-mar-1990	JS11	Barium	207.100	ug/g
		26-mar-1990	JS11	Barium	218.500	ug/g
		26-mar-1990	JS11	Molybdenum	6.100	ug/g
		26-mar-1990	JS11	Vanadium	87.900	ug/g
		26-mar-1990	JS11	Vanadium	84.600	ug/g
		26-mar-1990	JS11	Zinc	73.400	ug/g
		26-mar-1990	JS11	Zinc	79.200	ug/g
		26-mar-1990	LM19	Unknown 071 (TIC)	0.020	ug/g
	60.0	26-mar-1990	JD19	Arsenic	8.700	ug/g
		26-mar-1990	JS11	Barium	102.700	ug/g
		26-mar-1990	JS11	Vanadium	30.600	ug/g

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

POSITIVE SOIL RESULTS - DRMO TRENCH AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
DMO-06-SB	70.0	26-mar-1990	JD19	Arsenic	5.300	ug/g
		26-mar-1990	JS11	Barium	251.900	ug/g
		26-mar-1990	JS11	Molybdenum	3.400	ug/g
		26-mar-1990	JS11	Vanadium	66.000	ug/g
		26-mar-1990	LM18	Bis (2-ethylhexyl) phthalate	1.030	ug/g
	80.0	26-mar-1990	JD19	Arsenic	4.300	ug/g
		26-mar-1990	JS11	Barium	53.900	ug/g
		26-mar-1990	JS11	Vanadium	37.600	ug/g
	90.0	26-mar-1990	JD19	Arsenic	8.200	ug/g
		26-mar-1990	JS11	Barium	234.400	ug/g
		26-mar-1990	JS11	Vanadium	60.700	ug/g
		26-mar-1990	JS11	Zinc	72.800	ug/g
	95.0	26-mar-1990	JD19	Arsenic	4.500	ug/g
		26-mar-1990	JS11	Barium	292.300	ug/g
		26-mar-1990	JS11	Vanadium	65.000	ug/g
		26-mar-1990	JS11	Zinc	69.400	ug/g
DMO-07-SB	5.0	26-mar-1990	JD19	Arsenic	18.900	ug/g
		26-mar-1990	JS11	Barium	409.800	ug/g
		26-mar-1990	JS11	Vanadium	61.500	ug/g
		26-mar-1990	JS11	Zinc	77.200	ug/g
		26-mar-1990	JY02	Hexavalent chromium	1.100	ug/g
		26-mar-1990	LM18	Unknown 614 (TIC)	0.110	ug/g
	10.0	26-mar-1990	JD19	Arsenic	5.200	ug/g
		26-mar-1990	JS11	Barium	76.600	ug/g
		26-mar-1990	LH10	Heptachlor	0.010	ug/g
	15.0	26-mar-1990	JD19	Arsenic	6.600	ug/g
		26-mar-1990	JS11	Barium	270.500	ug/g
		26-mar-1990	JS11	Vanadium	81.700	ug/g
		26-mar-1990	JS11	Zinc	104.700	ug/g
	20.0	26-mar-1990	JD19	Arsenic	2.600	ug/g
		26-mar-1990	JS11	Barium	62.200	ug/g
		26-mar-1990	JS11	Vanadium	35.200	ug/g
		26-mar-1990	LM19	Unknown 071 (TIC)	0.010	ug/g
	25.0	26-mar-1990	JD19	Arsenic	6.600	ug/g
		26-mar-1990	JS11	Barium	113.100	ug/g
		26-mar-1990	JS11	Molybdenum	2.200	ug/g
		26-mar-1990	JS11	Vanadium	37.500	ug/g
		26-mar-1990	LM18	Bis (2-ethylhexyl) phthalate	17.490	ug/g
		26-mar-1990	LM18	Dioctyl adipate (TIC)	0.320	ug/g
		26-mar-1990	LM19	Unknown 071 (TIC)	0.020	ug/g
	30.0	26-mar-1990	JD19	Arsenic	1.300	ug/g
		26-mar-1990	JS11	Barium	155.000	ug/g

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POSITIVE SOIL RESULTS - DRMO TRENCH AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
DMO-07-SB	30.0	26-mar-1990	JS11	Vanadium	23.900	ug/g
	35.0	26-mar-1990	JD19	Arsenic	1.500	ug/g
		26-mar-1990	JS11	Barium	54.600	ug/g
		26-mar-1990	JS11	Vanadium	26.000	ug/g
		26-mar-1990	LM19	Unknown 071 (TIC)	0.020	ug/g
	45.0	29-mar-1990	JD19	Arsenic	3.800	ug/g
		29-mar-1990	JS11	Barium	145.400	ug/g
		29-mar-1990	JS11	Vanadium	45.700	ug/g
	50.0	29-mar-1990	JD19	Arsenic	3.700	ug/g
		29-mar-1990	JD19	Arsenic	6.200	ug/g
		29-mar-1990	JS11	Barium	264.700	ug/g
		29-mar-1990	JS11	Barium	233.100	ug/g
		29-mar-1990	JS11	Molybdenum	2.500	ug/g
		29-mar-1990	JS11	Molybdenum	2.300	ug/g
		29-mar-1990	JS11	Vanadium	75.000	ug/g
		29-mar-1990	JS11	Vanadium	76.400	ug/g
		29-mar-1990	JS11	Zinc	85.300	ug/g
		29-mar-1990	JS11	Zinc	88.700	ug/g
		29-mar-1990	LM18	Unknown 614 (TIC)	0.090	ug/g
	60.0	29-mar-1990	JD19	Arsenic	13.900	ug/g
		29-mar-1990	JS11	Barium	186.400	ug/g
		29-mar-1990	JS11	Vanadium	43.500	ug/g
	70.0	29-mar-1990	JD19	Arsenic	6.000	ug/g
		29-mar-1990	JS11	Barium	144.400	ug/g
		29-mar-1990	JS11	Molybdenum	2.100	ug/g
		29-mar-1990	JS11	Vanadium	35.100	ug/g
	80.0	29-mar-1990	JD19	Arsenic	6.100	ug/g
		29-mar-1990	JS11	Barium	56.900	ug/g
		29-mar-1990	JS11	Vanadium	23.100	ug/g
	90.0	29-mar-1990	JD19	Arsenic	14.400	ug/g
		29-mar-1990	JD19	Arsenic	4.400	ug/g
		29-mar-1990	JS11	Barium	137.600	ug/g
		29-mar-1990	JS11	Barium	173.000	ug/g
		29-mar-1990	JS11	Lead	68.300	ug/g
		29-mar-1990	JS11	Vanadium	48.800	ug/g
		29-mar-1990	JS11	Vanadium	61.000	ug/g
		29-mar-1990	JS11	Zinc	61.800	ug/g
		29-mar-1990	JS11	Zinc	65.100	ug/g
		29-mar-1990	LM19	Trichloroethene	0.000	ug/g
DMO-08-SB	5.0	27-mar-1990	JD19	Arsenic	11.400	ug/g
		27-mar-1990	JS11	Barium	245.800	ug/g
		27-mar-1990	JS11	Lead	7.500	ug/g
		27-mar-1990	JS11	Vanadium	55.100	ug/g
		27-mar-1990	JS11	Zinc	67.200	ug/g

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POSITIVE SOIL RESULTS - DRMO TRENCH AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
DMO-08-SB	5.0	27-mar-1990	LM19	Trichloroethene	0.020	ug/g
		27-mar-1990	LM19	Unknown 071 (TIC)	0.010	ug/g
	10.0	27-mar-1990	JB01	Mercury	0.100	ug/g
		27-mar-1990	JD19	Arsenic	5.500	ug/g
		27-mar-1990	JS11	Vanadium	20.900	ug/g
		27-mar-1990	LM19	Unknown 071 (TIC)	0.020	ug/g
	15.0	27-mar-1990	JD19	Arsenic	4.200	ug/g
		27-mar-1990	JS11	Barium	163.900	ug/g
		27-mar-1990	JS11	Vanadium	57.500	ug/g
		27-mar-1990	JS11	Zinc	68.500	ug/g
		27-mar-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.110	ug/g
		27-mar-1990	LM19	Unknown 071 (TIC)	0.010	ug/g
	20.0	27-mar-1990	JD19	Arsenic	4.100	ug/g
		27-mar-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.100	ug/g
	25.0	27-mar-1990	99	Heptachlor	0.010	ug/g
		27-mar-1990	JD19	Arsenic	3.200	ug/g
		27-mar-1990	JS11	Barium	143.400	ug/g
		27-mar-1990	JS11	Lead	12.000	ug/g
		27-mar-1990	JS11	Vanadium	35.800	ug/g
	30.0	27-mar-1990	JD19	Arsenic	2.200	ug/g
		27-mar-1990	JS11	Barium	73.400	ug/g
		27-mar-1990	JS11	Vanadium	27.100	ug/g
	35.0	27-mar-1990	JD19	Arsenic	1.800	ug/g
		27-mar-1990	JS11	Barium	57.400	ug/g
		27-mar-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.080	ug/g
		27-mar-1990	LM19	Toluene	0.000	ug/g
	40.0	27-mar-1990	JD19	Arsenic	4.400	ug/g
		27-mar-1990	JS11	Barium	110.600	ug/g
		27-mar-1990	JS11	Vanadium	36.400	ug/g
		27-mar-1990	LM18	Unknown 512 (TIC)	0.110	ug/g
	45.0	27-mar-1990	JD19	Arsenic	3.700	ug/g
		27-mar-1990	JS11	Barium	164.300	ug/g
		27-mar-1990	JS11	Vanadium	38.400	ug/g
		27-mar-1990	JS11	Zinc	59.300	ug/g
	50.0	27-mar-1990	JD19	Arsenic	4.700	ug/g
		27-mar-1990	JD19	Arsenic	4.900	ug/g
		27-mar-1990	JS11	Barium	121.000	ug/g
		27-mar-1990	JS11	Barium	138.100	ug/g
		27-mar-1990	JS11	Molybdenum	2.400	ug/g
		27-mar-1990	JS11	Molybdenum	2.300	ug/g
		27-mar-1990	JS11	Vanadium	46.200	ug/g
		27-mar-1990	JS11	Vanadium	58.100	ug/g
		27-mar-1990	JS11	Zinc	58.500	ug/g

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POSITIVE SOIL RESULTS - DRMO TRENCH AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
DMO-08-SB	50.0	27-mar-1990	LM18	Unknown 512 (TIC)	0.070	ug/g
		27-mar-1990	LM18	Unknown 512 (TIC)	0.110	ug/g
	60.0	27-mar-1990	JD19	Arsenic	11.700	ug/g
		27-mar-1990	JS11	Barium	92.600	ug/g
		27-mar-1990	JS11	Molybdenum	2.300	ug/g
		27-mar-1990	JS11	Vanadium	37.000	ug/g
		27-mar-1990	LM18	Unknown 512 (TIC)	0.100	ug/g
	70.0	27-mar-1990	JD19	Arsenic	9.300	ug/g
		27-mar-1990	JS11	Barium	128.700	ug/g
		27-mar-1990	JS11	Molybdenum	2.200	ug/g
		27-mar-1990	JS11	Lead	13.600	ug/g
		27-mar-1990	JS11	Vanadium	32.700	ug/g
		27-mar-1990	LM18	Unknown 512 (TIC)	0.100	ug/g
		27-mar-1990	LM19	Toluene	0.000	ug/g
	80.0	27-mar-1990	JD19	Arsenic	7.400	ug/g
		27-mar-1990	LM18	Unknown 512 (TIC)	0.100	ug/g
	90.0	27-mar-1990	JD19	Arsenic	6.300	ug/g
		27-mar-1990	JS11	Barium	136.000	ug/g
		27-mar-1990	JS11	Lead	21.500	ug/g
		27-mar-1990	JS11	Vanadium	40.800	ug/g
		27-mar-1990	LM18	Unknown 512 (TIC)	0.110	ug/g
	95.0	27-mar-1990	JD19	Arsenic	2.800	ug/g
		27-mar-1990	JS11	Barium	203.200	ug/g
		27-mar-1990	JS11	Vanadium	52.900	ug/g
		27-mar-1990	JS11	Zinc	64.200	ug/g
		27-mar-1990	LM18	Unknown 512 (TIC)	0.120	ug/g
DMO-09-SB	5.0	28-mar-1990	JD19	Arsenic	14.100	ug/g
		28-mar-1990	JS11	Barium	277.500	ug/g
		28-mar-1990	JS11	Vanadium	53.500	ug/g
		28-mar-1990	JS11	Zinc	72.200	ug/g
		28-mar-1990	JY02	Hexavalent chromium	0.700	ug/g
		28-mar-1990	LM18	Unknown 512 (TIC)	0.220	ug/g
	10.0	28-mar-1990	JD19	Arsenic	6.600	ug/g
		28-mar-1990	JS11	Barium	105.800	ug/g
		28-mar-1990	JS11	Vanadium	30.200	ug/g
	15.0	28-mar-1990	JD19	Arsenic	7.100	ug/g
		28-mar-1990	JS11	Barium	139.100	ug/g
		28-mar-1990	JS11	Vanadium	52.900	ug/g
	20.0	28-mar-1990	JD19	Arsenic	2.900	ug/g
	25.0	28-mar-1990	JD19	Arsenic	1.700	ug/g
		28-mar-1990	JS11	Barium	135.100	ug/g
		28-mar-1990	JS11	Lead	19.200	ug/g

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POSITIVE SOIL RESULTS - DRMO TRENCH AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
DMO-09-SB	25.0	28-mar-1990	JS11	Vanadium	44.500	ug/g
		28-mar-1990	JS11	Zinc	58.500	ug/g
	30.0	28-mar-1990	JD19	Arsenic	2.700	ug/g
		28-mar-1990	JS11	Barium	81.700	ug/g
		28-mar-1990	JS11	Lead	21.800	ug/g
		28-mar-1990	JS11	Vanadium	36.300	ug/g
	35.0	28-mar-1990	JD19	Arsenic	1.600	ug/g
		28-mar-1990	JS11	Vanadium	22.600	ug/g
	40.0	28-mar-1990	JD19	Arsenic	2.600	ug/g
		28-mar-1990	JS11	Barium	90.900	ug/g
		28-mar-1990	JS11	Vanadium	26.700	ug/g
	45.0	28-mar-1990	JD19	Arsenic	3.400	ug/g
		28-mar-1990	JS11	Barium	109.300	ug/g
		28-mar-1990	JS11	Vanadium	35.900	ug/g
	50.0	28-mar-1990	JD19	Arsenic	7.500	ug/g
		28-mar-1990	JD19	Arsenic	7.500	ug/g
		28-mar-1990	JS11	Barium	181.300	ug/g
		28-mar-1990	JS11	Barium	99.900	ug/g
		28-mar-1990	JS11	Molybdenum	2.800	ug/g
		28-mar-1990	JS11	Molybdenum	2.300	ug/g
		28-mar-1990	JS11	Lead	7.700	ug/g
		28-mar-1990	JS11	Vanadium	51.500	ug/g
		28-mar-1990	JS11	Vanadium	35.100	ug/g
		28-mar-1990	JS11	Zinc	60.900	ug/g
	60.0	28-mar-1990	JD19	Arsenic	5.800	ug/g
		28-mar-1990	JS11	Barium	78.400	ug/g
		28-mar-1990	JS11	Vanadium	33.500	ug/g
	70.0	28-mar-1990	JD19	Arsenic	14.500	ug/g
		28-mar-1990	JS11	Barium	223.600	ug/g
		28-mar-1990	JS11	Molybdenum	4.700	ug/g
		28-mar-1990	JS11	Vanadium	57.600	ug/g
	80.0	28-mar-1990	JD19	Arsenic	3.500	ug/g
		28-mar-1990	JS11	Barium	61.800	ug/g
		28-mar-1990	JS11	Vanadium	49.400	ug/g
	90.0	28-mar-1990	JD19	Arsenic	4.300	ug/g
		28-mar-1990	JS11	Barium	196.500	ug/g
		28-mar-1990	JS11	Lead	8.700	ug/g
		28-mar-1990	JS11	Vanadium	60.600	ug/g
		28-mar-1990	JS11	Zinc	64.900	ug/g
DMO-10-SB	5.0	28-mar-1990	JD19	Arsenic	9.300	ug/g
		28-mar-1990	JS11	Barium	260.900	ug/g
		28-mar-1990	JS11	Molybdenum	2.000	ug/g

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POSITIVE SOIL RESULTS - DRMO TRENCH AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
DMO-10-SB	5.0	28-mar-1990	JS11	Lead	16.100	ug/g
		28-mar-1990	JS11	Vanadium	49.900	ug/g
		28-mar-1990	JS11	Zinc	141.700	ug/g
		28-mar-1990	JY02	Hexavalent chromium	1.200	ug/g
		28-mar-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.100	ug/g
		28-mar-1990	LM18	1,1,2,2-Tetrachloroethane	0.210	ug/g
		28-mar-1990	LM18	Unknown 536 (TIC)	0.100	ug/g
		28-mar-1990	LM18	Unknown 538 (TIC)	0.100	ug/g
		28-mar-1990	LM18	Unknown 556 (TIC)	0.100	ug/g
		28-mar-1990	LM18	Unknown 583 (TIC)	0.520	ug/g
		28-mar-1990	LM19	Trichloroethene	0.010	ug/g
	10.0	28-mar-1990	JD19	Arsenic	8.900	ug/g
		28-mar-1990	JS11	Barium	148.300	ug/g
		28-mar-1990	JS11	Vanadium	34.700	ug/g
		28-mar-1990	LH10	Heptachlor	0.010	ug/g
		28-mar-1990	LM18	Unknown 641 (TIC)	0.090	ug/g
		28-mar-1990	LM18	Unknown 645 (TIC)	0.310	ug/g
	15.0	28-mar-1990	JD19	Arsenic	10.400	ug/g
		28-mar-1990	JS11	Barium	247.500	ug/g
		28-mar-1990	JS11	Molybdenum	5.300	ug/g
		28-mar-1990	JS11	Vanadium	66.300	ug/g
		28-mar-1990	JS11	Zinc	73.900	ug/g
		28-mar-1990	LM18	Bis (2-ethylhexyl) phthalate	0.920	ug/g
		28-mar-1990	LM18	Unknown 614 (TIC)	0.100	ug/g
		28-mar-1990	LM18	Unknown 648 (TIC)	0.770	ug/g
	20.0	28-mar-1990	JD19	Arsenic	6.500	ug/g
		28-mar-1990	JS11	Barium	73.800	ug/g
		28-mar-1990	JS11	Vanadium	24.100	ug/g
	25.0	28-mar-1990	JD19	Arsenic	1.300	ug/g
	30.0	28-mar-1990	JD19	Arsenic	1.400	ug/g
		28-mar-1990	JS11	Barium	75.600	ug/g
		28-mar-1990	JS11	Vanadium	32.500	ug/g
	40.0	28-mar-1990	JD19	Arsenic	10.000	ug/g
		28-mar-1990	JS11	Barium	140.400	ug/g
		28-mar-1990	JS11	Molybdenum	4.100	ug/g
		28-mar-1990	JS11	Lead	9.600	ug/g
		28-mar-1990	JS11	Vanadium	49.400	ug/g
	45.0	28-mar-1990	JD19	Arsenic	2.900	ug/g
		28-mar-1990	JS11	Barium	118.400	ug/g
		28-mar-1990	JS11	Vanadium	37.000	ug/g
	50.0	28-mar-1990	JD19	Arsenic	3.500	ug/g
		28-mar-1990	JD19	Arsenic	4.000	ug/g
		28-mar-1990	JS11	Barium	206.400	ug/g
		28-mar-1990	JS11	Barium	167.200	ug/g

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POSITIVE SOIL RESULTS - DRMO TRENCH AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
DMO-10-SB	50.0	28-mar-1990	JS11	Vanadium	55.500	ug/g
		28-mar-1990	JS11	Vanadium	51.100	ug/g
		28-mar-1990	JS11	Zinc	59.100	ug/g
	60.0	29-mar-1990	JD19	Arsenic	10.600	ug/g
		29-mar-1990	JS11	Barium	488.600	ug/g
		29-mar-1990	JS11	Molybdenum	3.500	ug/g
		29-mar-1990	JS11	Lead	17.000	ug/g
		29-mar-1990	JS11	Vanadium	107.400	ug/g
		29-mar-1990	JS11	Zinc	108.200	ug/g
		29-mar-1990	LM18	Unknown 589 (TIC)	0.900	ug/g
		29-mar-1990	LM19	Methylene chloride	0.210	ug/g
		29-mar-1990	LM19	Trichloroethene	0.220	ug/g
		29-mar-1990	LM19	Unknown 129 (TIC)	0.030	ug/g
	70.0	29-mar-1990	JD19	Arsenic	2.800	ug/g
		29-mar-1990	JS11	Barium	208.400	ug/g
		29-mar-1990	JS11	Vanadium	68.700	ug/g
		29-mar-1990	JS11	Zinc	67.400	ug/g
		29-mar-1990	LM18	Unknown 589 (TIC)	0.700	ug/g
		29-mar-1990	LM19	Methylene chloride	0.030	ug/g
		29-mar-1990	LM19	Trichloroethene	0.090	ug/g
	80.0	29-mar-1990	JD19	Arsenic	4.200	ug/g
		29-mar-1990	JD19	Arsenic	4.400	ug/g
		29-mar-1990	JS11	Barium	95.500	ug/g
		29-mar-1990	JS11	Barium	153.300	ug/g
		29-mar-1990	JS11	Vanadium	47.000	ug/g
		29-mar-1990	JS11	Vanadium	55.800	ug/g
		29-mar-1990	JS11	Zinc	58.500	ug/g
		29-mar-1990	LM18	Unknown 589 (TIC)	0.210	ug/g
	90.0	29-mar-1990	JB01	Mercury	0.100	ug/g
		29-mar-1990	JD19	Arsenic	11.000	ug/g
		29-mar-1990	JS11	Barium	196.700	ug/g
		29-mar-1990	JS11	Lead	18.100	ug/g
		29-mar-1990	JS11	Vanadium	70.400	ug/g
		29-mar-1990	JS11	Zinc	63.600	ug/g
		29-mar-1990	LM18	Unknown 589 (TIC)	0.120	ug/g
		29-mar-1990	LM19	Trichloroethene	0.020	ug/g
DMO-11-SB	5.0	30-mar-1990	JD19	Arsenic	11.000	ug/g
		30-mar-1990	JS11	Barium	257.300	ug/g
		30-mar-1990	JS11	Molybdenum	1.900	ug/g
		30-mar-1990	JS11	Lead	14.400	ug/g
		30-mar-1990	JS11	Vanadium	43.300	ug/g
		30-mar-1990	LM18	Unknown 589 (TIC)	0.100	ug/g
		30-mar-1990	LM19	Unknown 076 (TIC)	0.010	ug/g
	10.0	30-mar-1990	JD19	Arsenic	9.200	ug/g
		30-mar-1990	JS11	Barium	224.800	ug/g
		30-mar-1990	JS11	Lead	10.700	ug/g

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POSITIVE SOIL RESULTS - DRMO TRENCH AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound		Concentration	Units
DMO-11-SB	10.0	30-mar-1990	JS11	Vanadium		44.300	ug/g
		30-mar-1990	JS11	Zinc		64.700	ug/g
		30-mar-1990	LM18	Unknown 589 (TIC)		0.090	ug/g
	15.0	30-mar-1990	JD19	Arsenic		5.200	ug/g
		30-mar-1990	JS11	Barium		302.200	ug/g
		30-mar-1990	JS11	Molybdenum		2.100	ug/g
		30-mar-1990	JS11	Lead		9.700	ug/g
		30-mar-1990	JS11	Vanadium		100.500	ug/g
		30-mar-1990	JS11	Zinc		125.800	ug/g
		30-mar-1990	LH10	Aldrin		0.060	ug/g
		30-mar-1990	LH10	p,p-DDD		2.230	ug/g
		30-mar-1990	LH10	p,p-DDE		0.020	ug/g
		30-mar-1990	LH10	p,p-DDT		2.560	ug/g
		30-mar-1990	LM18	1,2-Dichlorobenzene		76.630	ug/g
		30-mar-1990	LM18	1,4-Dichlorobenzene		23.600	ug/g
		30-mar-1990	LM18	2,6-Dimethylundecane (TIC)		22.500	ug/g
		30-mar-1990	LM18	2,6,10,14-Tetramethylpentadecane (TIC)		44.990	ug/g
		30-mar-1990	LM18	Dodecane (TIC)		5.620	ug/g
		30-mar-1990	LM18	Tridecane (TIC)		112.490	ug/g
		30-mar-1990	LM18	Tetradecane (TIC)		56.240	ug/g
		30-mar-1990	LM18	Pentadecane (TIC)		112.490	ug/g
		30-mar-1990	LM18	Hexadecane (TIC)		56.240	ug/g
		30-mar-1990	LM18	Heptadecane (TIC)		56.240	ug/g
		30-mar-1990	LM18	Nonadecane (TIC)		33.750	ug/g
		30-mar-1990	LM18	Eicosane (TIC)		22.500	ug/g
		30-mar-1990	LM18	Unknown 539 (TIC)		22.500	ug/g
		30-mar-1990	LM18	Unknown 545 (TIC)		39.370	ug/g
		30-mar-1990	LM18	Unknown 552 (TIC)		33.750	ug/g
		30-mar-1990	LM18	Unknown 558 (TIC)		16.870	ug/g
		30-mar-1990	LM18	Unknown 567 (TIC)		28.120	ug/g
		30-mar-1990	LM18	Unknown 574 (TIC)		22.500	ug/g
		30-mar-1990	LM18	Unknown 579 (TIC)		16.870	ug/g
		30-mar-1990	LM18	Unknown 580 (TIC)		39.370	ug/g
		30-mar-1990	LM18	Unknown 592 (TIC)		28.120	ug/g
		30-mar-1990	LM18	Unknown 601 (TIC)		28.120	ug/g
		30-mar-1990	LM19	1,1,1-Trichloroethane	>	1.000	ug/g
		30-mar-1990	LM19	1,1,3-Trimethylcyclohexane (TIC)		3.940	ug/g
		30-mar-1990	LM19	1,1-Dichloroethene		0.160	ug/g
		30-mar-1990	LM19	1,2-Dichloroethane		0.110	ug/g
		30-mar-1990	LM19	1,2-Dichloropropane		0.050	ug/g
		30-mar-1990	LM19	Benzene		1.100	ug/g
		30-mar-1990	LM19	Methylene chloride		0.570	ug/g
		30-mar-1990	LM19	Chloroform		0.050	ug/g
		30-mar-1990	LM19	Dichlorobenzenes		224.970	ug/g
		30-mar-1990	LM19	Chlorobenzene	>	1.000	ug/g
		30-mar-1990	LM19	Ethylbenzene	>	1.000	ug/g
		30-mar-1990	LM19	Toluene	>	1.000	ug/g
		30-mar-1990	LM19	Methylcyclopentane (TIC)		0.560	ug/g
		30-mar-1990	LM19	1,1,2,2-Tetrachloroethane	>	1.000	ug/g
		30-mar-1990	LM19	Tetrachloroethene	>	1.000	ug/g
		30-mar-1990	LM19	Trichloroethene	>	1.000	ug/g

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

POSITIVE SOIL RESULTS - DRMO TRENCH AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
DMO-11-SB	15.0	30-mar-1990	LM19	Unknown 094 (TIC)	0.390	ug/g
		30-mar-1990	LM19	Unknown 098 (TIC)	1.120	ug/g
		30-mar-1990	LM19	Unknown 103 (TIC)	0.560	ug/g
		30-mar-1990	LM19	Unknown 115 (TIC)	2.250	ug/g
		30-mar-1990	LM19	Unknown 128 (TIC)	0.560	ug/g
		30-mar-1990	LM19	Unknown 138 (TIC)	3.370	ug/g
		30-mar-1990	LM19	Unknown 143 (TIC)	0.560	ug/g
		30-mar-1990	LM19	Xylenes	> 1.000	ug/g
	20.0	30-mar-1990	JD19	Arsenic	8.400	ug/g
		30-mar-1990	JS11	Barium	130.100	ug/g
		30-mar-1990	JS11	Molybdenum	3.700	ug/g
		30-mar-1990	JS11	Lead	8.100	ug/g
		30-mar-1990	JS11	Vanadium	50.600	ug/g
		30-mar-1990	LH10	p,p-DDT	0.010	ug/g
		30-mar-1990	LM18	2,6,10,14-Tetramethylpentadecane (TIC)	2.100	ug/g
		30-mar-1990	LM18	Tridecane (TIC)	1.050	ug/g
		30-mar-1990	LM18	Tetradecane (TIC)	2.100	ug/g
		30-mar-1990	LM18	Pentadecane (TIC)	2.100	ug/g
		30-mar-1990	LM18	Hexadecane (TIC)	2.100	ug/g
		30-mar-1990	LM18	Heptadecane (TIC)	3.150	ug/g
		30-mar-1990	LM18	Eicosane (TIC)	1.050	ug/g
		30-mar-1990	LM18	Unknown 542 (TIC)	0.420	ug/g
		30-mar-1990	LM18	Unknown 567 (TIC)	0.320	ug/g
		30-mar-1990	LM18	Unknown 578 (TIC)	0.110	ug/g
		30-mar-1990	LM18	Unknown 579 (TIC)	0.320	ug/g
		30-mar-1990	LM18	Unknown 580 (TIC)	0.210	ug/g
		30-mar-1990	LM18	Unknown 581 (TIC)	0.950	ug/g
		30-mar-1990	LM18	Unknown 586 (TIC)	0.210	ug/g
		30-mar-1990	LM18	Unknown 587 (TIC)	0.320	ug/g
		30-mar-1990	LM18	Unknown 601 (TIC)	0.630	ug/g
		30-mar-1990	LM18	Unknown 606 (TIC)	2.100	ug/g
		30-mar-1990	LM18	Unknown 615 (TIC)	0.210	ug/g
		30-mar-1990	LM18	Unknown 616 (TIC)	0.840	ug/g
		30-mar-1990	LM18	Unknown 623 (TIC)	0.740	ug/g
	25.0	30-mar-1990	JD19	Arsenic	8.100	ug/g
		30-mar-1990	JS11	Barium	220.200	ug/g
		30-mar-1990	JS11	Molybdenum	2.200	ug/g
		30-mar-1990	JS11	Vanadium	74.000	ug/g
		30-mar-1990	JS11	Zinc	66.600	ug/g
		30-mar-1990	LM18	2,6,10,14-Tetramethylpentadecane (TIC)	0.350	ug/g
		30-mar-1990	LM18	Tetradecane (TIC)	0.120	ug/g
		30-mar-1990	LM18	Pentadecane (TIC)	0.470	ug/g
		30-mar-1990	LM18	Hexadecane (TIC)	0.700	ug/g
		30-mar-1990	LM18	Heptadecane (TIC)	0.590	ug/g
		30-mar-1990	LM18	Octadecane (TIC)	0.230	ug/g
		30-mar-1990	LM18	Nonadecane (TIC)	0.350	ug/g
		30-mar-1990	LM18	Eicosane (TIC)	0.230	ug/g
		30-mar-1990	LM18	Unknown 581 (TIC)	0.120	ug/g
		30-mar-1990	LM18	Unknown 592 (TIC)	0.230	ug/g
		30-mar-1990	LM18	Unknown 616 (TIC)	0.230	ug/g

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

POSITIVE SOIL RESULTS - DRMO TRENCH AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
DMO-11-SB	25.0	30-mar-1990	LM18	Unknown 623 (TIC)	0.230	ug/g
		30-mar-1990	LM19	Methylene chloride	0.010	ug/g
		30-mar-1990	LM19	Trichloroethene	0.030	ug/g
		30-mar-1990	LM19	Unknown 092 (TIC)	0.010	ug/g
	30.0	30-mar-1990	JD19	Arsenic	2.700	ug/g
		30-mar-1990	JS11	Barium	120.900	ug/g
		30-mar-1990	JS11	Vanadium	35.300	ug/g
		30-mar-1990	LM19	Unknown 092 (TIC)	0.020	ug/g
	35.0	30-mar-1990	JD19	Arsenic	9.300	ug/g
		30-mar-1990	LM18	Unknown 589 (TIC)	0.090	ug/g
	40.0	30-mar-1990	JD19	Arsenic	5.100	ug/g
		30-mar-1990	JS11	Barium	87.000	ug/g
		30-mar-1990	JS11	Vanadium	29.600	ug/g
	45.0	30-mar-1990	JD19	Arsenic	2.600	ug/g
		30-mar-1990	JD19	Arsenic	3.200	ug/g
		30-mar-1990	JS11	Barium	203.900	ug/g
		30-mar-1990	JS11	Barium	253.700	ug/g
		30-mar-1990	JS11	Vanadium	54.300	ug/g
		30-mar-1990	JS11	Vanadium	63.400	ug/g
		30-mar-1990	JS11	Zinc	68.900	ug/g
		30-mar-1990	JS11	Zinc	79.000	ug/g
		30-mar-1990	LM18	Phenol	0.670	ug/g
	50.0	30-mar-1990	JD19	Arsenic	2.700	ug/g
		30-mar-1990	JS11	Barium	64.400	ug/g
		30-mar-1990	JS11	Vanadium	35.900	ug/g
		30-mar-1990	LM18	Cyclohexanone (TIC)	0.530	ug/g
		30-mar-1990	LM18	Phenol	1.820	ug/g
		30-mar-1990	LM19	Unknown 128 (TIC)	0.010	ug/g
	60.0	30-mar-1990	JD19	Arsenic	6.100	ug/g
		30-mar-1990	JS11	Barium	135.300	ug/g
		30-mar-1990	JS11	Molybdenum	2.500	ug/g
		30-mar-1990	JS11	Vanadium	68.000	ug/g
		30-mar-1990	LM19	Unknown 128 (TIC)	0.020	ug/g
	70.0	30-mar-1990	JD19	Arsenic	3.200	ug/g
		30-mar-1990	JS11	Barium	232.000	ug/g
		30-mar-1990	JS11	Molybdenum	2.200	ug/g
		30-mar-1990	JS11	Vanadium	79.500	ug/g
		30-mar-1990	JS11	Zinc	75.600	ug/g
	80.0	30-mar-1990	JD19	Arsenic	4.300	ug/g
		30-mar-1990	JS11	Barium	58.600	ug/g
		30-mar-1990	JS11	Vanadium	53.700	ug/g
		30-mar-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.110	ug/g
	90.0	30-mar-1990	JD19	Arsenic	3.400	ug/g

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

POSITIVE SOIL RESULTS - DRMO TRENCH AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
DMO-11-SB	90.0	30-mar-1990	JS11	Barium	85.800	ug/g
		30-mar-1990	JS11	Vanadium	30.500	ug/g
		30-mar-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.110	ug/g
		30-mar-1990	LM18	Toluene	0.110	ug/g
DMO-12-SB	5.0	20-mar-1990	JD19	Arsenic	22.700	ug/g
		20-mar-1990	JS11	Barium	332.200	ug/g
		20-mar-1990	JS11	Molybdenum	2.300	ug/g
		20-mar-1990	JS11	Vanadium	39.500	ug/g
		20-mar-1990	LM19	Toluene	0.000	ug/g
		20-mar-1990	LM19	Unknown 071 (TIC)	0.110	ug/g
		20-mar-1990	LM19	Unknown 076 (TIC)	0.010	ug/g
	10.0	20-mar-1990	JD19	Arsenic	3.900	ug/g
		20-mar-1990	JS11	Barium	69.400	ug/g
		20-mar-1990	JS11	Vanadium	23.200	ug/g
		20-mar-1990	LM19	Toluene	0.000	ug/g
		20-mar-1990	LM19	Unknown 071 (TIC)	0.110	ug/g
		20-mar-1990	LM19	Unknown 076 (TIC)	0.010	ug/g
	15.0	20-mar-1990	JD19	Arsenic	6.300	ug/g
		20-mar-1990	JS11	Barium	121.600	ug/g
		20-mar-1990	JS11	Vanadium	34.000	ug/g
		20-mar-1990	LM18	Unknown 614 (TIC)	0.210	ug/g
		20-mar-1990	LM19	Toluene	0.000	ug/g
		20-mar-1990	LM19	Unknown 071 (TIC)	0.210	ug/g
		20-mar-1990	LM19	Unknown 076 (TIC)	0.020	ug/g
	20.0	20-mar-1990	JD19	Arsenic	6.200	ug/g
		20-mar-1990	JD19	Arsenic	4.600	ug/g
		20-mar-1990	JS11	Barium	111.300	ug/g
		20-mar-1990	JS11	Barium	53.500	ug/g
		20-mar-1990	JS11	Molybdenum	2.700	ug/g
		20-mar-1990	JS11	Vanadium	35.400	ug/g
		20-mar-1990	JS11	Vanadium	22.500	ug/g
		20-mar-1990	LM19	Toluene	0.000	ug/g
		20-mar-1990	LM19	Unknown 071 (TIC)	0.100	ug/g
		20-mar-1990	LM19	Unknown 076 (TIC)	0.010	ug/g
	25.0	20-mar-1990	JD19	Arsenic	1.600	ug/g
		20-mar-1990	JS11	Barium	84.100	ug/g
		20-mar-1990	JS11	Vanadium	28.100	ug/g
	30.0	20-mar-1990	JD19	Arsenic	4.200	ug/g
	35.0	20-mar-1990	JD19	Arsenic	1.800	ug/g
	40.0	20-mar-1990	JD19	Arsenic	9.300	ug/g
		20-mar-1990	JS11	Barium	221.300	ug/g
		20-mar-1990	JS11	Molybdenum	2.700	ug/g
		20-mar-1990	JS11	Lead	22.300	ug/g
		20-mar-1990	JS11	Vanadium	63.000	ug/g

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

POSITIVE SOIL RESULTS - DRMO TRENCH AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
DMO-12-SB	40.0	20-mar-1990	JS11	Zinc	69.800	ug/g
		20-mar-1990	LM19	Acetone	0.020	ug/g
		20-mar-1990	LM19	Bis (2-chloroethyl) ether	0.030	ug/g
	45.0	20-mar-1990	JD19	Arsenic	3.900	ug/g
		20-mar-1990	JS11	Barium	159.800	ug/g
		20-mar-1990	JS11	Vanadium	40.800	ug/g
		20-mar-1990	LM19	Bis (2-chloroethyl) ether	0.020	ug/g
	50.0	20-mar-1990	JD19	Arsenic	7.800	ug/g
		20-mar-1990	JS11	Barium	200.200	ug/g
		20-mar-1990	JS11	Molybdenum	2.200	ug/g
		20-mar-1990	JS11	Vanadium	55.700	ug/g
		20-mar-1990	JS11	Zinc	67.600	ug/g
	60.0	20-mar-1990	JD19	Arsenic	4.000	ug/g
		20-mar-1990	JS11	Barium	297.600	ug/g
		20-mar-1990	JS11	Vanadium	82.000	ug/g
		20-mar-1990	JS11	Zinc	85.800	ug/g
		20-mar-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.240	ug/g
		20-mar-1990	LM19	Bis (2-chloroethyl) ether	0.120	ug/g
	70.0	20-mar-1990	JD19	Arsenic	4.100	ug/g
		20-mar-1990	JS11	Barium	141.800	ug/g
		20-mar-1990	JS11	Vanadium	50.900	ug/g
		20-mar-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.230	ug/g
	80.0	20-mar-1990	JD19	Arsenic	4.500	ug/g
		20-mar-1990	JS11	Barium	76.800	ug/g
		20-mar-1990	JS11	Vanadium	47.400	ug/g
		20-mar-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.210	ug/g
	90.0	20-mar-1990	JD19	Arsenic	4.900	ug/g
		20-mar-1990	JS11	Barium	153.700	ug/g
		20-mar-1990	JS11	Vanadium	56.500	ug/g
		20-mar-1990	JS11	Zinc	64.000	ug/g
		20-mar-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.110	ug/g
	95.0	20-mar-1990	JD19	Arsenic	3.700	ug/g
		20-mar-1990	JS11	Barium	353.900	ug/g
		20-mar-1990	JS11	Vanadium	82.700	ug/g
		20-mar-1990	JS11	Zinc	93.600	ug/g
		20-mar-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.250	ug/g
DMO-13-SB	5.0	20-mar-1990	JD19	Arsenic	19.200	ug/g
		20-mar-1990	JS11	Barium	415.000	ug/g
		20-mar-1990	JS11	Molybdenum	3.500	ug/g
		20-mar-1990	JS11	Vanadium	67.200	ug/g
		20-mar-1990	JS11	Zinc	80.800	ug/g
	10.0	20-mar-1990	JD19	Arsenic	2.400	ug/g
		20-mar-1990	LH10	Heptachlor	0.010	ug/g

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

POSITIVE SOIL RESULTS - DRMO TRENCH AREA SITE

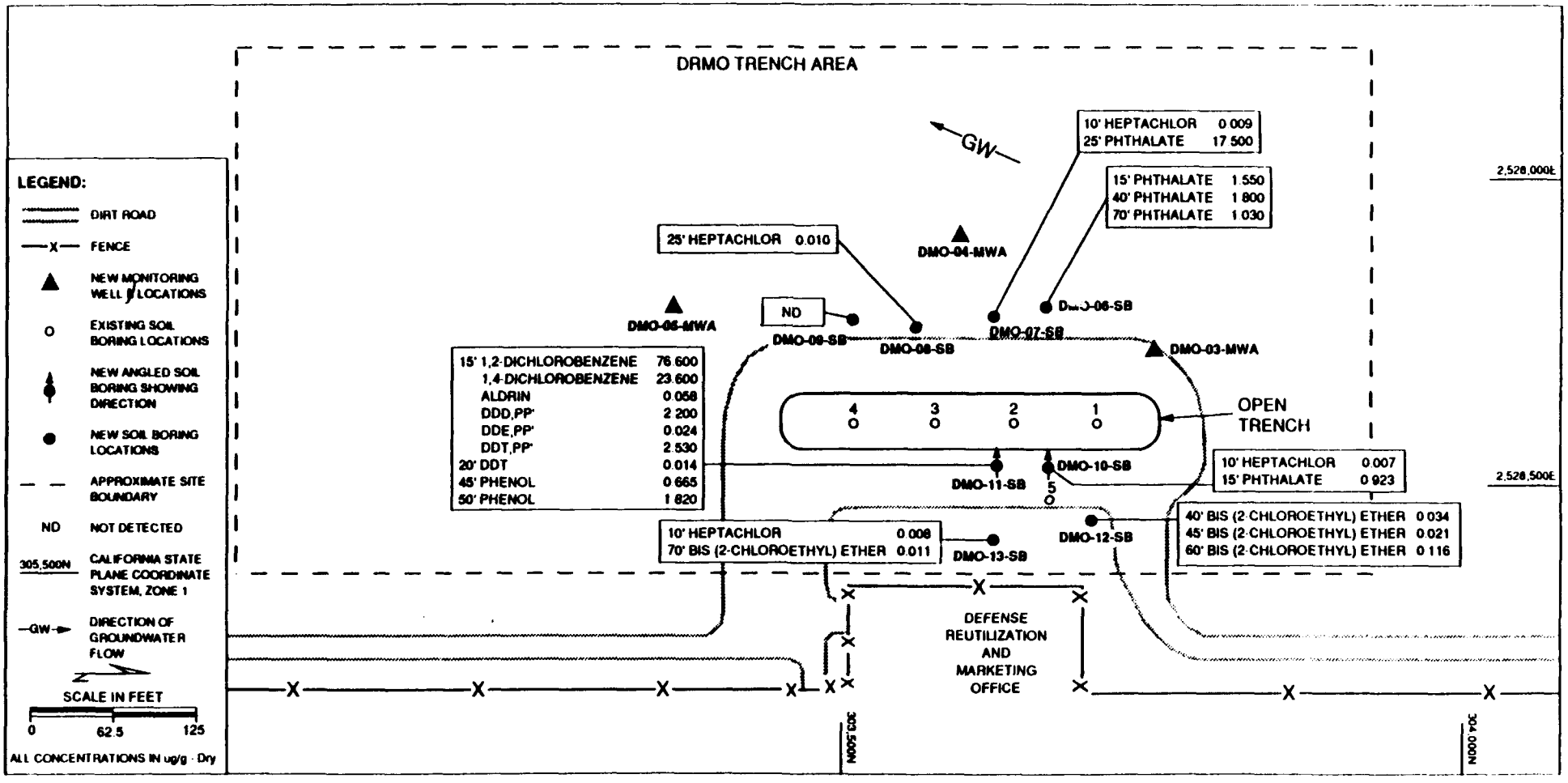
Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
DMO-13-SB	15.0	20-mar-1990	JD19	Arsenic	10.300	ug/g
		20-mar-1990	JS11	Barium	383.600	ug/g
		20-mar-1990	JS11	Molybdenum	2.700	ug/g
		20-mar-1990	JS11	Lead	18.200	ug/g
		20-mar-1990	JS11	Vanadium	108.100	ug/g
		20-mar-1990	JS11	Zinc	154.400	ug/g
	20.0	20-mar-1990	JD19	Arsenic	3.600	ug/g
		20-mar-1990	JS11	Barium	61.100	ug/g
		20-mar-1990	JS11	Vanadium	23.700	ug/g
	25.0	20-mar-1990	JD19	Arsenic	3.100	ug/g
		20-mar-1990	JS11	Barium	123.200	ug/g
		20-mar-1990	JS11	Vanadium	43.000	ug/g
		20-mar-1990	LM19	Unknown 055 (TIC)	0.010	ug/g
	30.0	20-mar-1990	JD19	Arsenic	3.400	ug/g
	35.0	20-mar-1990	JD19	Arsenic	1.200	ug/g
	40.0	20-mar-1990	JD19	Arsenic	8.000	ug/g
		20-mar-1990	JS11	Barium	174.900	ug/g
		20-mar-1990	JS11	Molybdenum	2.900	ug/g
		20-mar-1990	JS11	Vanadium	49.300	ug/g
		20-mar-1990	JS11	Zinc	58.200	ug/g
	45.0	20-mar-1990	JD19	Arsenic	3.100	ug/g
		20-mar-1990	JS11	Barium	144.900	ug/g
		20-mar-1990	JS11	Vanadium	44.800	ug/g
		20-mar-1990	JS11	Zinc	58.100	ug/g
	50.0	20-mar-1990	JD19	Arsenic	3.500	ug/g
		20-mar-1990	JD19	Arsenic	3.200	ug/g
		20-mar-1990	JS11	Barium	120.300	ug/g
		20-mar-1990	JS11	Barium	122.800	ug/g
		20-mar-1990	JS11	Vanadium	28.500	ug/g
		20-mar-1990	JS11	Vanadium	44.500	ug/g
		20-mar-1990	LM19	Unknown 055 (TIC)	0.020	ug/g
		20-mar-1990	LM19	Unknown 055 (TIC)	0.010	ug/g
	60.0	20-mar-1990	JD19	Arsenic	4.200	ug/g
		20-mar-1990	JS11	Barium	308.400	ug/g
		20-mar-1990	JS11	Vanadium	80.700	ug/g
		20-mar-1990	JS11	Zinc	84.200	ug/g
	70.0	20-mar-1990	JD19	Arsenic	8.300	ug/g
		20-mar-1990	JS11	Barium	205.000	ug/g
		20-mar-1990	JS11	Molybdenum	3.400	ug/g
		20-mar-1990	JS11	Vanadium	44.200	ug/g
		20-mar-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.220	ug/g
		20-mar-1990	LM19	Bis (2-chloroethyl) ether	0.010	ug/g

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

POSITIVE SOIL RESULTS - DRMO TRENCH AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
DMO-13-SB	80.0	20-mar-1990	JD19	Arsenic	8.100	ug/g
		20-mar-1990	JS11	Barium	147.200	ug/g
		20-mar-1990	JS11	Vanadium	65.000	ug/g
		20-mar-1990	JS11	Zinc	68.300	ug/g
		20-mar-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.230	ug/g
	90.0	20-mar-1990	JD19	Arsenic	8.300	ug/g
		20-mar-1990	JS11	Barium	239.700	ug/g
		20-mar-1990	JS11	Vanadium	60.000	ug/g
		20-mar-1990	JS11	Zinc	90.200	ug/g
	95.0	20-mar-1990	JD19	Arsenic	2.900	ug/g
		20-mar-1990	JS11	Barium	385.100	ug/g
		20-mar-1990	JS11	Lead	12.000	ug/g
		20-mar-1990	JS11	Vanadium	86.900	ug/g
		20-mar-1990	JS11	Zinc	99.000	ug/g
		20-mar-1990	LM18	1,2-Epoxycyclohexene (TIC)	0.240	ug/g

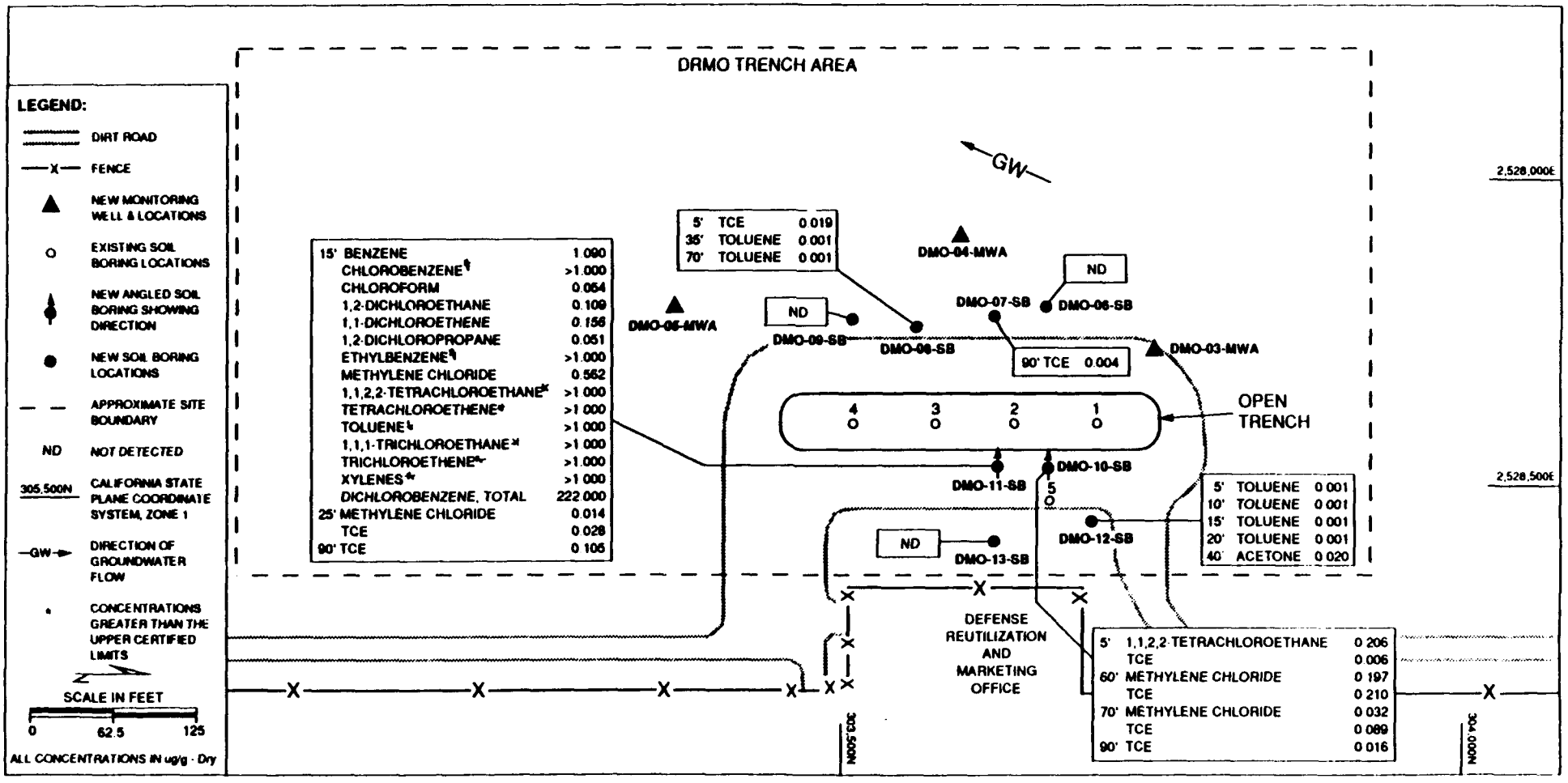
Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.



SIERRA ARMY DEPOT

EXTRACTABLE ORGANIC COMPOUND CONCENTRATIONS AT SOIL BORING LOCATIONS: DRMO TRENCH AREA

FIGURE 6-9



SIERRA ARMY DEPOT

VOC CONCENTRATIONS AT SOIL BORING LOCATIONS: DRMO TRENCH AREA

FIGURE 6-10

contributes to the degradation of these compounds and may be responsible for the generally lower concentrations in the surface soils.

Phenol was detected in DMO-11-SB at 45- and 50-foot intervals at concentrations of 0.665 μg/g and 1.820 μg/g, respectively. These intervals correspond to a silt and clay zone. Phenol is relatively mobile in soil/water systems and is only weakly sorbed by soils containing organic matter and there is essentially no sorption on clays and minerals (DOE, 1989). However, due to the low estimated hydraulic conductivity of the intermittent silt and clay layer that exists in the 40- to 50-foot interval (Figures 5-11 through 5-13), phenol is not expected to migrate below this layer.

VOCs

Of 113 VOCs measured, levels exceeding detection limits were observed in only 11 percent of the samples. Detected values are shown in Table 6-12 and Figure 6-10. TCE, acetone, toluene, and methylene chloride were sporadically distributed in DMO-07-SB, DMO-08-SB, DMO-10-SB, DMO-11-SB, and DMO-12-SB. TCE was detected in the 90-foot interval of DMO-07-SB at 0.004 μg/g and the 5-foot interval of DMO-08-SB at 0.019 μg/g. No other VOCs were detected in these borings. Low levels of toluene (0.001 μg/g) were detected in the 5- to 20-foot interval of DMO-12-SB. No other VOCs were detected in this boring.

TCE, methylene chloride, and 1,1,2,2-tetrachloroethane were detected at various intervals in DMO-10-SB. TCE was detected in the 5-foot (0.006 μg/g), 60-foot (0.210 μg/g), 70-foot (0.089 μg/g) and 90-foot (0.016 μg/g) intervals. The 90-foot interval represents the soil/groundwater interface. The presence of TCE at these depth indicate that this contaminant has been vertically transported through the vadose zone to the water table at this site. However, the absence of TCE in near-surface soils suggests that a near surface TCE source is no longer present and that any TCE available for vertical migration may have already been transported to the groundwater.

Fifteen individual VOCs were detected in the 15-foot interval of DMO-11-SB where a 5-foot-thick silt and clay layer was encountered. This low permeability zone may have acted as a

barrier to downward contaminant migration. The most significant VOC values (greater than 1 μg/g, the analytical method quantifiable limit) at this interval include: chlorobenzene, ethylbenzene, 1,1,2,2-tetrachloroethane, tetrachloroethane, toluene, 1,1,1-trichlorethane, trichloroethene, total xylenes, and total dichlorobenzenes. TCE (0.028 μg/g) and methylene chloride (0.014 μg/g) were detected at the 25-foot interval in this boring. Toluene was detected in the 90-foot interval at 0.105 μg/g. No other VOCs were detected at any other depths in this boring.

In general, VOCs are relatively mobile in the soil/groundwater system, particularly in soils with low organic content (DOE, 1989). Therefore, in the presence of additional flux it would be expected that the VOCs found in the 15-foot interval of DMO-11-SB would be transported to greater depths. However, given the low amounts of precipitation at SIAD, there is an absence of driving force that would transport contamination present in the 15-foot interval to groundwater.

Inorganics

No inorganics constituents were detected in soil above what are considered background levels at this site.

6.2.4.4 Groundwater

Groundwater from the three monitoring wells installed during the Phase I RI was sampled and analyzed on successive months for extractable organic compounds (BNAs and pesticides/PCBs), VOCs, and inorganics (priority pollutant metals). Both Rounds 1 and 2 results are presented in Tables 6-13 and 6-14.

Extractable Organic Compounds

No extractable organic compounds were detected in the Round 1 or Round 2 groundwater samples from this site (Table 6-13).

POSITIVE GROUNDWATER RESULTS - ROUND 1 - DRMO TRENCH AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
DMO-03-MWA	94.8	19-apr-1990	99	Total dissolved solids	902000.000	ug/l
		19-apr-1990	SD21	Selenium	11.300	ug/l
		19-apr-1990	SD22	Arsenic	2.880	ug/l
		19-apr-1990	SS10	Barium	35.000	ug/l
		19-apr-1990	SS10	Calcium	120000.000	ug/l
		19-apr-1990	SS10	Sodium	77000.000	ug/l
		19-apr-1990	SS10	Zinc	25.300	ug/l
		19-apr-1990	TT10	Chloride	66000.000	ug/l
		19-apr-1990	TT10	Sulfate	450000.000	ug/l
		19-apr-1990	UM18	Unknown 557 (TIC)	2.000	ug/l
		19-apr-1990	UM18	Unknown 559 (TIC)	1.000	ug/l
		19-apr-1990	UM18	Unknown 598 (TIC)	10.000	ug/l
		19-apr-1990	UM20	Trichloroethene	10.500	ug/l
DMO-04-MWA	94.9	19-apr-1990	99	Total dissolved solids	710000.000	ug/l
		19-apr-1990	SD21	Selenium	5.110	ug/l
		19-apr-1990	SD22	Arsenic	7.040	ug/l
		19-apr-1990	SS10	Barium	17.100	ug/l
		19-apr-1990	SS10	Calcium	91000.000	ug/l
		19-apr-1990	SS10	Sodium	64000.000	ug/l
		19-apr-1990	SS10	Zinc	34.700	ug/l
		19-apr-1990	TT10	Chloride	60000.000	ug/l
		19-apr-1990	TT10	Sulfate	224000.000	ug/l
		19-apr-1990	UM18	Unknown 598 (TIC)	2.000	ug/l
		19-apr-1990	UM20	Trichloroethene	4.190	ug/l
DMO-05-MWA	94.1	19-apr-1990	99	Total dissolved solids	826000.000	ug/l
		19-apr-1990	99	Total dissolved solids	840000.000	ug/l
		19-apr-1990	SD21	Selenium	11.600	ug/l
		19-apr-1990	SD21	Selenium	11.800	ug/l
		19-apr-1990	SD22	Arsenic	4.800	ug/l
		19-apr-1990	SD22	Arsenic	4.580	ug/l
		19-apr-1990	SS10	Barium	28.900	ug/l
		19-apr-1990	SS10	Barium	21.400	ug/l
		19-apr-1990	SS10	Calcium	97000.000	ug/l
		19-apr-1990	SS10	Calcium	95000.000	ug/l
		19-apr-1990	SS10	Copper	11.500	ug/l
		19-apr-1990	SS10	Sodium	71000.000	ug/l
		19-apr-1990	SS10	Sodium	64000.000	ug/l
		19-apr-1990	SS10	Zinc	72.100	ug/l
		19-apr-1990	TT10	Chloride	60000.000	ug/l
		19-apr-1990	TT10	Chloride	60000.000	ug/l
		19-apr-1990	TT10	Sulfate	330000.000	ug/l
		19-apr-1990	TT10	Sulfate	330000.000	ug/l
		19-apr-1990	UM18	Bis (2-ethylhexyl) phthalate	4.640	ug/l
		19-apr-1990	UM20	Trichloroethene	20.000	ug/l
		19-apr-1990	UM20	Trichloroethene	25.700	ug/l

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

POSITIVE GROUNDWATER RESULTS - ROUND 2 - DRMO TRENCH AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
DMO-03-MWA	94.8	31-may-1990	99	Total dissolved solids	1070000.000	ug/l
		31-may-1990	99	Total dissolved solids	1090000.000	ug/l
		31-may-1990	SD20	Lead	1.950	ug/l
		31-may-1990	SD20	Lead	4.340	ug/l
		31-may-1990	SD21	Selenium	13.200	ug/l
		31-may-1990	SD21	Selenium	12.600	ug/l
		31-may-1990	SD22	Arsenic	2.770	ug/l
		31-may-1990	SS10	Barium	36.400	ug/l
		31-may-1990	SS10	Barium	34.400	ug/l
		31-may-1990	SS10	Calcium	120000.000	ug/l
		31-may-1990	SS10	Calcium	120000.000	ug/l
		31-may-1990	SS10	Sodium	69000.000	ug/l
		31-may-1990	SS10	Sodium	78000.000	ug/l
		31-may-1990	TT10	Chloride	52000.000	ug/l
		31-may-1990	TT10	Chloride	53000.000	ug/l
		31-may-1990	TT10	Sulfate	380000.000	ug/l
		31-may-1990	TT10	Sulfate	380000.000	ug/l
		31-may-1990	UM18	Unknown 558 (TIC)	5.000	ug/l
		31-may-1990	UM20	Methylene chloride	6.600	ug/l
		31-may-1990	UM20	Methylene chloride	7.450	ug/l
		31-may-1990	UM20	Trichloroethene	2.570	ug/l
		31-may-1990	UM20	Trichloroethene	2.570	ug/l
DMO-04-MWA	94.9	31-may-1990	99	Total dissolved solids	776000.000	ug/l
		31-may-1990	SD20	Lead	2.280	ug/l
		31-may-1990	SD21	Selenium	6.220	ug/l
		31-may-1990	SD22	Arsenic	4.260	ug/l
		31-may-1990	TT10	Chloride	50000.000	ug/l
		31-may-1990	TT10	Sulfate	223000.000	ug/l
		31-may-1990	UM20	Trichloroethene	2.190	ug/l
	95.0	31-may-1990	SS10	Barium	18.700	ug/l
		31-may-1990	SS10	Calcium	85000.000	ug/l
		31-may-1990	SS10	Sodium	67000.000	ug/l
DMO-05-MWA	94.1	31-may-1990	99	Total dissolved solids	916000.000	ug/l
		31-may-1990	SD21	Selenium	11.400	ug/l
		31-may-1990	SD22	Arsenic	4.480	ug/l
		31-may-1990	SS10	Barium	23.100	ug/l
		31-may-1990	SS10	Calcium	97000.000	ug/l
		31-may-1990	SS10	Sodium	75000.000	ug/l
		31-may-1990	TT10	Chloride	60000.000	ug/l
		31-may-1990	TT10	Sulfate	280000.000	ug/l
		31-may-1990	UM20	Trichloroethene	18.100	ug/l

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

VOCs

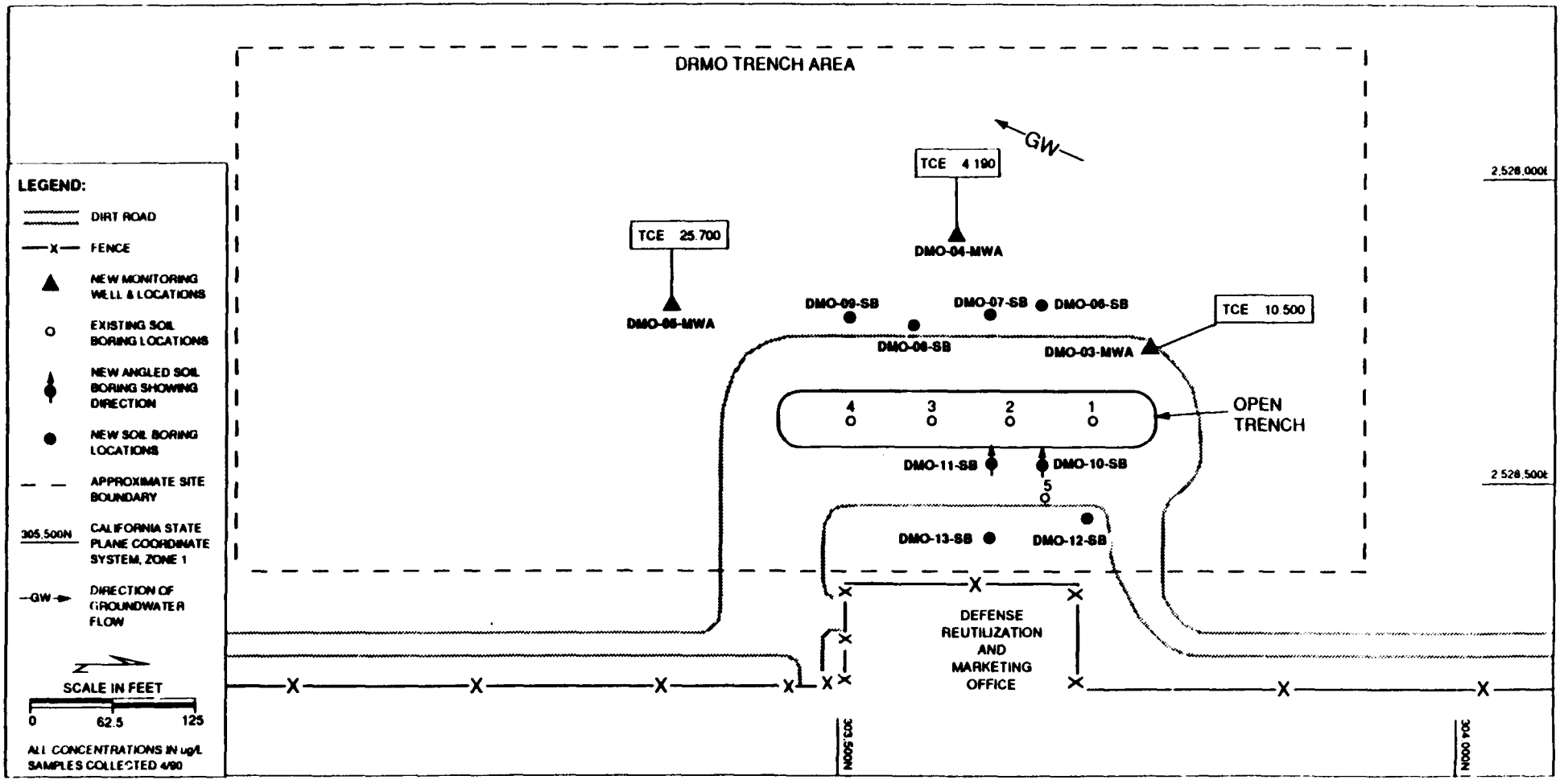
TCE was detected in Round 1 groundwater samples taken from DMO-03-MWA, DMO-04-MWA, and DMO-05-MWA at 10.500 μg/L, 4.190 μg/L, and 20.700 μg/L, respectively (Table 6-13 and Figure 6-11). The California MCL for TCE is 5.0 μg/L. TCE was detected above the MCL (5.000 μg/L) in Round 2 groundwater samples from DMO-03-MWA, DMO-04-MWA, and DMO-05-MWA at 2.570 μg/L, 2.190 μg/L, and 18.100 μg/L, respectively (Table 6-14). Methylene chloride was detected in Round 2 groundwater samples collected from DMO-03-MWA at 7.450 μg/L. The highest TCE values from both sampling rounds are in the southernmost well, DMO-05-MWA. This well is a downgradient well due to a slight reversal of the groundwater gradient at this site (See Section 5 for a discussion of site hydrogeology). The boundaries of the TCE plume could not be determined due to the limited data at this site. However, the distribution of TCE in the groundwater (the highest concentration in the southernmost well) suggests that TCE is moving in a southerly direction.

Inorganics

Selenium was detected in Round 1 groundwater samples from DMO-03-MWA, DMO-04-MWA, and DMO-05-MWA at 11.300 μg/L, 5.110 μg/L, and 11.600 μg/L, respectively (Table 6-13 and Figure 6-12). Selenium values in Round 2 groundwater samples were 13.200 μg/L (DMO-03-MWA), 6.220 μg/L (DMO-04-MWA), and 11.400 μg/L (DMO-05-MWA). The California MCL for selenium is 10.0 μg/L. No selenium soil source was found at the site. It is noted that selenium is associated with desert soils generated from the weathering of bedrock (Albasel, et al., 1989). Therefore, the selenium found in the water at this site is interpreted as representing natural conditions.

6.2.4.5 DRMO Trench Area Summary

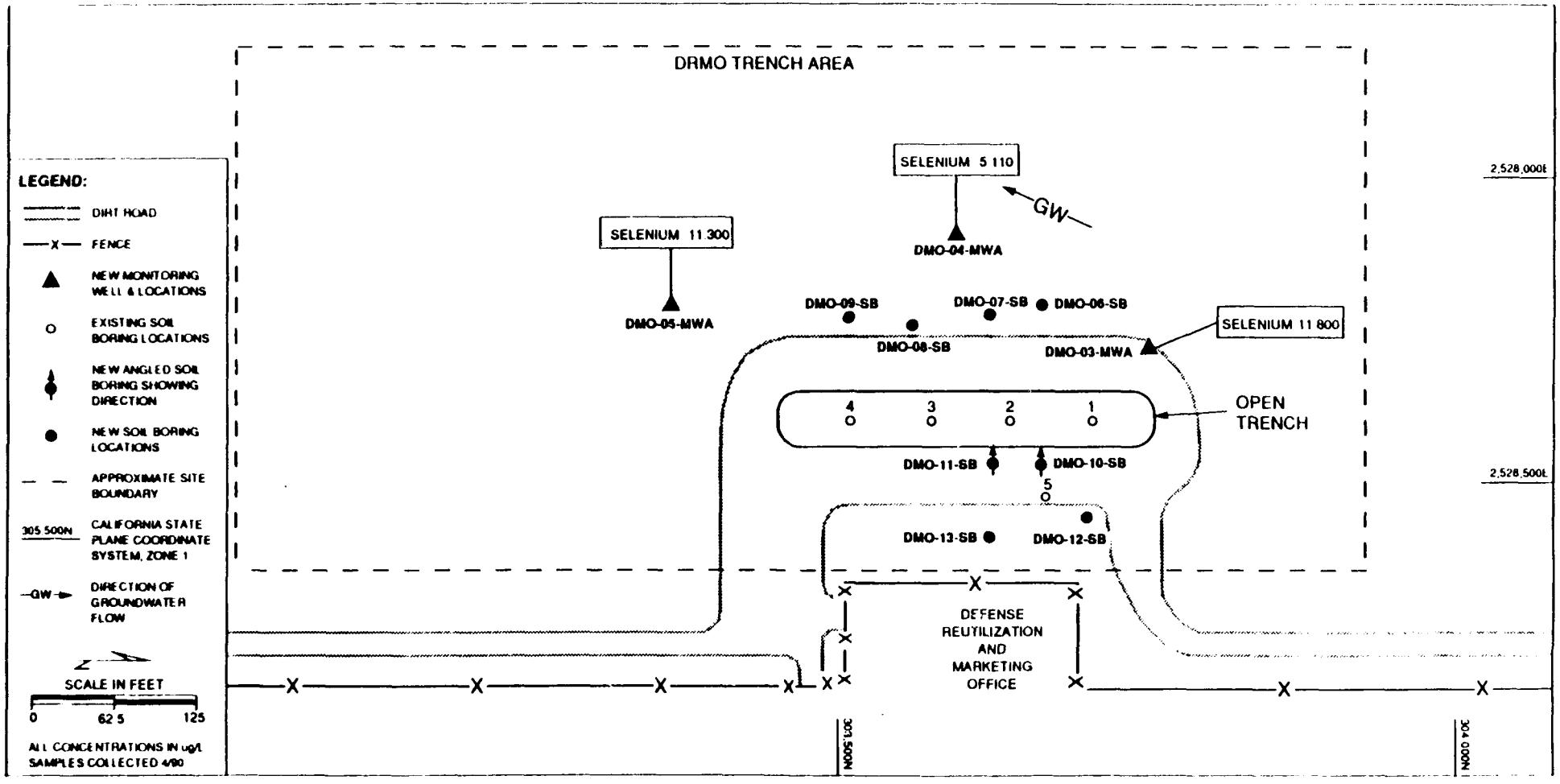
Extractable organic compounds, primarily pesticides, were detected in only 10 percent of the soil samples collected from this site. The highest concentrations were found in the 15-foot interval of DMO-11-SB. As stated, this boring was drilled at an angle adjacent to the trench; therefore, the 15-foot sample correlates to a depth of about 5 feet below the trench bottom.



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TCE CONCENTRATIONS FROM "A" ZONE WELLS: DRMO TRENCH AREA

FIGURE 6-11



SIERRA ARMY DEPOT

SELENIUM CONCENTRATIONS FROM "A" ZONE WELLS: DRMO TRENCH AREA

FIGURE 6-12

Pesticides were not found in soil deeper than 15 feet. This may be due to the strong adsorption characteristics of these pesticides to soil.

Fifteen individual VOCs were also found in the 15-foot interval at DMO-11-SB. TCE and methylene chloride were detected in soils near the water table in DMO-10-SB, although they were virtually absent in soils above 60 feet, except for low levels found at 5 feet. The distribution of TCE in DMO-10-SB suggests that downward migration of TCE to the water table has occurred at this site. After reaching the groundwater, contaminants may have migrated down both groundwater and chemical gradients. This conclusion is supported by the presence of TCE in the two downgradient and one slightly upgradient monitoring wells installed as part of the Phase I RI. No significant soil contaminants were detected in areas other than those adjacent to the open trench. This suggests that the open trench is the source of contamination and that lateral contaminant migration in the soil has not occurred. Due to the limited amount of data from the open trench area, contaminant mass could not be estimated.

TCE values were highest in the southernmost well, suggesting that TCE is migrating in a southern (downgradient) direction in this area. The boundaries of TCE in the groundwater could not be defined due to a limited data set. A burn and debris area was discovered about 120 feet southwest of the open trench, but was not sampled. Groundwater from two of three monitoring wells at this site registered TCE values above the California MCL.

6.2.5 TNT Leaching Beds Area

The distribution and extent of contamination at the TNT Leaching Beds Area site was assessed based on the following Phase I RI activities: soil gas survey, 8 composited surface soil samples, 13 soil borings, and 24 monitoring wells.

6.2.5.1 Soil Gas Survey

One hundred and ten soil gas samples were collected at this site to identify and delineate VOCs in the soil and/or groundwater. Target soil gas compounds were TCE, carbon

tetrachloride, methylene chloride, chloroform, 1,2-DCA, BETX, and THC Analytical procedures and results are presented in Appendix D.

An area of elevated soil gas concentrations was detected near the Vehicle Maintenance Area Subsite (Figures 6-13 through 6-16.) Highest organic concentrations from about 7 feet below ground surface were of THC, chloroform, carbon tetrachloride, and TCE at 1.0, 0.05, 0.5, and 3.0 μg/L, respectively. The highest concentrations consistently occurred adjacent to the Vehicle Maintenance Area foundation and concrete pad. This implies that the Vehicle Maintenance Area is the VOC source at this site.

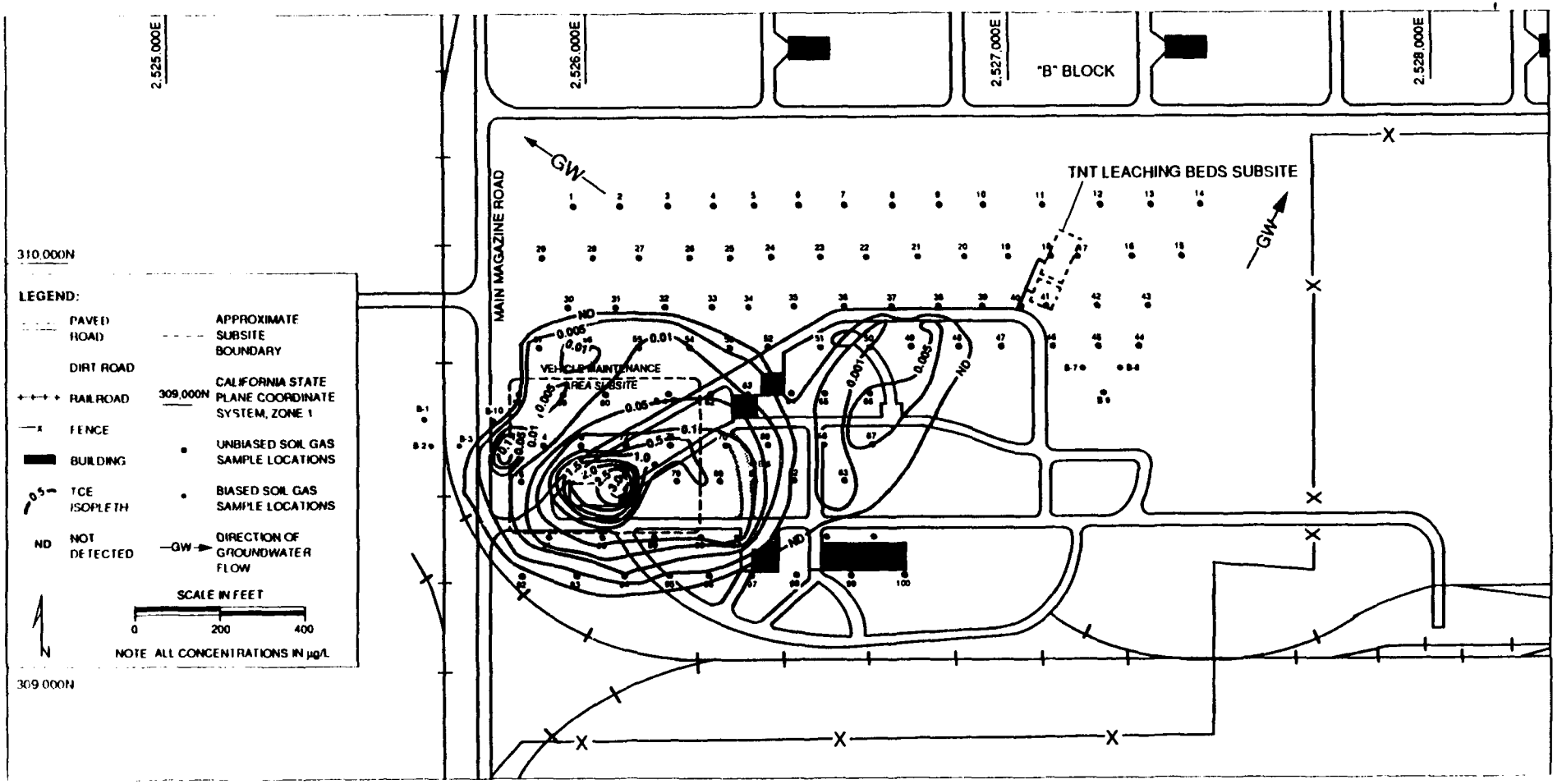
Of the four contaminants comprising the plume, carbon tetrachloride and TCE are the most widely distributed. Common TCE degradation products such as vinyl chloride and 1,2-DCA were not detected in the soil gas. Monitoring wells TNT-10-MWA, B, C, TNT-11-MWA and TNT-12-MWA and soil borings TNT-07-SB, TNT-08-SB, TNT-09-SB, TNT-10-SB and TNT-11-SB are located in the vicinity of the soil gas plume. Analytical results for these monitoring wells and soil borings are discussed in the following sections.

6.2.5.2 Surface Soil

To further characterize the distribution of surface soil contamination at the TNT Leaching Beds Subsite, eight surface soil samples were collected and analyzed for inorganics (TTLC metals and STLC metals) and explosives. Detected values are presented in Table 6-15 and Figures 6-17 and 6-18.

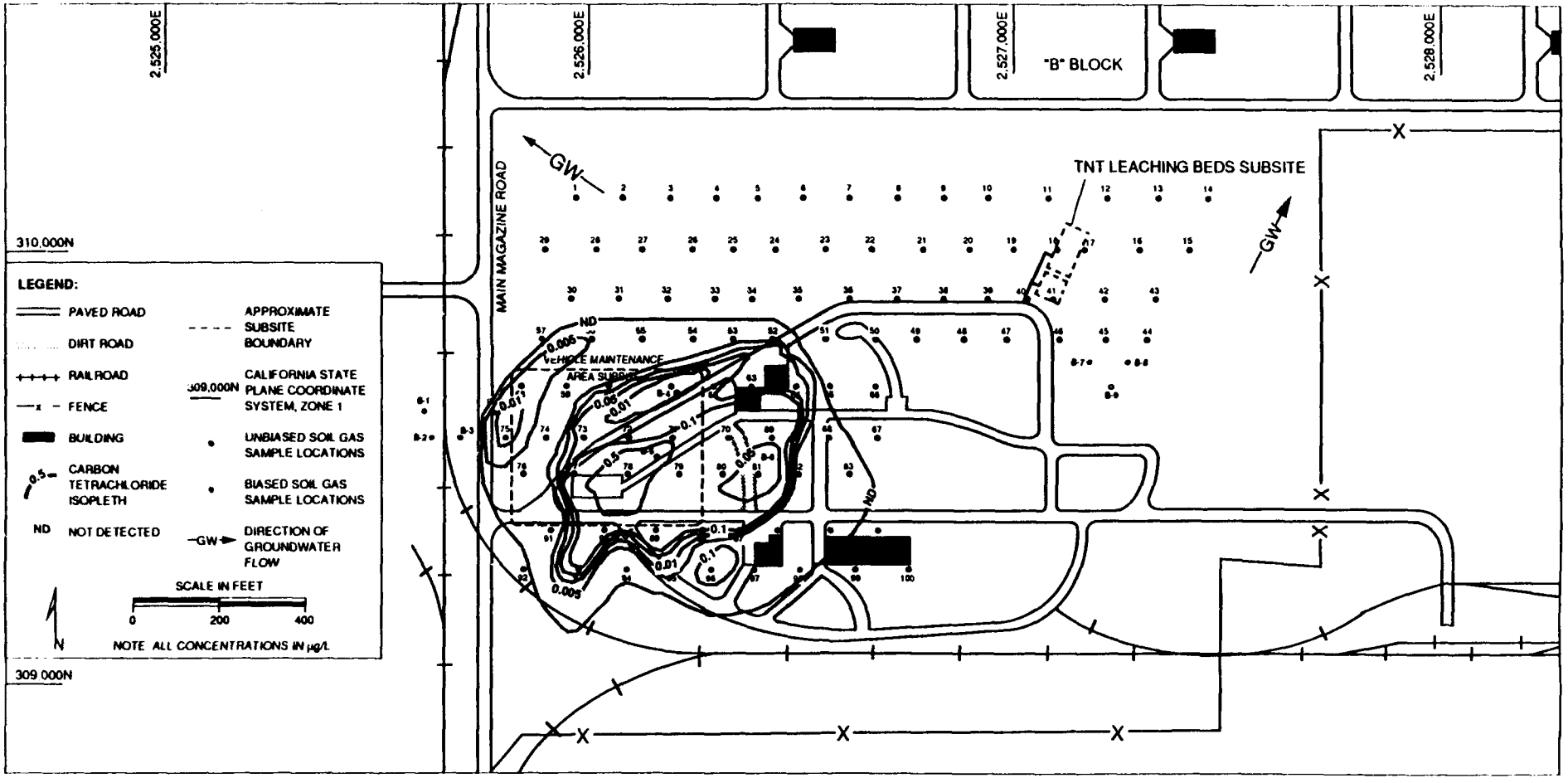
Inorganics

No inorganic constituents were detected in surface soils above what are considered background levels at this site.



SIERRA ARMY DEPOT
TCE SOIL GAS PLUME:
TNT LEACHING BEDS AREA

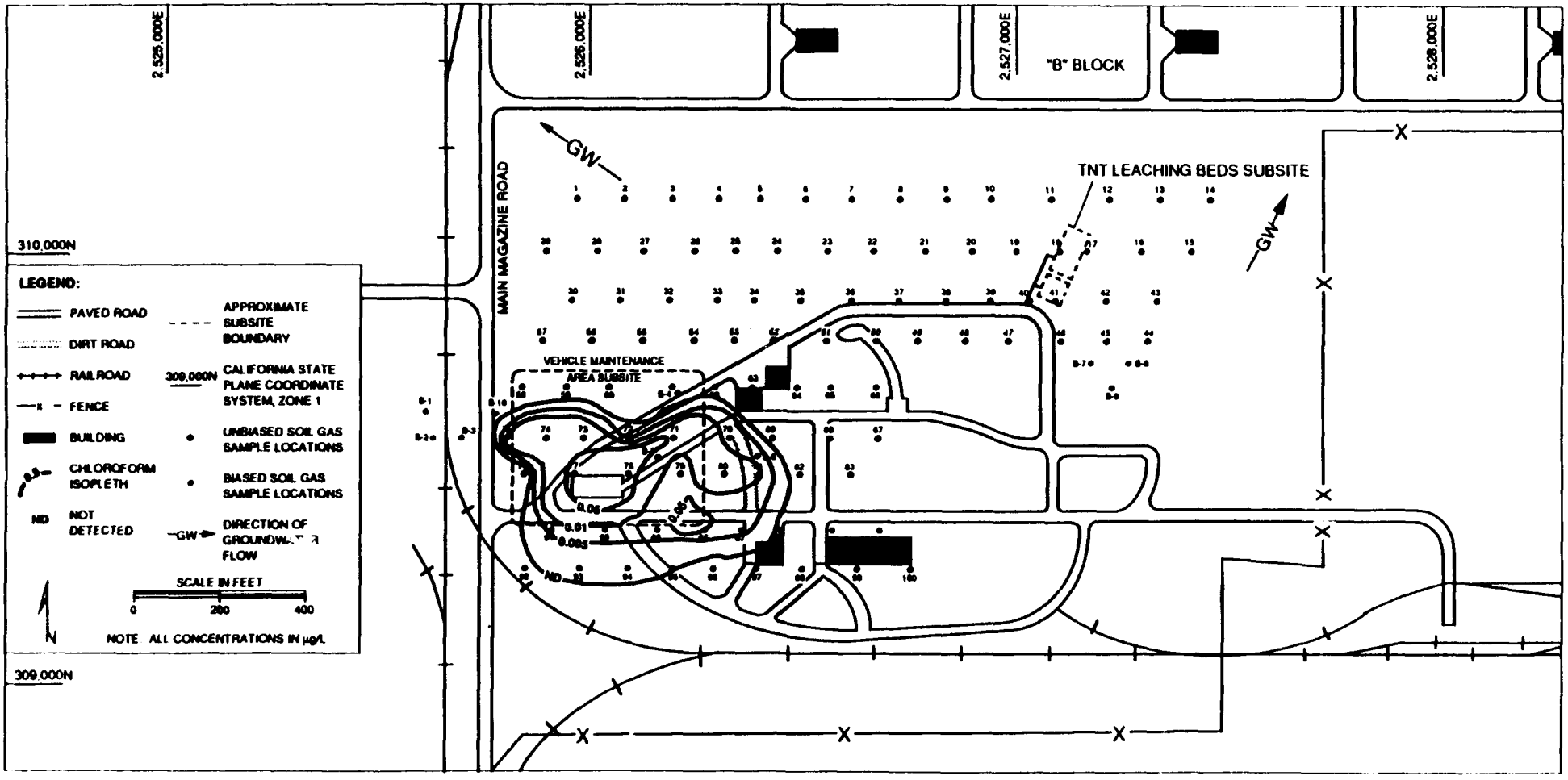
FIGURE 6-13



SIERRA ARMY DEPOT

CARBON TETRACHLORIDE SOIL GAS PLUME: TNT LEACHING BEDS AREA

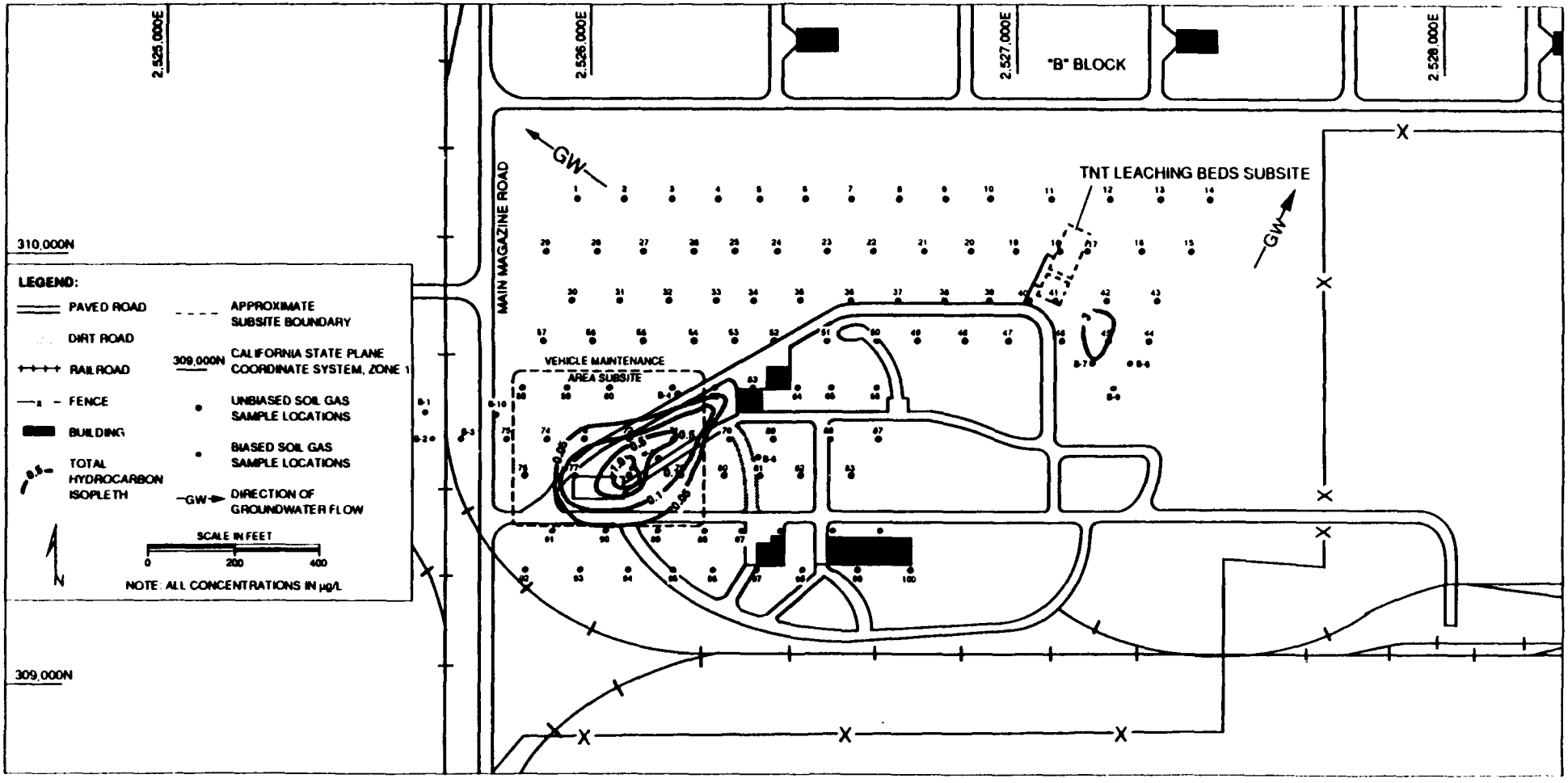
FIGURE 6-14



SIERRA ARMY DEPOT

CHLOROFORM SOIL GAS PLUME: TNT LEACHING BEDS AREA

FIGURE 6-15



SIERRA ARMY DEPOT

TOTAL HYDROCARBONS SOIL GAS PLUME: TNT LEACHING BEDS AREA

FIGURE 6-16

Explosives

Explosives compounds were detected in all eight samples. The results of the explosives analyses are presented in Table 6-15 and Figure 6-18.

The total mass of 1,3,5-TNB, and total explosives, was calculated for the 0- to 2.5-foot interval (Tables 6-16 and 6-17). To calculate the total explosive and 1,3,5-TNB mass in this interval, it was assumed that the concentrations found in the surface soils were representative of the 0- to 2.5-foot interval. Mass was calculated as follows:

$$M = \frac{A \times T}{27\ ft^3/yd^3} \times \frac{3{,}000\ lbs.}{yd^3} \times \frac{concentration}{10^6}$$

where: M = Mass of compound(s)
A = Surface area of zone
T = Thickness of depth interval

Assuming 3,000 lbs/yd^3 for soil.

In the 0- to 2.5-foot interval, the mass of total 1,3,5-TNB and explosives is estimated to be 240 pounds, and 20,570 pounds, respectively.

None of the surface soil sampies were determined to be reactive. Based on the ignitability criteria for liquids presented in 22 CAC 66702, two samples (TNT-01-SS and TNT-05-SS) were determined to be ignitable. Two samples (TNT-05-SS and TNT-05-SS DUP) were determined to be hazardous on the basis of aquatic bioassay tests, as each was found to have an acute 96-hour LC50 of less than 500 milligrams per liter when measured in soft water with fathead minnows.

No surface soil samples were collected at the Vehicle Maintenance Area Subsite.

POSITIVE SURFACE SOIL RESULTS - TNT LEACHING BEDS AREA SITE

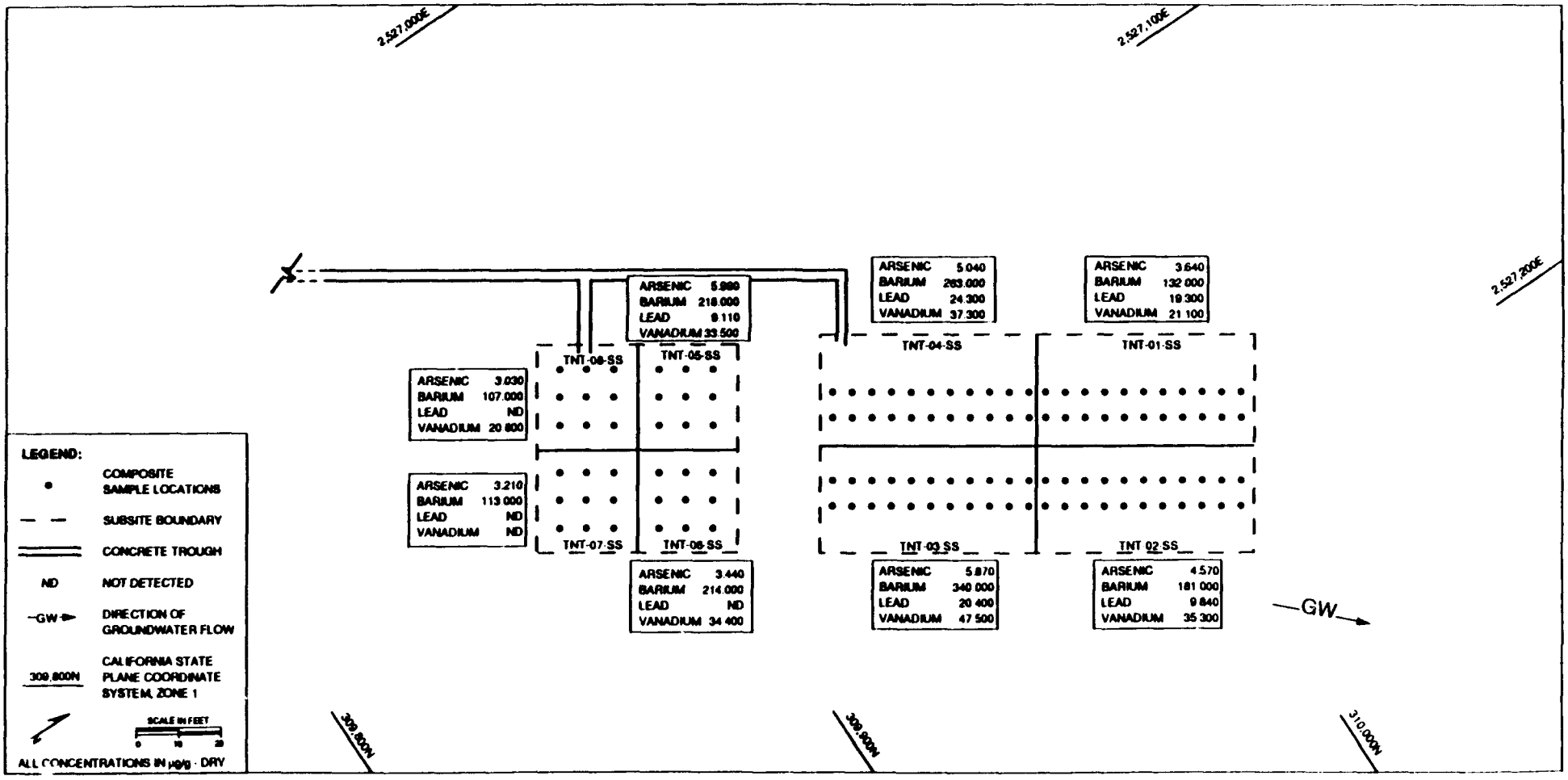
Site	Depth (ft)	Sample Date	Test Method	Compound		Concentration	Units
TNT-01-SS	0.5	04-apr-1990	00	Ignitability		25.000	deg
		04-apr-1990	JD19	Arsenic		3.640	ug/g
		04-apr-1990	JS11	Barium		132.000	ug/g
		04-apr-1990	JS11	Lead		19.300	ug/g
		04-apr-1990	JS11	Vanadium		21.100	ug/g
		04-apr-1990	LW12	1,3,5-Trinitrobenzene		110.000	ug/g
		04-apr-1990	LW12	2,4,6-Trinitrotoluene		12000.000	ug/g
		04-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)		7.000	ug/g
		04-apr-1990	LW12	Cyclonite (RDX)		310.000	ug/g
		04-apr-1990	N/A	96 hr Bioassay - LC50		590.000	mg/l
TNT-02-SS		04-apr-1990	00	Ignitability		85.000	deg
		04-apr-1990	JD19	Arsenic		4.570	ug/g
		04-apr-1990	JS11	Barium		181.000	ug/g
		04-apr-1990	JS11	Lead		9.840	ug/g
		04-apr-1990	JS11	Vanadium		35.300	ug/g
		04-apr-1990	LW12	1,3,5-Trinitrobenzene		120.000	ug/g
		04-apr-1990	LW12	2,4,6-Trinitrotoluene		4600.000	ug/g
		04-apr-1990	LW12	2,4-Dinitrotoluene		19.000	ug/g
		04-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)		23.000	ug/g
		04-apr-1990	LW12	Cyclonite (RDX)		1300.000	ug/g
		04-apr-1990	N/A	96 hr Bioassay - LC50	>	750.000	mg/l
TNT-03-SS		04-apr-1990	00	Ignitability		90.000	deg
		04-apr-1990	JD19	Arsenic		5.870	ug/g
		04-apr-1990	JS11	Barium		340.000	ug/g
		04-apr-1990	JS11	Lead		20.400	ug/g
		04-apr-1990	JS11	Vanadium		47.500	ug/g
		04-apr-1990	LW12	1,3,5-Trinitrobenzene		48.000	ug/g
		04-apr-1990	LW12	2,4,6-Trinitrotoluene		2200.000	ug/g
		04-apr-1990	LW12	2,4-Dinitrotoluene		8.200	ug/g
		04-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)		10.000	ug/g
		04-apr-1990	LW12	Cyclonite (RDX)		370.000	ug/g
		04-apr-1990	N/A	96 hr Bioassay - LC50	>	750.000	mg/l
TNT-04-SS		04-apr-1990	00	Ignitability		90.000	deg
		04-apr-1990	JD19	Arsenic		5.040	ug/g
		04-apr-1990	JS11	Barium		263.000	ug/g
		04-apr-1990	JS11	Lead		24.300	ug/g
		04-apr-1990	JS11	Vanadium		37.300	ug/g
		04-apr-1990	LW12	1,3,5-Trinitrobenzene		94.000	ug/g
		04-apr-1990	LW12	2,4,6-Trinitrotoluene		8300.000	ug/g
		04-apr-1990	LW12	Cyclonite (RDX)		110.000	ug/g
		04-apr-1990	N/A	96 hr Bioassay - LC50	>	750.000	mg/l
TNT-05-SS		04-apr-1990	00	Ignitability		50.000	deg
		04-apr-1990	00	Ignitability	>	100.000	deg
		04-apr-1990	JD19	Arsenic		5.990	ug/g
		04-apr-1990	JD19	Arsenic		4.180	ug/g
		04-apr-1990	JS11	Barium		208.000	ug/g

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

POSITIVE SURFACE SOIL RESULTS - TNT LEACHING BEDS AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound		Concentration	Units
TNT-05-SS	0.5	04-apr-1990	JS11	Barium		218.000	ug/g
		04-apr-1990	JS11	Lead		9.110	ug/g
		04-apr-1990	JS11	Vanadium		25.100	ug/g
		04-apr-1990	JS11	Vanadium		33.500	ug/g
		04-apr-1990	LW12	1,3,5-Trinitrobenzene		41.000	ug/g
		04-apr-1990	LW12	1,3,5-Trinitrobenzene		43.000	ug/g
		04-apr-1990	LW12	2,4,6-Trinitrotoluene		6500.000	ug/g
		04-apr-1990	LW12	2,4,6-Trinitrotoluene		9900.000	ug/g
		04-apr-1990	LW12	Cyclonite (RDX)		2.720	ug/g
		04-apr-1990	N/A	96 hr Bioassay - LC50	<	400.000	mg/l
		04-apr-1990	N/A	96 hr Bioassay - LC50	<	400.000	mg/l
TNT-06-SS		04-apr-1990	00	Ignitability	>	100.000	deg
		04-apr-1990	JD19	Arsenic		3.440	ug/g
		04-apr-1990	JS11	Barium		214.000	ug/g
		04-apr-1990	JS11	Vanadium		34.400	ug/g
		04-apr-1990	LW12	1,3,5-Trinitrobenzene		22.000	ug/g
		04-apr-1990	LW12	2,4,6-Trinitrotoluene		5900.000	ug/g
		04-apr-1990	N/A	96 hr Bioassay - LC50	>	750.000	mg/l
TNT-07-SS		04-apr-1990	00	Ignitability		72.000	deg
		04-apr-1990	JD19	Arsenic		3.210	ug/g
		04-apr-1990	JS11	Barium		113.000	ug/g
		04-apr-1990	LW12	1,3,5-Trinitrobenzene		11.000	ug/g
		04-apr-1990	LW12	2,4,6-Trinitrotoluene		290.000	ug/g
		04-apr-1990	N/A	96 hr Bioassay - LC50	>	750.000	mg/l
TNT-08-SS		04-apr-1990	00	Ignitability	>	100.000	deg
		04-apr-1990	JD19	Arsenic		3.030	ug/g
		04-apr-1990	JS11	Barium		107.000	ug/g
		04-apr-1990	JS11	Vanadium		20.800	ug/g
		04-apr-1990	LW12	1,3,5-Trinitrobenzene		1.420	ug/g
		04-apr-1990	LW12	2,4,6-Trinitrotoluene		7.780	ug/g
		04-apr-1990	N/A	96 hr Bioassay - LC50	>	750.000	mg/l

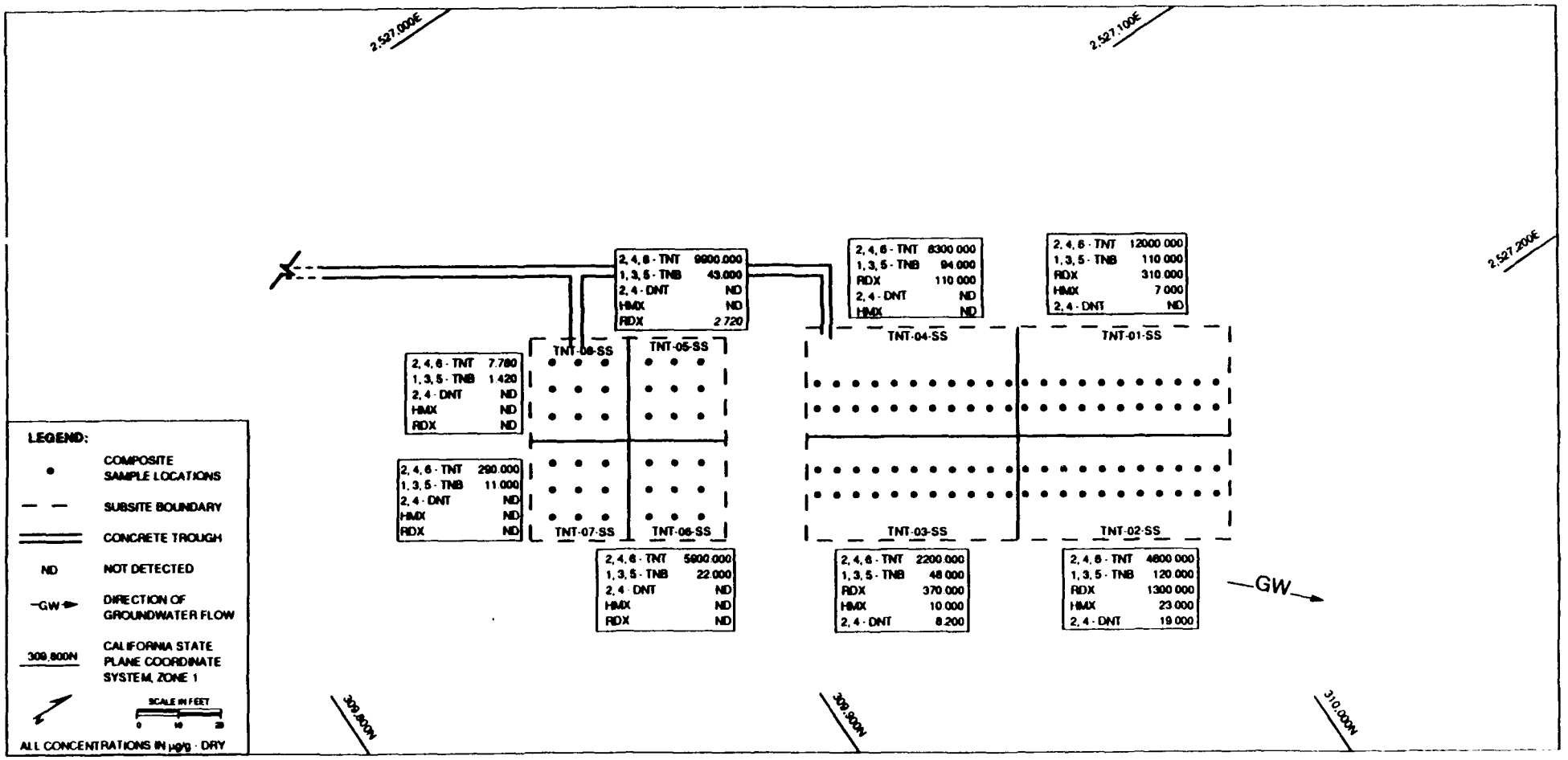
Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.



SIERRA ARMY DEPOT

METAL CONCENTRATIONS FROM COMPOSITE SURFACE SOIL SAMPLES: TNT LEACHING BEDS SUBSITE

FIGURE 6-17



SIERRA ARMY DEPOT

EXPLOSIVE COMPOUND CONCENTRATIONS FROM COMPOSITE SURFACE SOIL SAMPLES: TNT LEACHING BEDS SUBSITE

FIGURE 6-18

TABLE 6-16

1,3,5-TNB MASS (lbs.)
TNT LEACHING BEDS SUBSITE

Depth Interval (ft.)	Sample Depth (ft.)	Zone 12 Mass (lbs.)	Zone 13 Mass (lbs.)	Zone 14 Mass (lbs.)	Zone 15 Mass (lbs.)	Zone 16 Mass (lbs.)	Zone 17 Mass (lbs.)	Zone 18 Mass (lbs.)	Zone 19 Mass (lbs.)	Total lbs
0-2.5	0.5	66.91	74.74	26.43	51.70	12.87	6.83	3.29	0.43	243.20
2.5-7.5	5.0	22.18	34.84	24.60	31.81	11.68	10.22	13.42	9.85	158.60
7.5-12.5	10.0	47.02	30.14	18.40	22.94	20.51	13.07	12.69	16.02	180.79
12.5-17.5	15.0	58.95	36.41	4.18	21.28	25.47	8.95	16.68	5.94	177.86
17.5-22.5	20.0	17.84	27.00	7.95	8.86	7.50	3.99	2.63	2.71	78.48
22.5-27.5	25.0	14.11	42.44	6.54	17.29	4.33	5.99	4.45	2.79	97.94
27.5-32.5	30.0	9.37	8.35	5.82	6.90	2.95	3.00	3.46	1.65	41.50
32.5-37.5	35.0	9.62	4.59	10.29	8.06	6.11	7.38	6.65	6.35	59.05
37.5-42.5	40.0	1.30	12.90	4.15	16.19	5.17	10.59	4.13	6.83	61.26
42.5-47.5	45.0	1.57	4.01	11.06	10.29	ND	1.31	1.17	ND	29.41
47.5-52.5	50.0	2.83	7.98	11.64	1.53	ND	7.86	0.44	ND	32.28
Total (lbs)		251.70	283.40	131.06	196.85	96.59	79.19	69.01	52.57	1160.37
Area of Zone (ft^2)		2,170	2,170	1,995	1,995	1,088	1,088	1,088	1,088	12,682

ND - Not detected

TABLE 6-17

TOTAL EXPLOSIVES MASS (lbs.)
TNT LEACHING BEDS AREA SUBSITE

Depth Interval (ft.)	Sample Depth (ft.)	Zone 12 Mass (lbs.)	Zone 13 Mass (lbs.)	Zone 14 Mass (lbs.)	Zone 15 Mass (lbs.)	Zone 16 Mass (lbs.)	Zone 17 Mass (lbs.)	Zone 18 Mass (lbs.)	Zone 19 Mass (lbs.)	Total lbs.
0-2.5	0.5	7250.23	3620.58	1441.34	4718.9	1653.75	1792.96	91.24	2.78	20,571.78
2.5-7.5	5.0	131.14	43.07	31.67	45.35	21.70	11.82	14.54	14.30	313.59
7.5-12.5	10.0	90.51	41.24	25.13	29.12	21.74	13.06	13.27	16.02	250.29
12.5-17.5	15.0	89.13	51.86	2.45	42.81	25.45	10.10	21.94	6.55	253.29
17.5-22.5	20.0	35.46	45.21	17.80	13.80	10.70	3.99	2.63	2.71	132.30
22.5-27.5	25.0	34.80	98.52	13.27	47.57	4.55	5.99	4.89	2.79	212.38
27.5-32.5	30.0	23.83	17.71	8.60	13.50	3.37	3.00	3.46	1.65	75.12
32.5-37.5	35.0	27.47	14.79	18.41	11.55	6.64	7.37	7.31	7.39	10. 93
37.5-42.5	40.0	3.27	26.74	4.75	24.37	6.22	11.48	4.53	7.83	89.19
42.5-47.5	45.0	2.17	7.50	15.01	19.26	1.26	1.31	1.56	ND	49.07
47.5-52.5	50.0	4.97	10.24	19.83	5.43	1.04	9.01	0.44	ND	50.96
Total (lbs)		7693.98	3977.46	1601.26	4971.66	1756.42	1870.09	165.81	62.02	22099
Area of Zone (ft^2)		2,170	2,170	1,995	1,995	1,088	1,088	1,088	1,088	12,682

ND - Not detected

6.2.5.3 Subsurface Soil

6.2.5.3.1 TNT Leaching Beds Subsite

Eight soil borings (four per bed), TNT-12-SB through TNT-19-SB, were drilled and sampled at 5-foot intervals at the TNT Leaching Beds Subsite (Figures 6-19 through 6-21). Thirty-five samples were collected and analyzed for VOCs. A total of 80 samples, collected from the eight borings, were analyzed for inorganics (priority pollutant metals) and explosives. The analytical results are presented in Table 6-18 and Figures 6-19 through 6-21. Total explosives and 1,3,5-TNB mass are presented in Tables 6-16 and 6-17.

VOCs

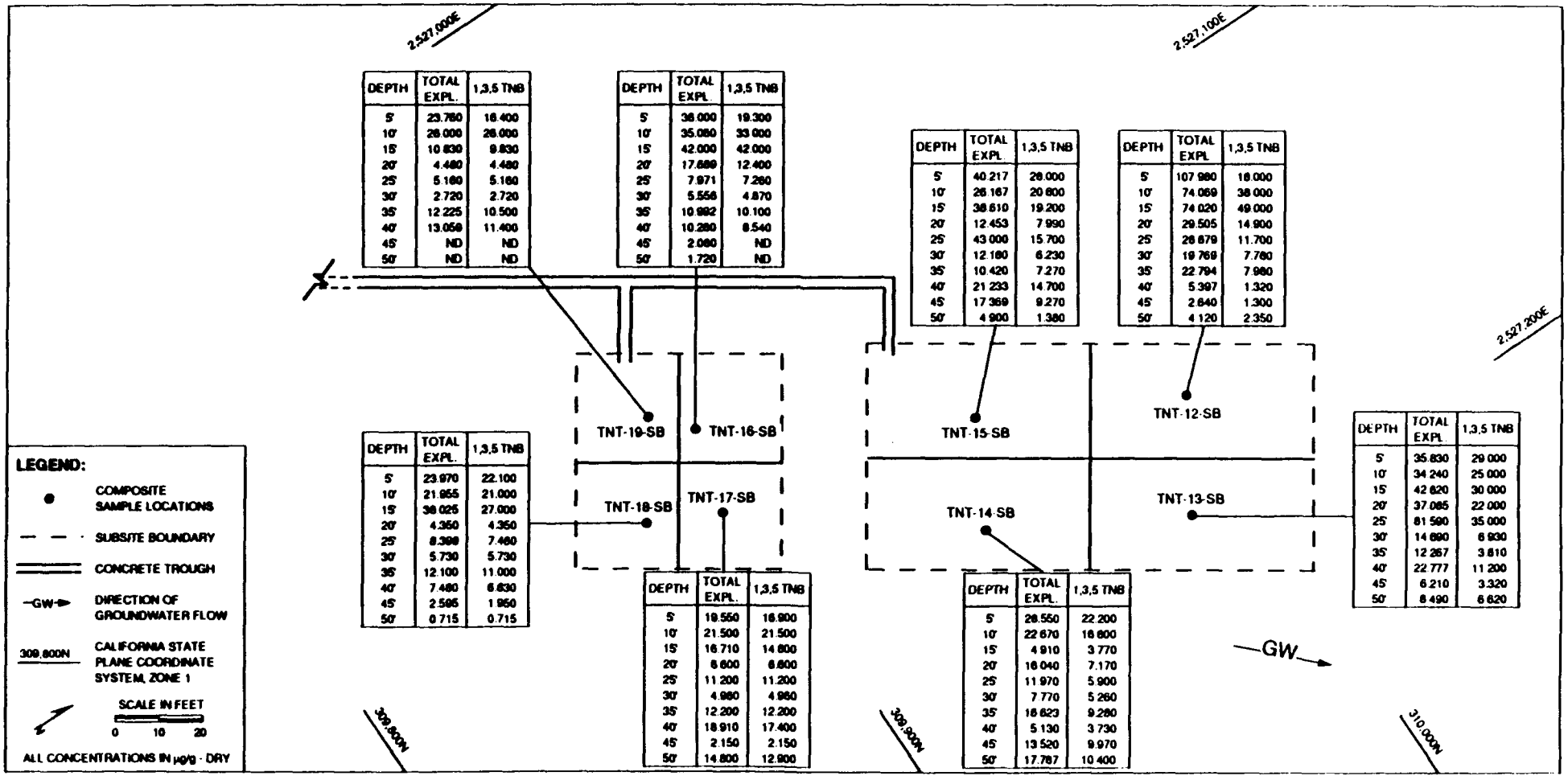
Of 35 samples that measured VOCs, levels exceeding detection limits were observed in only 6 percent of the samples. Detected values are shown in Table 6-16. TCE was detected at the 40-foot interval in Boring TNT-12-SB (0.003 μg/g), and at the 5-foot interval in Boring TNT-13-SB (0.028 μg/g). The source of the TCE is considered to be random dumping of TCE either directly into the beds or into the concrete troughs that empty into the beds. Because of the low frequency of occurrence, the low concentrations detected, and the distance of TCE in soil from groundwater (25 to 50 feet), TCE is considered an unlikely continuing source of groundwater contamination.

Inorganic

No inorganic constituents were detected in soil above what are considered background levels at this site.

Explosives

Eight borings TNT-12-SB through TNT-19-SB were drilled and sampled to the water table. Explosives compounds were detected in 80 of the 82 subsurface soil samples (98 percent) that were collected (Table 6-16 and Figures 6-19 through 6-21). With the exception of the 45-



DEPTH	TOTAL EXPL.	1,3,5 TNB
5'	23.760	16.400
10'	26.000	26.000
15'	10.830	9.830
20'	4.480	4.480
25'	5.160	5.160
30'	2.720	2.720
35'	12.225	10.500
40'	13.058	11.400
45'	ND	ND
50'	ND	ND

DEPTH	TOTAL EXPL.	1,3,5 TNB
5'	36.000	19.300
10'	35.080	33.000
15'	42.000	42.000
20'	17.689	12.400
25'	7.971	7.260
30'	5.556	4.870
35'	10.992	10.100
40'	10.280	8.540
45'	2.080	ND
50'	1.720	ND

DEPTH	TOTAL EXPL.	1,3,5 TNB
5'	40.217	28.000
10'	26.167	20.600
15'	38.610	19.200
20'	12.453	7.990
25'	43.000	15.700
30'	12.160	6.230
35'	10.420	7.270
40'	21.233	14.700
45'	17.369	9.270
50'	4.900	1.380

DEPTH	TOTAL EXPL.	1,3,5 TNB
5'	107.980	18.000
10'	74.069	38.000
15'	74.020	49.000
20'	29.505	14.900
25'	28.679	11.700
30'	19.769	7.760
35'	22.794	7.980
40'	5.397	1.320
45'	2.640	1.300
50'	4.120	2.350

DEPTH	TOTAL EXPL.	1,3,5 TNB
5'	23.970	22.100
10'	21.955	21.000
15'	38.025	27.000
20'	4.350	4.350
25'	8.398	7.460
30'	5.730	5.730
35'	12.100	11.000
40'	7.480	6.830
45'	2.595	1.950
50'	0.715	0.715

DEPTH	TOTAL EXPL.	1,3,5 TNB
5'	19.550	16.900
10'	21.500	21.500
15'	16.710	14.800
20'	6.600	6.600
25'	11.200	11.200
30'	4.980	4.960
35'	12.200	12.200
40'	18.910	17.400
45'	2.150	2.150
50'	14.800	12.900

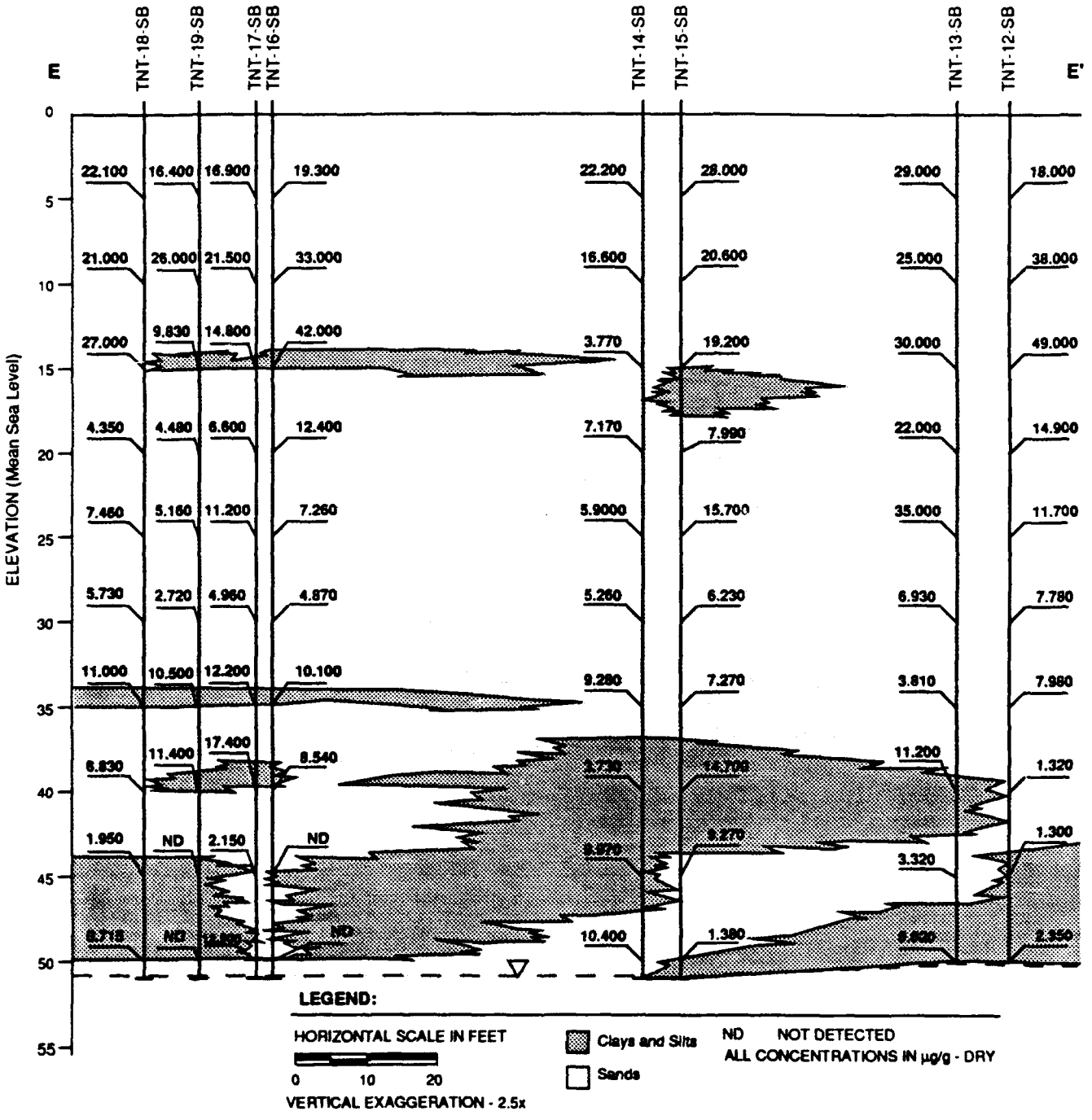
DEPTH	TOTAL EXPL.	1,3,5 TNB
5'	28.550	22.200
10'	22.670	16.600
15'	4.910	3.770
20'	16.040	7.170
25'	11.970	5.900
30'	7.770	5.260
35'	16.623	9.260
40'	5.130	3.730
45'	13.520	9.970
50'	17.787	10.400

DEPTH	TOTAL EXPL.	1,3,5 TNB
5'	35.830	29.000
10'	34.240	25.000
15'	42.820	30.000
20'	37.085	22.000
25'	81.590	35.000
30'	14.690	6.930
35'	12.267	3.810
40'	22.777	11.200
45'	6.210	3.320
50'	8.490	6.620

SIERRA ARMY DEPOT

TOTAL EXPLOSIVE COMPOUND AND 1,3,5-TRINITROTOLUENE CONCENTRATIONS FROM SOIL BORINGS: TNT LEACHING BEDS SUBSITE

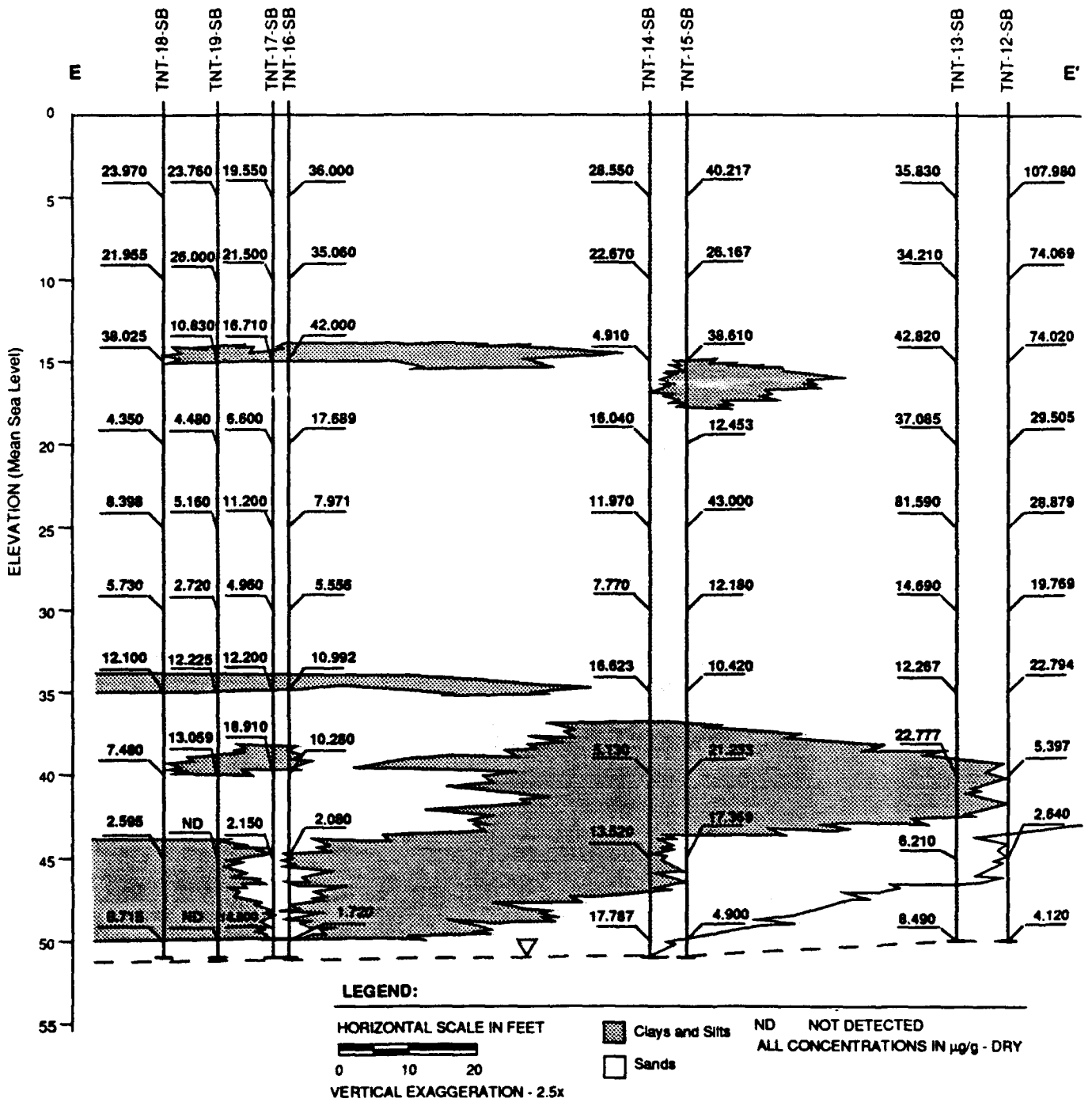
FIGURE 6-19



SIERRA ARMY DEPOT

1,3,5 - TRINITROBENZENE CONCENTRATIONS FROM SOIL BORINGS: TNT LEACHING BEDS SUBSITE

FIGURE 6-20



SIERRA ARMY DEPOT

TOTAL EXPLOSIVE COMPOUND CONCENTRATIONS FROM SOIL BORINGS: TNT LEACHING BEDS SUBSITE

FIGURE 6-21

POSITIVE SOIL RESULTS - TNT LEACHING BEDS AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
TNT-07-SB	5.0	03-apr-1990	JD19	Arsenic	3.500	ug/g
	10.0	03-apr-1990	JD19	Arsenic	2.900	ug/g
	15.0	03-apr-1990	JD19	Arsenic	9.700	ug/g
	20.0	03-apr-1990	JD19	Arsenic	4.700	ug/g
	25.0	03-apr-1990	JD19	Arsenic	4.900	ug/g
	30.0	03-apr-1990	JD19	Arsenic	5.400	ug/g
	35.0	03-apr-1990	JD15	Selenium	0.400	ug/g
		03-apr-1990	JD19	Arsenic	4.200	ug/g
		03-apr-1990	LW12	2,4,6-Trinitrotoluene	2.500	ug/g
		03-apr-1990	LW12	2,4-Dinitrotoluene	0.900	ug/g
		03-apr-1990	LW12	Nitramine (Tetryl)	0.800	ug/g
	40.0	03-apr-1990	JD19	Arsenic	6.400	ug/g
		03-apr-1990	JD19	Arsenic	6.200	ug/g
	45.0	03-apr-1990	JD19	Arsenic	9.600	ug/g
	50.0	03-apr-1990	JD19	Arsenic	6.000	ug/g
	55.0	03-apr-1990	JD19	Arsenic	14.900	ug/g
TNT-08-SB	5.0	03-apr-1990	JD19	Arsenic	5.200	ug/g
		03-apr-1990	JS11	Lead	29.600	ug/g
	10.0	03-apr-1990	JD19	Arsenic	3.700	ug/g
	15.0	03-apr-1990	JD19	Arsenic	2.800	ug/g
	20.0	03-apr-1990	JD19	Arsenic	7.800	ug/g
	25.0	03-apr-1990	JD19	Arsenic	3.000	ug/g
	30.0	03-apr-1990	JD19	Arsenic	2.800	ug/g
	35.0	03-apr-1990	JD19	Arsenic	3.200	ug/g
		03-apr-1990	JD19	Arsenic	3.300	ug/g
	40.0	03-apr-1990	JD19	Arsenic	4.200	ug/g
	45.0	03-apr-1990	JD19	Arsenic	3.200	ug/g
	50.0	03-apr-1990	JD19	Arsenic	4.600	ug/g
	55.0	03-apr-1990	JD19	Arsenic	14.200	ug/g

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

POSITIVE SOIL RESULTS - TNT LEACHING BEDS AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
TNT-09-SB	5.0	03-apr-1990	JD19	Arsenic	5.800	ug/g
		03-apr-1990	JS11	Lead	13.100	ug/g
	10.0	03-apr-1990	JD19	Arsenic	3.200	ug/g
	15.0	03-apr-1990	JD19	Arsenic	6.500	ug/g
	20.0	03-apr-1990	JD19	Arsenic	5.100	ug/g
	25.0	03-apr-1990	JD19	Arsenic	3.500	ug/g
	30.0	03-apr-1990	JD19	Arsenic	3.700	ug/g
	35.0	03-apr-1990	JD19	Arsenic	5.100	ug/g
		03-apr-1990	JD19	Arsenic	6.600	ug/g
		03-apr-1990	JS11	Zinc	64.800	ug/g
	40.0	03-apr-1990	JD19	Arsenic	5.000	ug/g
	45.0	03-apr-1990	JD19	Arsenic	3.200	ug/g
	50.0	03-apr-1990	JD19	Arsenic	3.700	ug/g
	55.0	03-apr-1990	JD19	Arsenic	10.700	ug/g
TNT-10-SB	5.0	02-apr-1990	JD19	Arsenic	8.900	ug/g
		02-apr-1990	JS11	Lead	8.300	ug/g
	10.0	02-apr-1990	JD19	Arsenic	4.100	ug/g
	15.0	02-apr-1990	JD19	Arsenic	8.300	ug/g
		02-apr-1990	JS11	Zinc	57.700	ug/g
		02-apr-1990	LM19	Unknown 071 (TIC)	0.020	ug/g
	20.0	02-apr-1990	JD19	Arsenic	9.200	ug/g
	25.0	02-apr-1990	JD19	Arsenic	4.400	ug/g
	30.0	02-apr-1990	JD19	Arsenic	4.400	ug/g
		02-apr-1990	JS11	Zinc	69.000	ug/g
	35.0	02-apr-1990	JD19	Arsenic	2.700	ug/g
		02-apr-1990	JD19	Arsenic	6.700	ug/g
		02-apr-1990	JS11	Zinc	62.400	ug/g
		02-apr-1990	JS11	Zinc	86.300	ug/g
		02-apr-1990	LM19	Toluene	0.000	ug/g
	40.0	02-apr-1990	JD19	Arsenic	6.500	ug/g
	45.0	02-apr-1990	JD19	Arsenic	1.600	ug/g
		02-apr-1990	JS11	Zinc	72.400	ug/g

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

POSITIVE SOIL RESULTS - TNT LEACHING BEDS AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
TNT-10-SB	50.0	02-apr-1990	JD19	Arsenic	11.000	ug/g
TNT-11-SB	5.0	02-apr-1990	JD19	Arsenic	2.900	ug/g
	10.0	02-apr-1990	JD19	Arsenic	3.800	ug/g
	15.0	02-apr-1990	JD19	Arsenic	16.100	ug/g
		02-apr-1990	JS11	Zinc	82.100	ug/g
	20.0	02-apr-1990	JD19	Arsenic	5.600	ug/g
	25.0	02-apr-1990	JD19	Arsenic	1.800	ug/g
	30.0	02-apr-1990	JD19	Arsenic	2.100	ug/g
	35.0	02-apr-1990	JD19	Arsenic	4.200	ug/g
		02-apr-1990	JD19	Arsenic	3.600	ug/g
		02-apr-1990	LM19	Unknown 112 (TIC)	0.010	ug/g
	40.0	02-apr-1990	JD19	Arsenic	3.600	ug/g
	45.0	02-apr-1990	JD19	Arsenic	3.200	ug/g
	50.0	02-apr-1990	JD19	Arsenic	8.300	ug/g
TNT-12-SB	5.0	04-apr-1990	JD19	Arsenic	5.800	ug/g
		04-apr-1990	LW12	1,3,5-Trinitrobenzene	18.200	ug/g
		04-apr-1990	LW12	2,4,6-Trinitrotoluene	25.800	ug/g
		04-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	5.000	ug/g
		04-apr-1990	LW12	Cyclonite (RDX)	59.400	ug/g
	10.0	04-apr-1990	JD19	Arsenic	2.600	ug/g
		04-apr-1990	LW12	1,3,5-Trinitrobenzene	38.500	ug/g
		04-apr-1990	LW12	2,4,6-Trinitrotoluene	4.000	ug/g
		04-apr-1990	LW12	2,4-Dinitrotoluene	1.000	ug/g
		04-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	14.900	ug/g
		04-apr-1990	LW12	Cyclonite (RDX)	16.200	ug/g
	15.0	04-apr-1990	JD19	Arsenic	9.100	ug/g
		04-apr-1990	LW12	1,3,5-Trinitrobenzene	48.500	ug/g
		04-apr-1990	LW12	2,4,6-Trinitrotoluene	14.500	ug/g
		04-apr-1990	LW12	2,4-Dinitrotoluene	1.900	ug/g
		04-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	3.900	ug/g
		04-apr-1990	LW12	Cyclonite (RDX)	4.700	ug/g
	20.0	04-apr-1990	JD19	Arsenic	5.700	ug/g
		04-apr-1990	LW12	1,3,5-Trinitrobenzene	14.900	ug/g
		04-apr-1990	LW12	2,4,6-Trinitrotoluene	9.500	ug/g
		04-apr-1990	LW12	2,4-Dinitrotoluene	1.000	ug/g
		04-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	1.400	ug/g
		04-apr-1990	LW12	Cyclonite (RDX)	2.700	ug/g

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

POSITIVE SOIL RESULTS - TNT LEACHING BEDS AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
TNT-12-SB	25.0	04-apr-1990	JD19	Arsenic	9.700	ug/g
		04-apr-1990	LW12	1,3,5-Trinitrobenzene	11.700	ug/g
		04-apr-1990	LW12	2,4,6-Trinitrotoluene	3.700	ug/g
		04-apr-1990	LW12	2,4-Dinitrotoluene	0.800	ug/g
		04-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	3.100	ug/g
		04-apr-1990	LW12	Cyclonite (RDX)	9.600	ug/g
	30.0	04-apr-1990	JD19	Arsenic	6.600	ug/g
		04-apr-1990	LW12	1,3,5-Trinitrobenzene	7.800	ug/g
		04-apr-1990	LW12	2,4,6-Trinitrotoluene	4.600	ug/g
		04-apr-1990	LW12	2,4-Dinitrotoluene	0.700	ug/g
		04-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	2.300	ug/g
		04-apr-1990	LW12	Cyclonite (RDX)	4.300	ug/g
	35.0	04-apr-1990	JD19	Arsenic	10.000	ug/g
		04-apr-1990	JS11	Zinc	67.100	ug/g
		04-apr-1990	LW12	1,3,5-Trinitrobenzene	8.000	ug/g
		04-apr-1990	LW12	2,4,6-Trinitrotoluene	0.500	ug/g
		04-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	2.300	ug/g
		04-apr-1990	LW12	Cyclonite (RDX)	12.000	ug/g
	40.0	04-apr-1990	JD19	Arsenic	2.900	ug/g
		04-apr-1990	JD19	Arsenic	4.200	ug/g
		04-apr-1990	LM19	Trichloroethene	0.000	ug/g
		04-apr-1990	LW12	1,3,5-Trinitrobenzene	1.300	ug/g
		04-apr-1990	LW12	1,3,5-Trinitrobenzene	0.800	ug/g
		04-apr-1990	LW12	Cyclonite (RDX)	2.000	ug/g
		04-apr-1990	LW12	Cyclonite (RDX)	1.300	ug/g
	45.0	04-apr-1990	JD19	Arsenic	3.400	ug/g
		04-apr-1990	LW12	1,3,5-Trinitrobenzene	1.300	ug/g
		04-apr-1990	LW12	Cyclonite (RDX)	1.300	ug/g
	50.0	04-apr-1990	JD19	Arsenic	3.500	ug/g
		04-apr-1990	LW12	1,3,5-Trinitrobenzene	2.400	ug/g
		04-apr-1990	LW12	Cyclonite (RDX)	1.800	ug/g
TNT-13-SB	5.0	05-apr-1990	JD19	Arsenic	2.700	ug/g
		05-apr-1990	LM19	Trichloroethene	0.030	ug/g
		05-apr-1990	LW12	1,3,5-Trinitrobenzene	29.300	ug/g
		05-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	4.700	ug/g
		05-apr-1990	LW12	Cyclonite (RDX)	2.100	ug/g
	10.0	05-apr-1990	JD19	Arsenic	3.200	ug/g
		05-apr-1990	LW12	1,3,5-Trinitrobenzene	25.300	ug/g
		05-apr-1990	LW12	2,4,6-Trinitrotoluene	1.200	ug/g
		05-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	5.300	ug/g
		05-apr-1990	LW12	Cyclonite (RDX)	2.600	ug/g
	15.0	05-apr-1990	JD19	Arsenic	3.600	ug/g
		05-apr-1990	LW12	1,3,5-Trinitrobenzene	30.400	ug/g

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POSITIVE SOIL RESULTS - TNT LEACHING BEDS AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
TNT-13-SB	15.0	05-apr-1990	LW12	2,4,6-Trinitrotoluene	2.300	ug/g
		05-apr-1990	LW12	2,4-Dinitrotoluene	1.600	ug/g
		05-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	5.200	ug/g
		05-apr-1990	LW12	Cyclonite (RDX)	3.700	ug/g
	20.0	05-apr-1990	JD19	Arsenic	1.600	ug/g
		05-apr-1990	LW12	1,3,5-Trinitrobenzene	22.200	ug/g
		05-apr-1990	LW12	2,4,6-Trinitrotoluene	5.300	ug/g
		05-apr-1990	LW12	2,4-Dinitrotoluene	0.900	ug/g
		05-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	3.900	ug/g
		05-apr-1990	LW12	Cyclonite (RDX)	5.000	ug/g
	25.0	05-apr-1990	JD19	Arsenic	6.700	ug/g
		05-apr-1990	LW12	1,3,5-Trinitrobenzene	34.800	ug/g
		05-apr-1990	LW12	2,4,6-Trinitrotoluene	11.400	ug/g
		05-apr-1990	LW12	2,4-Dinitrotoluene	4.000	ug/g
		05-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	17.900	ug/g
		05-apr-1990	LW12	Cyclonite (RDX)	13.300	ug/g
	30.0	05-apr-1990	JD19	Arsenic	13.600	ug/g
		05-apr-1990	LW12	1,3,5-Trinitrobenzene	6.900	ug/g
		05-apr-1990	LW12	2,4,6-Trinitrotoluene	3.700	ug/g
		05-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	1.300	ug/g
		05-apr-1990	LW12	Cyclonite (RDX)	2.800	ug/g
	35.0	05-apr-1990	JD19	Arsenic	4.400	ug/g
		05-apr-1990	LW12	1,3,5-Trinitrobenzene	3.800	ug/g
		05-apr-1990	LW12	2,4,6-Trinitrotoluene	1.100	ug/g
		05-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	0.800	ug/g
		05-apr-1990	LW12	Cyclonite (RDX)	6.500	ug/g
	40.0	05-apr-1990	JD19	Arsenic	3.100	ug/g
		05-apr-1990	JD19	Arsenic	3.600	ug/g
		05-apr-1990	JS11	Zinc	85.300	ug/g
		05-apr-1990	LW12	1,3,5-Trinitrobenzene	10.200	ug/g
		05-apr-1990	LW12	1,3,5-Trinitrobenzene	11.200	ug/g
		05-apr-1990	LW12	2,4,6-Trinitrotoluene	1.700	ug/g
		05-apr-1990	LW12	2,4,6-Trinitrotoluene	1.100	ug/g
		05-apr-1990	LW12	2,4-Dinitrotoluene	0.500	ug/g
		05-apr-1990	LW12	2,4-Dinitrotoluene	0.600	ug/g
		05-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	0.900	ug/g
		05-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	0.900	ug/g
		05-apr-1990	LW12	Cyclonite (RDX)	8.500	ug/g
		05-apr-1990	LW12	Cyclonite (RDX)	8.700	ug/g
	45.0	05-apr-1990	JD19	Arsenic	2.600	ug/g
		05-apr-1990	LW12	1,3,5-Trinitrobenzene	3.300	ug/g
		05-apr-1990	LW12	Cyclonite (RDX)	2.900	ug/g
	50.0	05-apr-1990	JD19	Arsenic	2.900	ug/g
		05-apr-1990	LW12	1,3,5-Trinitrobenzene	6.600	ug/g
		05-apr-1990	LW12	Cyclonite (RDX)	1.900	ug/g

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POSITIVE SOIL RESULTS - TNT LEACHING BEDS AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
TNT-14-SB	5.0	09-apr-1990	JD19	Arsenic	5.100	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	22.200	ug/g
		09-apr-1990	LW12	2,4-Dinitrotoluene	1.200	ug/g
		09-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	5.200	ug/g
	10.0	09-apr-1990	JD19	Arsenic	3.100	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	16.600	ug/g
		09-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	5.300	ug/g
		09-apr-1990	LW12	Cyclonite (RDX)	0.800	ug/g
	15.0	09-apr-1990	JD19	Arsenic	6.900	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	3.800	ug/g
		09-apr-1990	LW12	Cyclonite (RDX)	1.100	ug/g
	20.0	09-apr-1990	JD19	Arsenic	2.600	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	7.200	ug/g
		09-apr-1990	LW12	2,4,6-Trinitrotoluene	3.400	ug/g
		09-apr-1990	LW12	2,4-Dinitrotoluene	1.100	ug/g
		09-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	1.900	ug/g
		09-apr-1990	LW12	Cyclonite (RDX)	2.500	ug/g
	25.0	09-apr-1990	JD19	Arsenic	3.900	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	5.900	ug/g
		09-apr-1990	LW12	2,4,6-Trinitrotoluene	1.200	ug/g
		09-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	1.000	ug/g
		09-apr-1990	LW12	Cyclonite (RDX)	3.800	ug/g
	30.0	09-apr-1990	JD19	Arsenic	8.100	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	5.300	ug/g
		09-apr-1990	LW12	2,4,6-Trinitrotoluene	1.200	ug/g
		09-apr-1990	LW12	Cyclonite (RDX)	1.400	ug/g
	35.0	09-apr-1990	JD19	Arsenic	6.400	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	9.300	ug/g
		09-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	0.700	ug/g
		09-apr-1990	LW12	Cyclonite (RDX)	6.600	ug/g
	40.0	09-apr-1990	JD19	Arsenic	1.900	ug/g
		09-apr-1990	JD19	Arsenic	3.300	ug/g
		09-apr-1990	JS11	Nickel	27.000	ug/g
		09-apr-1990	JS11	Zinc	75.200	ug/g
		09-apr-1990	JS11	Zinc	85.200	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	3.700	ug/g
		09-apr-1990	LW12	Cyclonite (RDX)	1.400	ug/g
		09-apr-1990	LW12	Cyclonite (RDX)	3.400	ug/g
	45.0	09-apr-1990	JD19	Arsenic	3.400	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	10.000	ug/g
		09-apr-1990	LW12	Cyclonite (RDX)	3.600	ug/g
	50.0	09-apr-1990	JD19	Arsenic	4.400	ug/g

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POSITIVE SOIL RESULTS - TNT LEACHING BEDS AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
TNT-14-SB	50.0	09-apr-1990	LW12	1,3,5-Trinitrobenzene	10.400	ug/g
		09-apr-1990	LW12	2,4,6-Trinitrotoluene	1.100	ug/g
		09-apr-1990	LW12	2,4-Dinitrotoluene	0.600	ug/g
		09-apr-1990	LW12	Cyclonite (RDX)	5.700	ug/g
TNT-15-SB	5.0	05-apr-1990	JD19	Arsenic	4.500	ug/g
		05-apr-1990	LW12	1,3,5-Trinitrobenzene	28.300	ug/g
		05-apr-1990	LW12	2,4,6-Trinitrotoluene	1.000	ug/g
		05-apr-1990	LW12	2,4-Dinitrotoluene	0.600	ug/g
		05-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	4.700	ug/g
		05-apr-1990	LW12	Cyclonite (RDX)	5.800	ug/g
	10.0	05-apr-1990	JD19	Arsenic	3.100	ug/g
		05-apr-1990	LW12	1,3,5-Trinitrobenzene	20.600	ug/g
		05-apr-1990	LW12	2,4,6-Trinitrotoluene	0.800	ug/g
		05-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	3.300	ug/g
		05-apr-1990	LW12	Cyclonite (RDX)	1.400	ug/g
	15.0	05-apr-1990	JD19	Arsenic	13.100	ug/g
		05-apr-1990	LW12	1,3,5-Trinitrobenzene	19.200	ug/g
		05-apr-1990	LW12	2,4,6-Trinitrotoluene	7.500	ug/g
		05-apr-1990	LW12	2,4-Dinitrotoluene	1.400	ug/g
		05-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	4.000	ug/g
		05-apr-1990	LW12	Cyclonite (RDX)	6.500	ug/g
	20.0	05-apr-1990	JD19	Arsenic	1.200	ug/g
		05-apr-1990	LW12	1,3,5-Trinitrobenzene	8.000	ug/g
		05-apr-1990	LW12	2,4,6-Trinitrotoluene	0.600	ug/g
		05-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	0.800	ug/g
		05-apr-1990	LW12	Cyclonite (RDX)	3.100	ug/g
	25.0	05-apr-1990	JD19	Arsenic	3.000	ug/g
		05-apr-1990	JS11	Zinc	64.400	ug/g
		05-apr-1990	LW12	1,3,5-Trinitrobenzene	15.700	ug/g
		05-apr-1990	LW12	2,4,6-Trinitrotoluene	4.600	ug/g
		05-apr-1990	LW12	2,4-Dinitrotoluene	1.300	ug/g
		05-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	5.600	ug/g
		05-apr-1990	LW12	Cyclonite (RDX)	15.800	ug/g
	30.0	05-apr-1990	JD19	Arsenic	9.600	ug/g
		05-apr-1990	LW12	1,3,5-Trinitrobenzene	6.200	ug/g
		05-apr-1990	LW12	2,4,6-Trinitrotoluene	2.100	ug/g
		05-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	0.900	ug/g
		05-apr-1990	LW12	Cyclonite (RDX)	2.900	ug/g
	35.0	05-apr-1990	JD19	Arsenic	4.200	ug/g
		05-apr-1990	LW12	1,3,5-Trinitrobenzene	7.300	ug/g
		05-apr-1990	LW12	Cyclonite (RDX)	3.200	ug/g
	40.0	05-apr-1990	JD19	Arsenic	5.400	ug/g
		05-apr-1990	JD19	Arsenic	4.600	ug/g
		05-apr-1990	JS11	Chromium	25.200	ug/g

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POSITIVE SOIL RESULTS - TNT LEACHING BEDS AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
TNT-15-SB	40.0	05-apr-1990	JS11	Zinc	86.300	ug/g
		05-apr-1990	JS11	Zinc	99.200	ug/g
		05-apr-1990	LW12	1,3,5-Trinitrobenzene	14.700	ug/g
		05-apr-1990	LW12	1,3,5-Trinitrobenzene	14.400	ug/g
		05-apr-1990	LW12	2,4,6-Trinitrotoluene	0.600	ug/g
		05-apr-1990	LW12	2,4,6-Trinitrotoluene	0.700	ug/g
		05-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	0.900	ug/g
		05-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	0.900	ug/g
		05-apr-1990	LW12	Cyclonite (RDX)	5.100	ug/g
		05-apr-1990	LW12	Cyclonite (RDX)	6.600	ug/g
	45.0	05-apr-1990	JD19	Arsenic	2.500	ug/g
		05-apr-1990	LW12	1,3,5-Trinitrobenzene	9.300	ug/g
		05-apr-1990	LW12	2,4,6-Trinitrotoluene	0.900	ug/g
		05-apr-1990	LW12	2,4-Dinitrotoluene	0.500	ug/g
		05-apr-1990	LW12	Cyclotetramethylenetetranitramine (HMX)	0.700	ug/g
		05-apr-1990	LW12	Cyclonite (RDX)	6.000	ug/g
	50.0	05-apr-1990	JD19	Arsenic	3.100	ug/g
		05-apr-1990	LW12	1,3,5-Trinitrobenzene	1.400	ug/g
		05-apr-1990	LW12	Cyclonite (RDX)	3.500	ug/g
TNT-16-SB	5.0	10-apr-1990	JD19	Arsenic	5.700	ug/g
		10-apr-1990	LW12	1,3,5-Trinitrobenzene	19.300	ug/g
		10-apr-1990	LW12	2,4,6-Trinitrotoluene	16.700	ug/g
	10.0	10-apr-1990	JD19	Arsenic	3.500	ug/g
		10-apr-1990	LW12	1,3,5-Trinitrobenzene	33.400	ug/g
		10-apr-1990	LW12	2,4,6-Trinitrotoluene	2.100	ug/g
	15.0	10-apr-1990	JD19	Arsenic	15.100	ug/g
		10-apr-1990	LW12	1,3,5-Trinitrobenzene	41.600	ug/g
	20.0	10-apr-1990	JD19	Arsenic	1.700	ug/g
		10-apr-1990	LW12	1,3,5-Trinitrobenzene	12.400	ug/g
		10-apr-1990	LW12	2,4,6-Trinitrotoluene	2.700	ug/g
		10-apr-1990	LW12	2,4-Dinitrotoluene	1.600	ug/g
		10-apr-1990	LW12	Cyclonite (RDX)	0.900	ug/g
	25.0	10-apr-1990	JD19	Arsenic	9.400	ug/g
		10-apr-1990	JD19	Arsenic	8.000	ug/g
		10-apr-1990	LW12	1,3,5-Trinitrobenzene	7.300	ug/g
		10-apr-1990	LW12	1,3,5-Trinitrobenzene	7.100	ug/g
		10-apr-1990	LW12	Cyclonite (RDX)	0.700	ug/g
	30.0	10-apr-1990	JD19	Arsenic	7.700	ug/g
		10-apr-1990	LW12	1,3,5-Trinitrobenzene	4.900	ug/g
		10-apr-1990	LW12	Cyclonite (RDX)	0.700	ug/g
	35.0	10-apr-1990	JD19	Arsenic	4.300	ug/g
		10-apr-1990	LW12	1,3,5-Trinitrobenzene	10.100	ug/g
		10-apr-1990	LW12	Cyclonite (RDX)	0.900	ug/g

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POSITIVE SOIL RESULTS - TNT LEACHING BEDS AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
TNT-16-SB	40.0	10-apr-1990	JD19	Arsenic	4.500	ug/g
		10-apr-1990	LW12	1,3,5-Trinitrobenzene	8.500	ug/g
		10-apr-1990	LW12	Cyclonite (RDX)	1.700	ug/g
	45.0	10-apr-1990	JD19	Arsenic	2.400	ug/g
		10-apr-1990	JS11	Zinc	58.000	ug/g
		10-apr-1990	LW12	Cyclonite (RDX)	2.100	ug/g
	50.0	10-apr-1990	JD19	Arsenic	3.200	ug/g
		10-apr-1990	LW12	Cyclonite (RDX)	1.700	ug/g
TNT-17-SB	5.0	09-apr-1990	JD19	Arsenic	3.600	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	16.900	ug/g
		09-apr-1990	LW12	2,4,6-Trinitrotoluene	2.600	ug/g
	10.0	09-apr-1990	JD19	Arsenic	3.300	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	21.500	ug/g
	15.0	09-apr-1990	JD19	Arsenic	5.200	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	14.800	ug/g
		09-apr-1990	LW12	2,4,6-Trinitrotoluene	1.900	ug/g
	20.0	09-apr-1990	JD19	Arsenic	1.700	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	6.600	ug/g
	25.0	09-apr-1990	JD19	Arsenic	4.600	ug/g
		09-apr-1990	JD19	Arsenic	4.400	ug/g
		09-apr-1990	JS11	Zinc	58.400	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	11.200	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	8.600	ug/g
	30.0	09-apr-1990	JD19	Arsenic	13.200	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	5.000	ug/g
	35.0	09-apr-1990	JD19	Arsenic	4.500	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	12.200	ug/g
	40.0	09-apr-1990	JD19	Arsenic	3.800	ug/g
		09-apr-1990	JS11	Zinc	67.700	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	17.500	ug/g
		09-apr-1990	LW12	Cyclonite (RDX)	1.500	ug/g
	45.0	09-apr-1990	JD19	Arsenic	6.100	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	2.200	ug/g
	50.0	09-apr-1990	JD19	Arsenic	2.500	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	12.900	ug/g
		09-apr-1990	LW12	Cyclonite (RDX)	1.900	ug/g
TNT-18-SB	5.0	09-apr-1990	JD19	Arsenic	3.400	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	22.100	ug/g

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POSITIVE SOIL RESULTS - TNT LEACHING BEDS AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
TNT-18-SB	5.0	09-apr-1990	LW12	2,4,6-Trinitrotoluene	1.900	ug/g
	10.0	09-apr-1990	JD19	Arsenic	4.800	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	21.000	ug/g
		09-apr-1990	LW12	2,4,6-Trinitrotoluene	1.000	ug/g
	15.0	09-apr-1990	JD19	Arsenic	3.800	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	27.400	ug/g
		09-apr-1990	LW12	2,4,6-Trinitrotoluene	8.700	ug/g
		09-apr-1990	LW12	2,4-Dinitrotoluene	1.400	ug/g
		09-apr-1990	LW12	Cyclonite (RDX)	0.900	ug/g
	20.0	09-apr-1990	JD19	Arsenic	2.500	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	4.400	ug/g
	25.0	09-apr-1990	JD19	Arsenic	10.800	ug/g
		09-apr-1990	JD19	Arsenic	8.500	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	7.100	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	7.500	ug/g
		09-apr-1990	LW12	2,4,6-Trinitrotoluene	0.500	ug/g
		09-apr-1990	LW12	2,4,6-Trinitrotoluene	0.700	ug/g
		09-apr-1990	LW12	2,4-Dinitrotoluene	0.500	ug/g
		09-apr-1990	LW12	2,4-Dinitrotoluene	0.700	ug/g
	30.0	09-apr-1990	JD19	Arsenic	10.800	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	5.700	ug/g
	35.0	09-apr-1990	JD19	Arsenic	4.300	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	10.900	ug/g
		09-apr-1990	LW12	Cyclonite (RDX)	1.100	ug/g
	40.0	09-apr-1990	JD19	Arsenic	2.100	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	6.800	ug/g
		09-apr-1990	LW12	Cyclonite (RDX)	0.600	ug/g
	45.0	09-apr-1990	JD19	Arsenic	3.300	ug/g
		09-apr-1990	JS11	Zinc	62.600	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	1.900	ug/g
		09-apr-1990	LW12	Cyclonite (RDX)	0.600	ug/g
	50.0	09-apr-1990	JD19	Arsenic	4.100	ug/g
		09-apr-1990	JS11	Zinc	85.700	ug/g
		09-apr-1990	LW12	1,3,5-Trinitrobenzene	0.700	ug/g
TNT-19-SB	5.0	10-apr-1990	JD19	Arsenic	4.200	ug/g
		10-apr-1990	LW12	1,3,5-Trinitrobenzene	16.400	ug/g
		10-apr-1990	LW12	2,4,6-Trinitrotoluene	7.400	ug/g
	10.0	10-apr-1990	JD19	Arsenic	3.600	ug/g
		10-apr-1990	LW12	1,3,5-Trinitrobenzene	26.300	ug/g
	15.0	10-apr-1990	JD19	Arsenic	8.400	ug/g

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

POSITIVE SOIL RESULTS - TNT LEACHING BEDS AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
TNT-19-SB	15.0	10-apr-1990	LW12	1,3,5-Trinitrobenzene	9.800	ug/g
		10-apr-1990	LW12	2,4-Dinitrotoluene	1.000	ug/g
	20.0	10-apr-1990	JD19	Arsenic	2.800	ug/g
		10-apr-1990	LW12	1,3,5-Trinitrobenzene	4.500	ug/g
	25.0	10-apr-1990	JD19	Arsenic	6.200	ug/g
		10-apr-1990	JD19	Arsenic	6.700	ug/g
		10-apr-1990	LW12	1,3,5-Trinitrobenzene	4.100	ug/g
		10-apr-1990	LW12	1,3,5-Trinitrobenzene	5.200	ug/g
	30.0	10-apr-1990	JD19	Arsenic	28.900	ug/g
		10-apr-1990	LW12	1,3,5-Trinitrobenzene	2.700	ug/g
	35.0	10-apr-1990	JD19	Arsenic	4.300	ug/g
		10-apr-1990	LW12	1,3,5-Trinitrobenzene	10.400	ug/g
		10-apr-1990	LW12	2,4-Dinitrotoluene	0.500	ug/g
		10-apr-1990	LW12	Cyclonite (RDX)	1.200	ug/g
	40.0	10-apr-1990	JD19	Arsenic	1.200	ug/g
		10-apr-1990	LW12	1,3,5-Trinitrobenzene	11.400	ug/g
		10-apr-1990	LW12	2,4-Dinitrotoluene	0.500	ug/g
		10-apr-1990	LW12	Cyclonite (RDX)	1.200	ug/g
	45.0	10-apr-1990	JD19	Arsenic	4.500	ug/g
	50.0	10-apr-1990	JD19	Arsenic	2.600	ug/g
		10-apr-1990	JS11	Zinc	68.000	ug/g

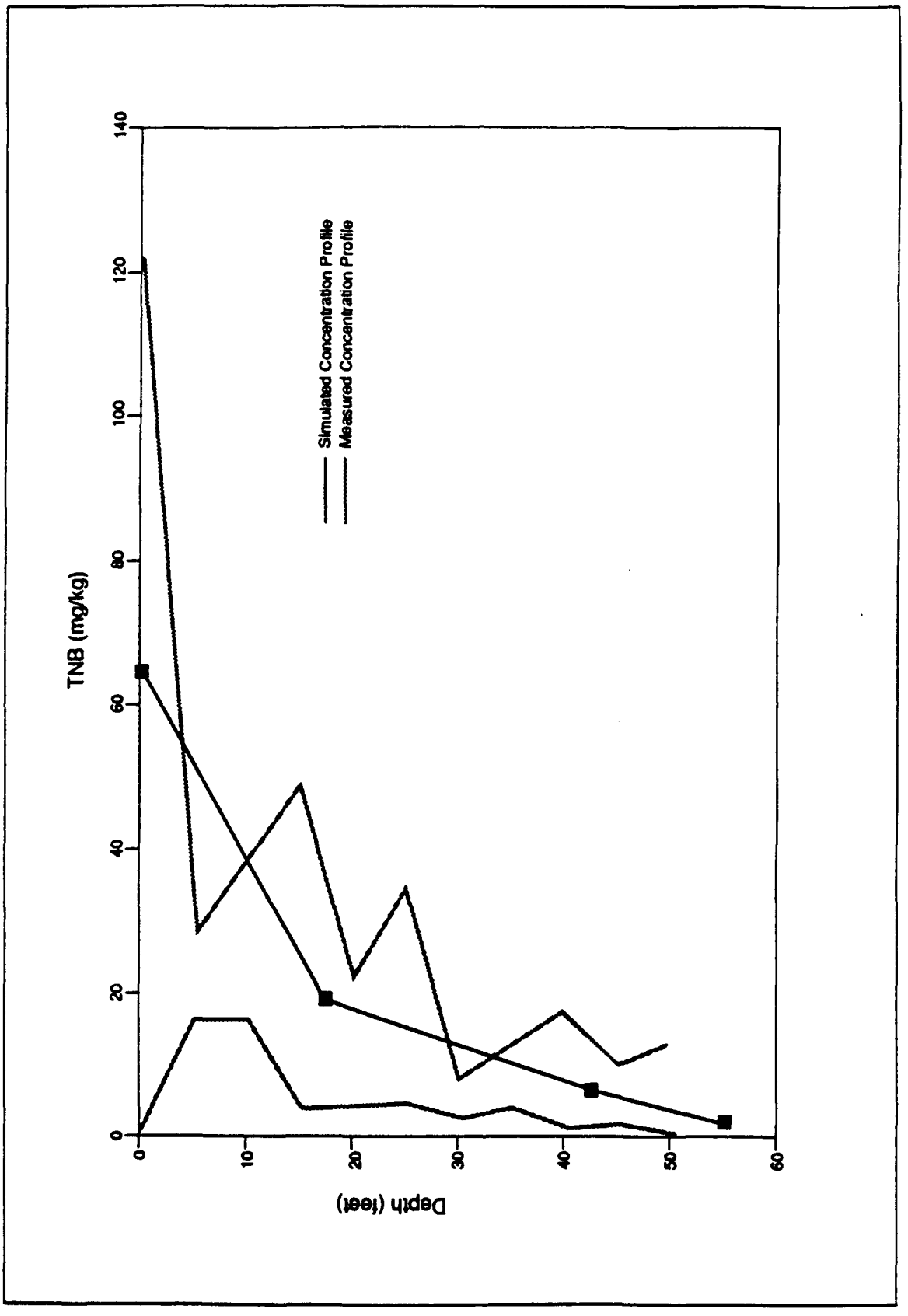
Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

and 50-foot interval in TNT-19-SB, explosives were detected at all sample depths. 1,3,5-TNB was detected in 93 percent of the soil samples, making it the most widely distributed explosive compound at this subsite. Except for the 45- and 50-foot interval samples in TNT-16-SB, the distribution of 1,3,5-TNB mirrors the distribution of total explosives (Figure 6-19). For this reason, 1,3,5-TNB was chosen as an indicator compound for vadose zone modeling.

Distribution of TNT compounds in the subsurface indicates explosives accumulate on the intermittent low permeability silt and clay zones present beneath this site. However, due to the high influx of water moving through the substrate when the leaching beds were in operation, as well as the intermittent nature of the silt and clay beds, these fine-grained zones only formed a partial barrier to vertical contaminant migration. This conclusion is evidenced by the presence of TNT compounds at the soil-water interface as well as their presence in the groundwater.

The SESOIL vadose zone contaminant transport model was used to simulate migration of 1,3,5-TNB over time. 1,3,5-TNB was chosen to be modeled because it is the most widely distributed explosive compound in both the soil and groundwater at this subsite. Thus, modeling this compound provides a conservative estimate of the distribution of all explosive compounds over time.

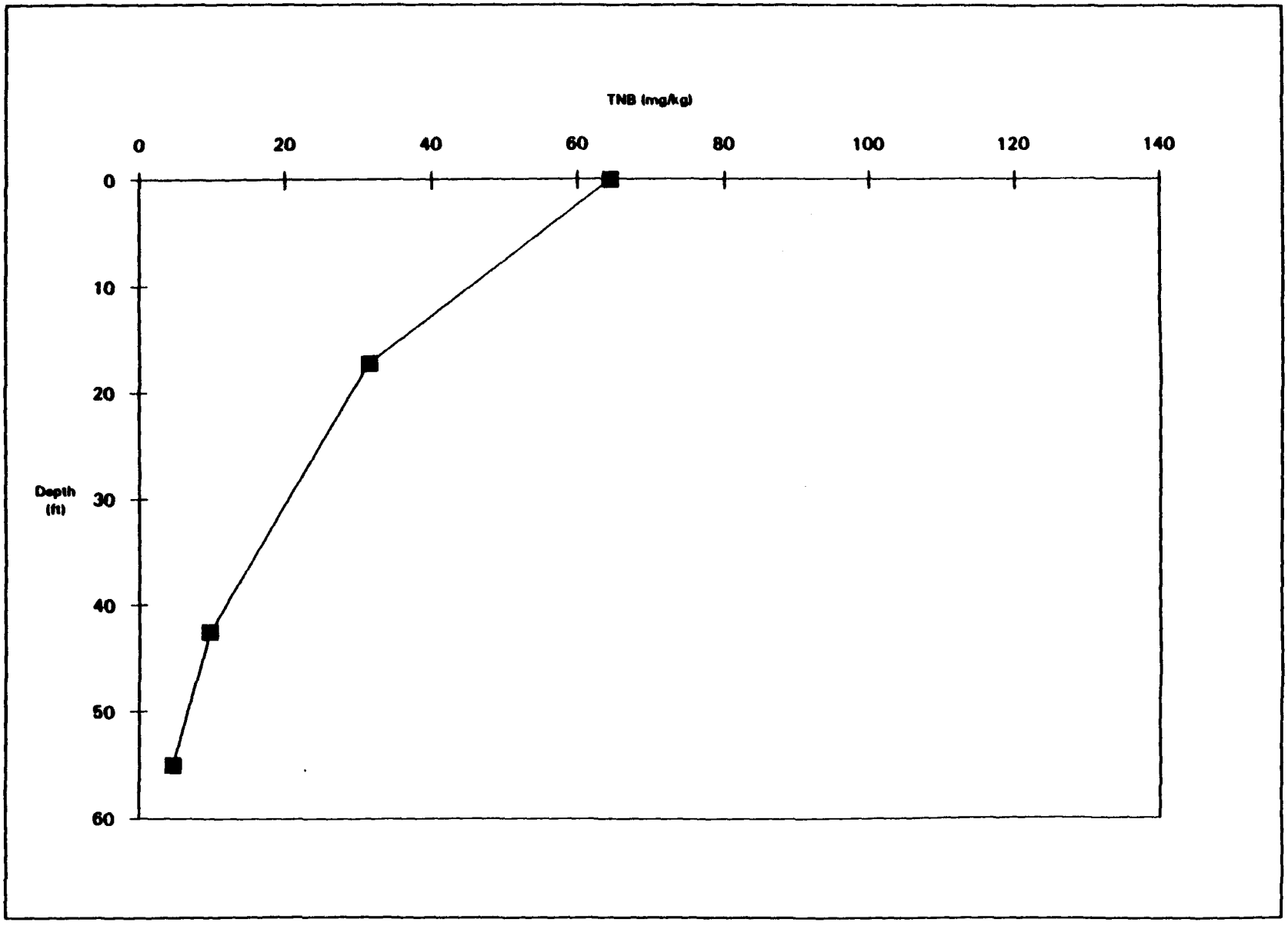
Simulation runs were conducted to simulate the migration of 1,3,5-TNB in the vadose zone from the year 1990 to the year 2000. Figures 6-22 through 6-26 present the 1,3,5-TNB concentration profile in 1990. The solid line represents the simulated concentration distribution. The dotted lines are concentration profiles plotted from soil boring analytical data collected in 1990. The lower dotted line represents the minimum concentration from each sample interval, while the higher dotted line represents the maximum concentration from each sample interval. The simulated concentration profile was in the middle of the two measured concentration profiles. Thus the SESOIL model simulation showed reasonable agreement with field data. Table 6-19 presents soil boring data values. Soil borings were collected at eight sample locations within the TNT Leaching Beds Subsite. At each sample location, the soil samples were taken at 5-foot depth intervals to a total depth of 50 feet.



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SIMULATED 1,3,5 TNB CONCENTRATION PROFILE IN 1990

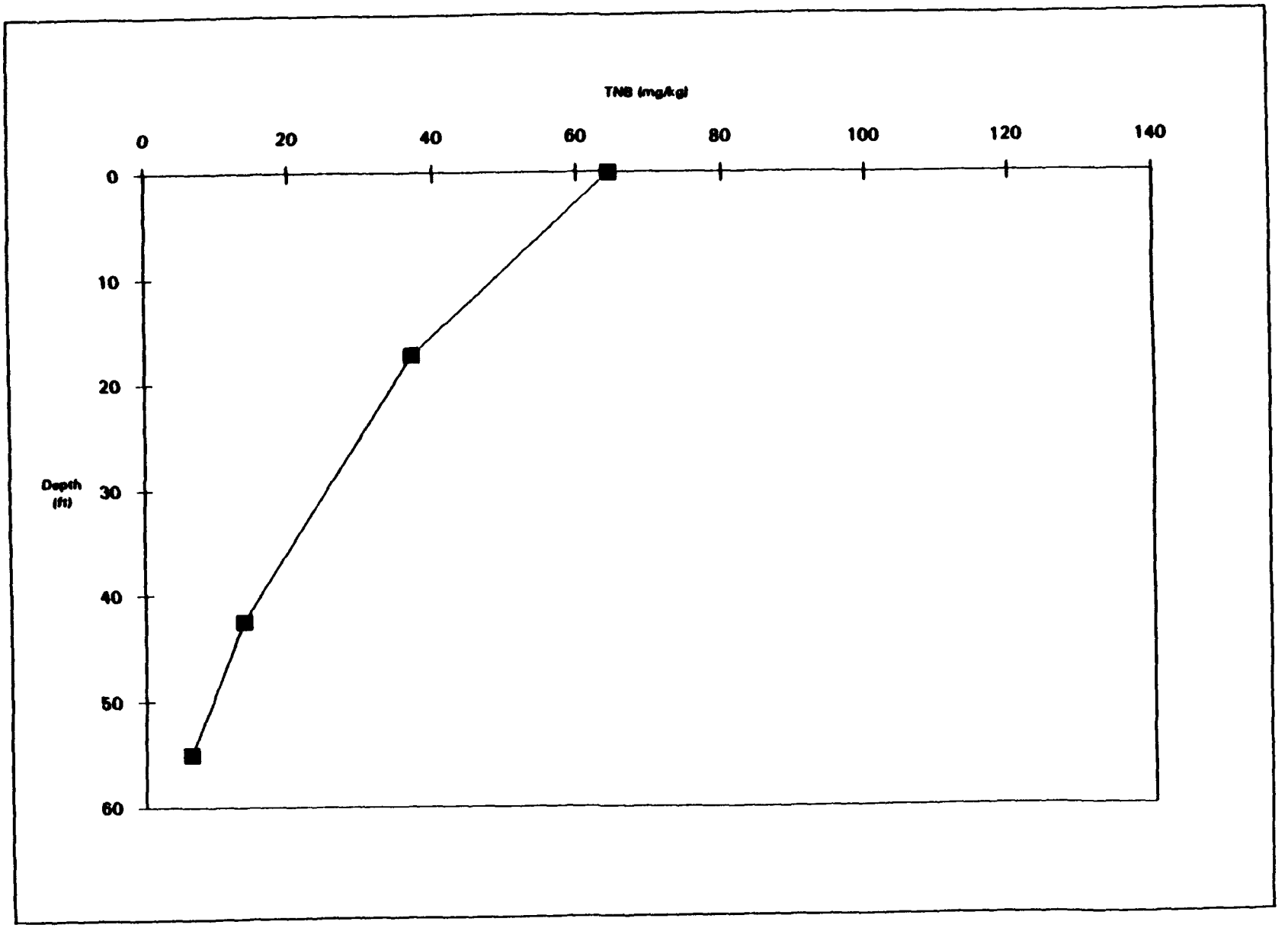
FIGURE 6-22



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SIMULATED 1, 3, 5 TNB CONCENTRATION PROFILE IN 1995

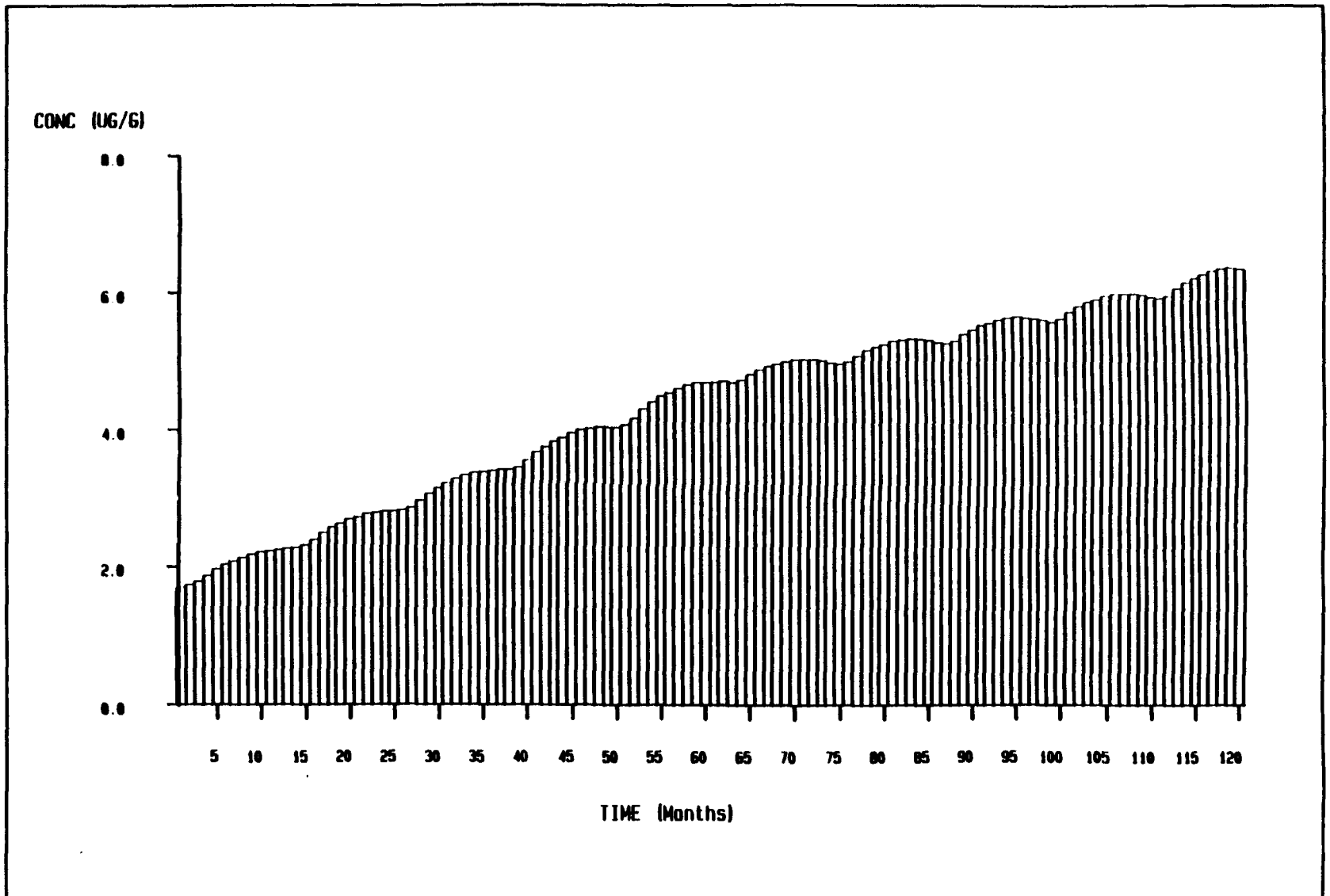
FIGURE 6-23



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SIMULATED 1, 3, 5 TNB CONCENTRATION PROFILE IN 2000

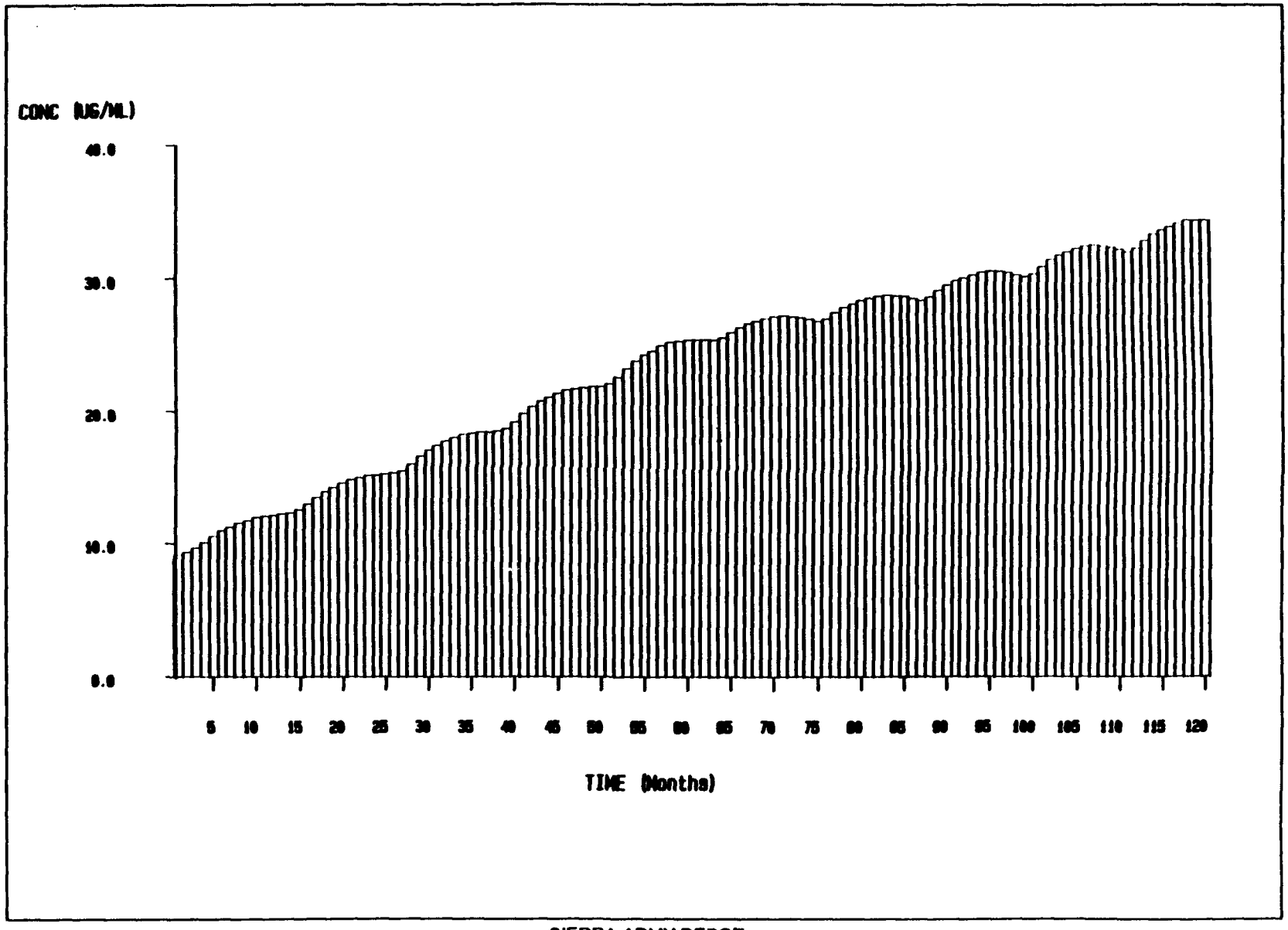
FIGURE 6-24



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SIMULATED 1, 3, 5 TNB CONCENTRATION (ABSORBED) AT 55 FEET BELOW GROUND SURFACE FROM YEAR 1990 THRU 2000

FIGURE 6-25



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SIMULATED 1, 3, 5 TNB CONCENTRATION (DISSOLVED) AT 55 FEET BELOW GROUND SURFACE FROM YEAR 1990 THRU 2000

FIGURE 6-26

Figures 6-23 and 6-24 present the simulated concentration profiles in the year 1995 and 2000, respectively. A comparison between Figures 6-22, 6-23, and 6-24 show that 1,3,5-TNB is migrating downward in the vadose zone. Results show that at 55 feet below ground surface the concentration of 1,3,5-TNB increases from 3 μg/g to 6 μg/g after 10 years.

Figure 6-25 is a plot of adsorbed 1,3,5-TNB concentration versus time at 55 feet below ground surface. Figure 6-26 is a plot of dissolved 1,3,5-TNB concentration versus time at 55 feet below ground surface. Both plots are from the SESOIL model simulation. These figures show the trend of increasing TNB concentration versus time. Figure 6-26 provides data to simulate mass loading for the groundwater contamination transport model study.

As mentioned above, 1,3,5-TNB is a stable chemical and the half-life period used in this study was selected as 10 years. A sensitivity run was conducted to examine the effect of 1,3,5-TNB half-life period. In the sensitivity run, 1,3,5-TNB half-life period was selected as 50 years. Test results of the sensitivity run are summarized in Table 6-20.

Table 6-20 suggests that the model is not sensitive to the half-life periods between 10 years and 50 years.

6.2.5.3.2 Vehicle Maintenance Area Subsite

Five soil borings were drilled and sampled at 5-foot depth intervals to the water table at the Vehicle Maintenance Area Subsite (Figure 6-22 and 6-23). Twenty-five samples were analyzed for VOCs. Fifty-three samples collected from the five borings were analyzed for inorganics (priority pollutant metals) and explosives. Analytical results are presented in Table 6-18.

VOCs

Although a well defined area of soil gas contamination (Section 6.2.5.1) was found at the Vehicle Maintenance Area Subsite, no significant VOC contamination was found in soil

TABLE 6-19

CONCENTRATION OF 1,3,5 TRINITROBENZENE IN SOIL BORING AT THE TNT LEACHING BEDS AREA SUBSITE (ppm)

Sample Depth (ft)	12-SB	13-SB	14-SB	15-SB	16-SB	17-SB	18-SB	19-SB
0	111.0	124.0	47.7	93.3	42.6	22.6	10.9	1.4
5	18.4	28.9	22.2	28.7	19.3	16.9	22.2	16.3
10	39.0	25.0	16.6	20.7	33.9	21.6	21.0	26.5
15	48.9	30.2	3.8	19.2	42.1	14.8	27.6	9.8
20	14.8	22.4	7.2	7.9	12.4	6.6	4.4	4.5
25	11.7	35.2	5.9	15.6	7.2	9.9	7.3	4.6
30	7.8	6.9	5.3	6.2	4.9	4.9	5.7	2.7
35	7.9	3.8	9.3	7.3	10.1	12.2	11.0	10.5
40	1.1	10.7	3.7	14.6	8.5	17.5	6.8	11.3
45	1.3	3.3	9.9	9.3	--	2.2	1.9	--
50	2.4	6.6	10.5	1.4	--	13.0	0.7	--

TABLE 6-20

SIMULATED CONCENTRATION OF 1,3,5 TNB IN VADOSE ZONE FROM 1990 TO 2000

Depth	1990	1995	2000
17.2	19 (19.2)	31.5 (37.1)	37.1 (48.2)
42.5	6.4 (6.4)	9.7 (12.4)	13.6 (20.4)
55.0	1.7 (1.7)	4.6 (6.1)	6.4 (10.4)

19 - half-life period equals 10 years
(19.2) - half-life period equals 50 years

borings at this subsite. Only one VOC, toluene, was detected at 0.001 μg/g in the 35-foot sample from Boring TNT-10-SB.

Inorganics

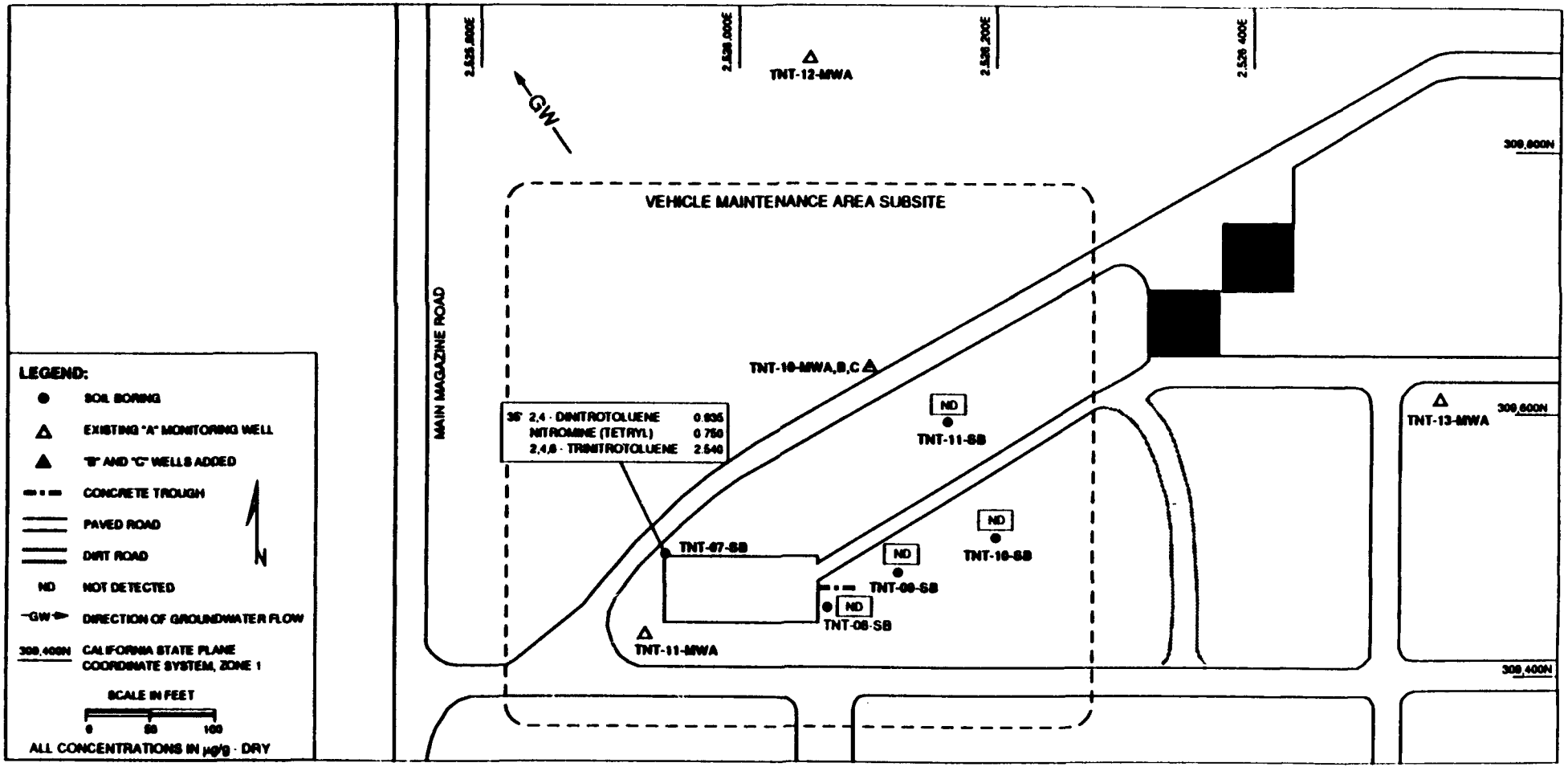
All detected inorganic constituents are considered to represent native soil conditions.

Explosives

Explosives were only detected in the 35-foot interval of boring, TNT-07-SB. 2,4-DNT (0.935 μg/g), nitramine (tetryl) (0.750 μg/g), and 2,4,6-TNT (2.540 μg/g) were detected (Figure 6-27). The presence of these compounds at this depth may represent an isolated discharge of water containing TNT compounds to the ground surface near the Vehicle Maintenance Area concrete pad. The TNT compounds apparently migrated vertically to approximately 35 feet below grade where they were adsorbed onto a low permeability silt and clay layer.

6.2.5.4 Groundwater

Groundwater from 24 monitoring wells at the TNT Leaching Beds Site was sampled and analyzed during successive months for extractable organic compounds (pesticides/PCBs and BNAs), VOCs, and inorganics (priority pollutant metals). Sixteen of the 24 wells are water table monitoring wells. Four 3-well nests are near TNT-01-MWA, TNT-02-MWA, TNT-07-MWA, and TNT-10-MWA. Each consists of an "A" zone water table well, and "B" zone well screened from 90 to 100 feet below ground surface, and a "C" zone well screened from 130 to 140 feet below grade. Both Rounds 1 and 2 are presented in Tables 6-21 and 6-22. It should be noted that high salinity in the upper portions of the aquifer occur at this site and is considered to be naturally occurring. This high salinity may preclude the "A" zone from being used as a potable water source.



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EXPLOSIVE COMPOUND CONCENTRATIONS FROM SOIL BORINGS: VEHICLE MAINTENANCE AREA SUBSITE

FIGURE 6-27

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POSITIVE GROUNDWATER RESULTS - ROUND 1 - TNT LEACHING BEDS AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
TNT-01-MWA	55.4	20-apr-1990	99	Total dissolved solids	864000.000	ug/l
		20-apr-1990	99	Total dissolved solids	856000.000	ug/l
		20-apr-1990	SD20	Lead	2.060	ug/l
		20-apr-1990	SD22	Arsenic	17.000	ug/l
		20-apr-1990	SD22	Arsenic	18.200	ug/l
		20-apr-1990	SS10	Barium	19.200	ug/l
		20-apr-1990	SS10	Barium	21.500	ug/l
		20-apr-1990	SS10	Calcium	16600.000	ug/l
		20-apr-1990	SS10	Calcium	17100.000	ug/l
		20-apr-1990	SS10	Sodium	190000.000	ug/l
		20-apr-1990	SS10	Sodium	230000.000	ug/l
		20-apr-1990	TT10	Chloride	47000.000	ug/l
		20-apr-1990	TT10	Chloride	53000.000	ug/l
		20-apr-1990	TT10	Sulfate	190000.000	ug/l
		20-apr-1990	TT10	Sulfate	200000.000	ug/l
		20-apr-1990	UM18	2,4-Dinitrotoluene	78.600	ug/l
		20-apr-1990	UM18	2,4-Dinitrotoluene	88.100	ug/l
		20-apr-1990	UM18	Unknown 587 (TIC)	4.000	ug/l
		20-apr-1990	UM18	Unknown 587 (TIC)	5.000	ug/l
		20-apr-1990	UM18	Unknown 594 (TIC)	400.000	ug/l
		20-apr-1990	UM18	Unknown 595 (TIC)	400.000	ug/l
		20-apr-1990	UM20	Trichloroethene	26.700	ug/l
		20-apr-1990	UM20	Trichloroethene	24.800	ug/l
		20-apr-1990	UW14	1,3,5-Trinitrobenzene	950.000	ug/l
		20-apr-1990	UW14	1,3,5-Trinitrobenzene	1100.000	ug/l
		20-apr-1990	UW14	2,4,6-Trinitrotoluene	1.050	ug/l
		20-apr-1990	UW14	2,4-Dinitrotoluene	66.000	ug/l
		20-apr-1990	UW14	2,4-Dinitrotoluene	90.000	ug/l
		20-apr-1990	UW14	Cyclotetramethylenetetranitramine (HMX)	3.700	ug/l
		20-apr-1990	UW14	Cyclotetramethylenetetranitramine (HMX)	1.950	ug/l
		20-apr-1990	UW14	Cyclonite (RDX)	90.000	ug/l
		20-apr-1990	UW14	Cyclonite (RDX)	99.000	ug/l
		20-apr-1990	UW14	Nitramine (Tetryl)	9.920	ug/l
		20-apr-1990	UW14	Nitramine (Tetryl)	9.680	ug/l
TNT-01-MWB	56.0	20-apr-1990	99	Total dissolved solids	878000.000	ug/l
		20-apr-1990	SD22	Arsenic	7.250	ug/l
		20-apr-1990	SS10	Barium	22.000	ug/l
		20-apr-1990	SS10	Calcium	69000.000	ug/l
		20-apr-1990	SS10	Sodium	180000.000	ug/l
		20-apr-1990	SS10	Zinc	26.900	ug/l
		20-apr-1990	TT10	Chloride	120000.000	ug/l
		20-apr-1990	TT10	Sulfate	260000.000	ug/l
		20-apr-1990	UM18	Bis (2-ethylhexyl) phthalate	4.820	ug/l
		20-apr-1990	UM18	Unknown 537 (TIC)	3.000	ug/l
		20-apr-1990	UM18	Unknown 557 (TIC)	7.000	ug/l
		20-apr-1990	UM18	Unknown 559 (TIC)	6.000	ug/l
		20-apr-1990	UM18	Unknown 563 (TIC)	3.000	ug/l
		20-apr-1990	UM18	Unknown 572 (TIC)	2.000	ug/l

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

POSITIVE GROUNDWATER RESULTS - ROUND 1 - TNT LEACHING BEDS AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
TNT-01-MWC	55.9	20-apr-1990	99	Total dissolved solids	806000.000	ug/l
		20-apr-1990	SD22	Arsenic	6.930	ug/l
		20-apr-1990	SS10	Barium	34.900	ug/l
		20-apr-1990	SS10	Calcium	70000.000	ug/l
		20-apr-1990	SS10	Sodium	140000.000	ug/l
		20-apr-1990	SS10	Zinc	109.000	ug/l
		20-apr-1990	TT10	Chloride	90000.000	ug/l
		20-apr-1990	TT10	Sulfate	250000.000	ug/l
		20-apr-1990	UM18	Unknown 537 (TIC)	3.000	ug/l
		20-apr-1990	UM18	Unknown 557 (TIC)	5.000	ug/l
		20-apr-1990	UM18	Unknown 559 (TIC)	4.000	ug/l
		20-apr-1990	UM18	Unknown 563 (TIC)	4.000	ug/l
		20-apr-1990	UW14	1,3,5-Trinitrobenzene	0.793	ug/l
TNT-02-MWA	54.3	21-apr-1990	99	Total dissolved solids	1280000.000	ug/l
		21-apr-1990	SD21	Selenium	4.050	ug/l
		21-apr-1990	SD22	Arsenic	6.500	ug/l
		21-apr-1990	SS10	Barium	31.600	ug/l
		21-apr-1990	SS10	Calcium	49000.000	ug/l
		21-apr-1990	SS10	Sodium	270000.000	ug/l
		21-apr-1990	TT10	Chloride	160000.000	ug/l
		21-apr-1990	TT10	Sulfate	260000.000	ug/l
		21-apr-1990	UM18	2-Cyclohexen-1-one (TIC)	1.000	ug/l
		21-apr-1990	UM18	Unknown 517 (TIC)	5.000	ug/l
		21-apr-1990	UM18	Unknown 533 (TIC)	1.000	ug/l
		21-apr-1990	UM18	Unknown 554 (TIC)	1.000	ug/l
		21-apr-1990	UM18	Unknown 563 (TIC)	0.800	ug/l
		21-apr-1990	UM18	Unknown 565 (TIC)	0.800	ug/l
		21-apr-1990	UM18	Unknown 583 (TIC)	0.700	ug/l
		21-apr-1990	UM18	Unknown 585 (TIC)	2.000	ug/l
		21-apr-1990	UM18	Unknown 587 (TIC)	2.000	ug/l
		21-apr-1990	UM18	Unknown 595 (TIC)	80.000	ug/l
		21-apr-1990	UM18	Unknown 604 (TIC)	1.000	ug/l
		21-apr-1990	UM18	Unknown 607 (TIC)	1.000	ug/l
		21-apr-1990	UM20	Trichloroethene	3.520	ug/l
		21-apr-1990	UW14	1,3,5-Trinitrobenzene	230.000	ug/l
		21-apr-1990	UW14	2,4,6-Trinitrotoluene	7.860	ug/l
		21-apr-1990	UW14	2,4-Dinitrotoluene	6.920	ug/l
		21-apr-1990	UW14	Cyclotetramethylenetetranitramine (HMX)	3.760	ug/l
		21-apr-1990	UW14	Cyclonite (RDX)	250.000	ug/l
TNT-02-MWB	54.6	21-apr-1990	99	Total dissolved solids	976000.000	ug/l
		21-apr-1990	SD22	Arsenic	6.930	ug/l
		21-apr-1990	SS10	Barium	20.600	ug/l
		21-apr-1990	SS10	Calcium	57000.000	ug/l
		21-apr-1990	SS10	Sodium	180000.000	ug/l
		21-apr-1990	SS10	Zinc	46.600	ug/l
		21-apr-1990	TT10	Chloride	140000.000	ug/l
		21-apr-1990	TT10	Sulfate	250000.000	ug/l
		21-apr-1990	UM18	Unknown 546 (TIC)	1.000	ug/l

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

POSITIVE GROUNDWATER RESULTS - ROUND 1 - TNT LEACHING BEDS AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
TNT-02-MWC	53.9	21-apr-1990	99	Total dissolved solids	738000.000	ug/l
		21-apr-1990	SD22	Arsenic	5.650	ug/l
		21-apr-1990	SS10	Barium	7.130	ug/l
		21-apr-1990	SS10	Calcium	14600.000	ug/l
		21-apr-1990	SS10	Chromium	11.800	ug/l
		21-apr-1990	SS10	Sodium	160000.000	ug/l
		21-apr-1990	TT10	Chloride	77000.000	ug/l
		21-apr-1990	TT10	Sulfate	240000.000	ug/l
	54.0	21-apr-1990	UM18	Unknown 557 (TIC)	1.000	ug/l
		21-apr-1990	UM18	Unknown 619 (TIC)	10.000	ug/l
		21-apr-1990	UM20	Methylene chloride	8.490	ug/l
TNT-03-MWA	52.7	01-may-1990	99	Total dissolved solids	956000.000	ug/l
		01-may-1990	SD22	Arsenic	10.300	ug/l
		01-may-1990	SS10	Barium	46.400	ug/l
		01-may-1990	SS10	Calcium	40000.000	ug/l
		01-may-1990	SS10	Sodium	220000.000	ug/l
		01-may-1990	TT10	Chloride	44000.000	ug/l
		01-may-1990	TT10	Sulfate	107000.000	ug/l
		01-may-1990	UM18	2,4-Dinitrophenol	17.500	ug/l
		01-may-1990	UM18	2,4-Dinitrotoluene	13.600	ug/l
		C1-may-1990	UM18	Unknown 517 (TIC)	5.000	ug/l
		01-may-1990	UM18	Unknown 555 (TIC)	2.000	ug/l
		01-may-1990	UM18	Unknown 557 (TIC)	1.000	ug/l
		01-may-1990	UM18	Unknown 569 (TIC)	3.000	ug/l
		01-may-1990	UM18	Unknown 574 (TIC)	1.000	ug/l
		01-may-1990	UM18	Unknown 607 (TIC)	10.000	ug/l
		01-may-1990	UW14	1,3,5-Trinitrobenzene	9.960	ug/l
		01-may-1990	UW14	2,4,6-Trinitrotoluene	2.940	ug/l
		01-may-1990	UW14	2,4-Dinitrotoluene	12.600	ug/l
		01-may-1990	UW14	Cyclotetramethylenetetranitramine (HMX)	7.690	ug/l
		01-may-1990	UW14	Cyclonite (RDX)	220.000	ug/l
TNT-04-MWA	53.7	01-may-1990	99	Total dissolved solids	996000.000	ug/l
		01-may-1990	SD21	Selenium	4.370	ug/l
		01-may-1990	SD22	Arsenic	8.100	ug/l
		01-may-1990	SS10	Barium	40.400	ug/l
		01-may-1990	SS10	Calcium	43000.000	ug/l
		01-may-1990	SS10	Sodium	200000.000	ug/l
		01-may-1990	TT10	Chloride	200000.000	ug/l
		01-may-1990	TT10	Sulfate	260000.000	ug/l
		01-may-1990	UM18	2,4-Dinitrotoluene	6.810	ug/l
		01-may-1990	UM18	Unknown 533 (TIC)	2.000	ug/l
		01-may-1990	UW14	1,3,5-Trinitrobenzene	2.990	ug/l
		01-may-1990	UW14	2,4,6-Trinitrotoluene	1.240	ug/l
		01-may-1990	UW14	2,4-Dinitrotoluene	8.140	ug/l
TNT-05-MWA	58.5	02-may-1990	99	Total dissolved solids	786000.000	ug/l
		02-may-1990	SD21	Selenium	4.150	ug/l
		02-may-1990	SD22	Arsenic	17.100	ug/l

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POSITIVE GROUNDWATER RESULTS - ROUND 1 - TNT LEACHING BEDS AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
TNT-05-MWA	58.5	02-may-1990	SS10	Barium	33.200	ug/l
		02-may-1990	SS10	Calcium	39000.000	ug/l
		02-may-1990	SS10	Sodium	150000.000	ug/l
		02-may-1990	TT10	Chloride	71000.000	ug/l
		02-may-1990	TT10	Sulfate	115000.000	ug/l
		02-may-1990	UM18	2-Cyclohexen-1-one (TIC)	1.000	ug/l
		02-may-1990	UM18	Bis (2-ethylhexyl) phthalate	7.820	ug/l
		02-may-1990	UM18	Unknown 556 (TIC)	1.000	ug/l
		02-may-1990	UW14	1,3,5-Trinitrobenzene	5.280	ug/l
TNT-06-MWA	54.6	02-may-1990	99	Total dissolved solids	1570000.000	ug/l
		02-may-1990	SD21	Selenium	8.840	ug/l
		02-may-1990	SD22	Arsenic	9.700	ug/l
		02-may-1990	SS10	Barium	46.400	ug/l
		02-may-1990	SS10	Calcium	66000.000	ug/l
		02-may-1990	SS10	Sodium	390000.000	ug/l
		02-may-1990	TT10	Chloride	240000.000	ug/l
		02-may-1990	TT10	Sulfate	440000.000	ug/l
		02-may-1990	UM18	Unknown 517 (TIC)	1.000	ug/l
		02-may-1990	UM18	Unknown 556 (TIC)	1.000	ug/l
		02-may-1990	UM18	Unknown 634 (TIC)	5.000	ug/l
		02-may-1990	UW14	1,3,5-Trinitrobenzene	1.650	ug/l
TNT-07-MWA	56.1	18-apr-1990	99	Total dissolved solids	978000.000	ug/l
		18-apr-1990	SD22	Arsenic	15.400	ug/l
		18-apr-1990	SS10	Barium	14.300	ug/l
		18-apr-1990	SS10	Calcium	15600.000	ug/l
		18-apr-1990	SS10	Chromium	6.890	ug/l
		18-apr-1990	SS10	Sodium	220000.000	ug/l
		18-apr-1990	SS10	Zinc	68.000	ug/l
		18-apr-1990	TT10	Chloride	99000.000	ug/l
		18-apr-1990	TT10	Sulfate	181000.000	ug/l
		18-apr-1990	UM20	Trichloroethene	2.290	ug/l
		18-apr-1990	UW14	1,3,5-Trinitrobenzene	5.590	ug/l
		18-apr-1990	UW14	2,4-Dinitrotoluene	2.040	ug/l
		18-apr-1990	UW14	Nitramine (Tetryl)	2.790	ug/l
TNT-07-MWB	56.0	18-apr-1990	99	Total dissolved solids	1160000.000	ug/l
		18-apr-1990	SD22	Arsenic	8.960	ug/l
		18-apr-1990	SS10	Barium	22.400	ug/l
		18-apr-1990	SS10	Calcium	44000.000	ug/l
		18-apr-1990	SS10	Copper	9.560	ug/l
		18-apr-1990	SS10	Sodium	210000.000	ug/l
		18-apr-1990	SS10	Zinc	77.100	ug/l
		18-apr-1990	TT10	Chloride	150000.000	ug/l
		18-apr-1990	TT10	Sulfate	260000.000	ug/l
TNT-07-MWC		18-apr-1990	99	Total dissolved solids	812000.000	ug/l
		18-apr-1990	SD22	Arsenic	8.530	ug/l
		18-apr-1990	SS10	Barium	27.500	ug/l
		18-apr-1990	SS10	Calcium	57000.000	ug/l
		18-apr-1990	SS10	Sodium	150000.000	ug/l

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POSITIVE GROUNDWATER RESULTS - ROUND 1 - TNT LEACHING BEDS AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
TNT-07-MWC	56.0	18-apr-1990	SS10	Zinc	32.700	ug/l
		18-apr-1990	TT10	Chloride	99000.000	ug/l
		18-apr-1990	TT10	Sulfate	260000.000	ug/l
		18-apr-1990	UM18	Unknown 557 (TIC)	3.000	ug/l
		18-apr-1990	UM18	Unknown 559 (TIC)	2.000	ug/l
		18-apr-1990	UM18	Unknown 563 (TIC)	2.000	ug/l
TNT-08-MWA	55.3	03-may-1990	99	Total dissolved solids	792000.000	ug/l
		03-may-1990	SD20	Lead	5.210	ug/l
		03-may-1990	SD22	Arsenic	13.300	ug/l
		03-may-1990	SS10	Barium	27.100	ug/l
		03-may-1990	SS10	Calcium	18000.000	ug/l
		03-may-1990	SS10	Sodium	200000.000	ug/l
		03-may-1990	TT10	Chloride	48000.000	ug/l
		03-may-1990	TT10	Sulfate	240000.000	ug/l
		03-may-1990	UM18	Unknown 533 (TIC)	2.000	ug/l
		03-may-1990	UM18	Unknown 556 (TIC)	2.000	ug/l
		03-may-1990	UM20	Trichloroethene	7.430	ug/l
		03-may-1990	UW14	1,3,5-Trinitrobenzene	0.892	ug/l
		03-may-1990	UW14	Nitramine (Tetryl)	1.560	ug/l
TNT-09-MWA	55.0	03-may-1990	99	Total dissolved solids	752000.000	ug/l
		03-may-1990	SD20	Lead	2.930	ug/l
		03-may-1990	SD22	Arsenic	8.960	ug/l
		03-may-1990	SS10	Barium	52.200	ug/l
		03-may-1990	SS10	Calcium	66000.000	ug/l
		03-may-1990	SS10	Sodium	120000.000	ug/l
		03-may-1990	TT10	Chloride	43000.000	ug/l
		03-may-1990	TT10	Sulfate	280000.000	ug/l
		03-may-1990	UM18	Unknown 556 (TIC)	6.000	ug/l
		03-may-1990	UM20	Trichloroethene	0.924	ug/l
		03-may-1990	UW14	1,3,5-Trinitrobenzene	1.470	ug/l
TNT-10-MWA	56.0	30-apr-1990	99	Total dissolved solids	1050000.000	ug/l
		30-apr-1990	99	Total dissolved solids	994000.000	ug/l
		30-apr-1990	SB01	Mercury	0.255	ug/l
		30-apr-1990	SD20	Lead	2.490	ug/l
		30-apr-1990	SD22	Arsenic	12.000	ug/l
		30-apr-1990	SD22	Arsenic	11.500	ug/l
		30-apr-1990	SS10	Barium	47.100	ug/l
		30-apr-1990	SS10	Barium	46.700	ug/l
		30-apr-1990	SS10	Calcium	59000.000	ug/l
		30-apr-1990	SS10	Calcium	61000.000	ug/l
		30-apr-1990	SS10	Chromium	227.000	ug/l
		30-apr-1990	SS10	Chromium	225.000	ug/l
		30-apr-1990	SS10	Sodium	260000.000	ug/l
		30-apr-1990	SS10	Sodium	270000.000	ug/l
		30-apr-1990	TT10	Chloride	88000.000	ug/l
		30-apr-1990	TT10	Chloride	86000.000	ug/l
		30-apr-1990	TT10	Sulfate	190000.000	ug/l
		30-apr-1990	TT10	Sulfate	189000.000	ug/l
		30-apr-1990	UM18	Unknown 532 (TIC)	2.000	ug/l

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POSITIVE GROUNDWATER RESULTS - ROUND 1 - TNT LEACHING BEDS AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
TNT-10-MWA	56.0	30-apr-1990	UM18	Unknown 532 (TIC)	2.000	ug/l
		30-apr-1990	UM18	Unknown 537 (TIC)	5.000	ug/l
		30-apr-1990	UM18	Unknown 537 (TIC)	4.000	ug/l
		30-apr-1990	UM18	Unknown 587 (TIC)	1.000	ug/l
		30-apr-1990	UM20	1,2-Dichloroethane	101.000	ug/l
		30-apr-1990	UM20	1,2-Dichloroethane	101.000	ug/l
		30-apr-1990	UM20	Carbon tetrachloride	190.000	ug/l
		30-apr-1990	UM20	Carbon tetrachloride	190.000	ug/l
		30-apr-1990	UM20	Chloroform	923.000	ug/l
		30-apr-1990	UM20	Chloroform	513.000	ug/l
		30-apr-1990	UM20	Toluene	2.450	ug/l
		30-apr-1990	UM20	Trichloroethene	952.000	ug/l
		30-apr-1990	UM20	Trichloroethene	952.000	ug/l
TNT-10-MWB	56.8	30-apr-1990	99	Total dissolved solids	802000.000	ug/l
		30-apr-1990	SD22	Arsenic	11.400	ug/l
		30-apr-1990	SS10	Barium	23.900	ug/l
		30-apr-1990	SS10	Calcium	55000.000	ug/l
		30-apr-1990	SS10	Cadmium	12.900	ug/l
		30-apr-1990	SS10	Sodium	180000.000	ug/l
		30-apr-1990	SS10	Zinc	81.700	ug/l
		30-apr-1990	TT10	Chloride	130000.000	ug/l
		30-apr-1990	TT10	Sulfate	233000.000	ug/l
		30-apr-1990	UM18	Unknown 557 (TIC)	3.000	ug/l
		30-apr-1990	UM18	Unknown 559 (TIC)	2.000	ug/l
		30-apr-1990	UM18	Unknown 563 (TIC)	2.000	ug/l
		30-apr-1990	UM20	Chloroform	0.697	ug/l
		30-apr-1990	UM20	Trichloroethene	0.724	ug/l
TNT-10-MWC	55.9	30-apr-1990	99	Total dissolved solids	636000.000	ug/l
		30-apr-1990	SD22	Arsenic	12.400	ug/l
		30-apr-1990	SS10	Barium	33.600	ug/l
		30-apr-1990	SS10	Calcium	55000.000	ug/l
		30-apr-1990	SS10	Sodium	130000.000	ug/l
		30-apr-1990	TT10	Chloride	71000.000	ug/l
		30-apr-1990	TT10	Sulfate	212000.000	ug/l
		30-apr-1990	UM18	Unknown 557 (TIC)	3.000	ug/l
		30-apr-1990	UM18	Unknown 559 (TIC)	2.000	ug/l
		30-apr-1990	UM18	Unknown 563 (TIC)	1.000	ug/l
		30-apr-1990	UM20	Chloroform	1.230	ug/l
		30-apr-1990	UM20	Trichloroethene	2.000	ug/l
TNT-11-MWA	59.2	03-may-1990	99	Total dissolved solids	2180000.000	ug/l
		03-may-1990	SD20	Lead	1.520	ug/l
		03-may-1990	SD21	Selenium	9.160	ug/l
		03-may-1990	SD22	Arsenic	15.200	ug/l
		03-may-1990	SS10	Barium	17.300	ug/l
		03-may-1990	SS10	Calcium	130000.000	ug/l
		03-may-1990	SS10	Sodium	470000.000	ug/l
		03-may-1990	TT10	Chloride	190000.000	ug/l
		03-may-1990	TT10	Sulfate	790000.000	ug/l
		03-may-1990	UM18	Unknown 556 (TIC)	3.000	ug/l

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POSITIVE GROUNDWATER RESULTS - ROUND 1 - TNT LEACHING BEDS AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
TNT-11-MWA	59.2	03-may-1990	UM20	1,2-Dichloroethane	0.824	ug/l
		03-may-1990	UM20	Carbon tetrachloride	11.400	ug/l
		03-may-1990	UM20	Chloroform	21.500	ug/l
		03-may-1990	UM20	Trichloroethene	114.000	ug/l
TNT-12-MWA	50.3	25-apr-1990	99	Total dissolved solids	1180000.000	ug/l
		25-apr-1990	SD20	Lead	2.280	ug/l
		25-apr-1990	SD21	Selenium	3.410	ug/l
		25-apr-1990	SD22	Arsenic	28.400	ug/l
		25-apr-1990	SS10	Barium	24.600	ug/l
		25-apr-1990	SS10	Calcium	42000.000	ug/l
		25-apr-1990	SS10	Sodium	290000.000	ug/l
		25-apr-1990	TT10	Chloride	77000.000	ug/l
		25-apr-1990	TT10	Sulfate	380000.000	ug/l
		25-apr-1990	UM18	Bis (2-ethylhexyl) phthalate	7.180	ug/l
		25-apr-1990	UM18	Unknown 546 (TIC)	1.000	ug/l
		25-apr-1990	UM20	Trichloroethene	1.050	ug/l
TNT-13-MWA	52.2	01-may-1990	99	Total dissolved solids	892000.000	ug/l
		01-may-1990	SD22	Arsenic	13.600	ug/l
		01-may-1990	SS10	Barium	44.400	ug/l
		01-may-1990	SS10	Calcium	34000.000	ug/l
		01-may-1990	SS10	Sodium	220000.000	ug/l
		01-may-1990	TT10	Chloride	55000.000	ug/l
		01-may-1990	TT10	Sulfate	230000.000	ug/l
		01-may-1990	UM20	Trichloroethene	8.570	ug/l
TNT-14-MWA	49.5	24-apr-1990	99	Total dissolved solids	1030000.000	ug/l
		24-apr-1990	SB01	Mercury	0.402	ug/l
		24-apr-1990	SD21	Selenium	46.600	ug/l
		24-apr-1990	SD22	Arsenic	31.400	ug/l
		24-apr-1990	SS10	Barium	44.200	ug/l
		24-apr-1990	SS10	Calcium	28000.000	ug/l
		24-apr-1990	SS10	Sodium	290000.000	ug/l
		24-apr-1990	TT10	Chloride	66000.000	ug/l
		24-apr-1990	TT10	Sulfate	132000.000	ug/l
		24-apr-1990	UM18	Unknown 546 (TIC)	1.000	ug/l
		24-apr-1990	UM18	Unknown 557 (TIC)	2.000	ug/l
		24-apr-1990	UW14	1,3,5-Trinitrobenzene	11.900	ug/l
TNT-15-MWA	52.0	02-may-1990	99	Total dissolved solids	1310000.000	ug/l
		02-may-1990	SD21	Selenium	7.450	ug/l
		02-may-1990	SD22	Arsenic	8.850	ug/l
		02-may-1990	SS10	Barium	36.300	ug/l
		02-may-1990	SS10	Calcium	60000.000	ug/l
		02-may-1990	SS10	Sodium	35000.000	ug/l
		02-may-1990	TT10	Chloride	290000.000	ug/l
		02-may-1990	TT10	Sulfate	400000.000	ug/l
		02-may-1990	UW14	Nitramine (Tetryl)	1.120	ug/l
TNT-16-MWA	56.7	02-may-1990	99	Total dissolved solids	658000.000	ug/l
		02-may-1990	SD20	Lead	2.060	ug/l

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POSITIVE GROUNDWATER RESULTS - ROUND 1 - TNT LEACHING BEDS AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
TNT-16-MWA	56.7	02-may-1990	SD22	Arsenic	7.360	ug/l
		02-may-1990	SS10	Barium	26.400	ug/l
		02-may-1990	SS10	Calcium	51000.000	ug/l
		02-may-1990	SS10	Sodium	140000.000	ug/l
		02-may-1990	TT10	Chloride	66000.000	ug/l
		02-may-1990	TT10	Sulfate	220000.000	ug/l
		02-may-1990	UN18	Unknown 598 (TIC)	1.000	ug/l

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POSITIVE GROUNDWATER RESULTS - ROUND 2 - TNT LEACHING BEDS AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
TNT-01-MWA	55.4	08-jun-1990	99	Total dissolved solids	830000.000	ug/l
		08-jun-1990	99	Total dissolved solids	840000.000	ug/l
		08-jun-1990	SD20	Lead	7.480	ug/l
		08-jun-1990	SD20	Lead	10.200	ug/l
		08-jun-1990	SD22	Arsenic	15.000	ug/l
		08-jun-1990	SD22	Arsenic	12.900	ug/l
		08-jun-1990	SS10	Barium	26.000	ug/l
		08-jun-1990	SS10	Barium	23.000	ug/l
		08-jun-1990	SS10	Calcium	14800.000	ug/l
		08-jun-1990	SS10	Calcium	15300.000	ug/l
		08-jun-1990	SS10	Sodium	190000.000	ug/l
		08-jun-1990	SS10	Sodium	210000.000	ug/l
		08-jun-1990	TT10	Chloride	40000.000	ug/l
		08-jun-1990	TT10	Chloride	41000.000	ug/l
		08-jun-1990	TT10	Sulfate	188000.000	ug/l
		08-jun-1990	TT10	Sulfate	185000.000	ug/l
		08-jun-1990	UM18	2,4-Dinitrotoluene	52.400	ug/l
		08-jun-1990	UM18	2,4-Dinitrotoluene	49.300	ug/l
		08-jun-1990	UM18	Unknown 595 (TIC)	200.000	ug/l
		08-jun-1990	UM20	Trichloroethene	29.500	ug/l
		08-jun-1990	UM20	Trichloroethene	30.500	ug/l
		08-jun-1990	UW14	1,3,5-Trinitrobenzene	640.000	ug/l
		08-jun-1990	UW14	1,3,5-Trinitrobenzene	1100.000	ug/l
		08-jun-1990	UW14	2,4,6-Trinitrotoluene	1.220	ug/l
		08-jun-1990	UW14	2,4-Dinitrotoluene	46.700	ug/l
		08-jun-1990	UW14	2,4-Dinitrotoluene	86.000	ug/l
		08-jun-1990	UW14	Cyclonite (RDX)	54.000	ug/l
		08-jun-1990	UW14	Cyclonite (RDX)	87.000	ug/l
TNT-01-MWB	56.0	05-jun-1990	99	Total dissolved solids	946000.000	ug/l
		05-jun-1990	SD20	Lead	1.630	ug/l
		05-jun-1990	SD22	Arsenic	5.440	ug/l
		05-jun-1990	SS10	Barium	21.900	ug/l
		05-jun-1990	SS10	Calcium	81000.000	ug/l
		05-jun-1990	SS10	Sodium	190000.000	ug/l
		05-jun-1990	SS10	Zinc	135.000	ug/l
		05-jun-1990	TT10	Chloride	130000.000	ug/l
		05-jun-1990	TT10	Sulfate	270000.000	ug/l
		05-jun-1990	UM18	2-(2-N-Butoxyethoxy) ethanol (TIC)	800.000	ug/l
		05-jun-1990	UM18	Unknown 558 (TIC)	4.000	ug/l
		05-jun-1990	UM18	Unknown 598 (TIC)	10.000	ug/l
TNT-01-MWC	55.9	05-jun-1990	99	Total dissolved solids	766000.000	ug/l
		05-jun-1990	SD20	Lead	3.360	ug/l
		05-jun-1990	SD22	Arsenic	6.180	ug/l
		05-jun-1990	SS10	Barium	30.600	ug/l
		05-jun-1990	SS10	Calcium	84000.000	ug/l
		05-jun-1990	SS10	Sodium	140000.000	ug/l
		05-jun-1990	SS10	Zinc	210.000	ug/l
		05-jun-1990	TT10	Chloride	82000.000	ug/l

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POSITIVE GROUNDWATER RESULTS - ROUND 2 - TNT LEACHING BEDS AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
TNT-01-MWC	55.9	05-jun-1990	TT10	Sulfate	220000.000	ug/l
		05-jun-1990	UM18	2-(2-N-Butoxyethoxy) ethanol (TIC)	4000.000	ug/l
		05-jun-1990	UM18	Bis (2-ethylhexyl) phthalate	6.450	ug/l
		05-jun-1990	UM18	Unknown 537 (TIC)	5.000	ug/l
		05-jun-1990	UM18	Unknown 559 (TIC)	20.000	ug/l
		05-jun-1990	UM18	Unknown 595 (TIC)	30.000	ug/l
		05-jun-1990	UM20	Chloroform	1.130	ug/l
		05-jun-1990	UM20	Trichloroethene	2.000	ug/l
		05-jun-1990	UW14	Cyclonite (RDX)	4.180	ug/l
TNT-02-MWA	54.3	04-jun-1990	99	Total dissolved solids	1280000.000	ug/l
		04-jun-1990	SD20	Lead	5.420	ug/l
		04-jun-1990	SD21	Selenium	3.910	ug/l
		04-jun-1990	SD22	Arsenic	7.360	ug/l
		04-jun-1990	SS10	Barium	38.800	ug/l
		04-jun-1990	SS10	Calcium	56000.000	ug/l
		04-jun-1990	SS10	Chromium	6.070	ug/l
		04-jun-1990	SS10	Sodium	270000.000	ug/l
		04-jun-1990	SS10	Zinc	23.800	ug/l
		04-jun-1990	TT10	Chloride	160000.000	ug/l
		04-jun-1990	TT10	Sulfate	260000.000	ug/l
		04-jun-1990	UM18	2-Cyclohexen-1-one (TIC)	4.000	ug/l
		04-jun-1990	UM18	Unknown 595 (TIC)	30.000	ug/l
		04-jun-1990	UM20	Trichloroethene	2.570	ug/l
		04-jun-1990	UW14	1,3,5-Trinitrobenzene	220.000	ug/l
		04-jun-1990	UW14	2,4,6-Trinitrotoluene	8.140	ug/l
		04-jun-1990	UW14	2,4-Dinitrotoluene	5.930	ug/l
		04-jun-1990	UW14	Cyclonite (RDX)	220.000	ug/l
TNT-02-MWB	54.6	04-jun-1990	99	Total dissolved solids	900000.000	ug/l
		04-jun-1990	SD20	Lead	3.250	ug/l
		04-jun-1990	SD22	Arsenic	14.000	ug/l
		04-jun-1990	SS10	Barium	18.700	ug/l
		04-jun-1990	SS10	Calcium	62000.000	ug/l
		04-jun-1990	SS10	Sodium	210000.000	ug/l
		04-jun-1990	SS10	Zinc	90.100	ug/l
		04-jun-1990	TT10	Chloride	140000.000	ug/l
		04-jun-1990	TT10	Sulfate	260000.000	ug/l
		04-jun-1990	UM18	2-(2-N-Butoxyethoxy) ethanol (TIC)	3000.000	ug/l
		04-jun-1990	UM18	2-Butoxyethanol (TIC)	30.000	ug/l
		04-jun-1990	UM18	Bis (2-ethylhexyl) phthalate	4.550	ug/l
		04-jun-1990	UM18	Benzothiazole	6.000	ug/l
		04-jun-1990	UM18	Unknown 559 (TIC)	50.000	ug/l
		04-jun-1990	UM18	Unknown 595 (TIC)	10.000	ug/l
		04-jun-1990	UM18	Unknown 599 (TIC)	500.000	ug/l
		04-jun-1990	UM18	Unknown 601 (TIC)	4.000	ug/l
		04-jun-1990	UM18	Unknown 613 (TIC)	20.000	ug/l
		04-jun-1990	UM18	Unknown 634 (TIC)	6.000	ug/l
		04-jun-1990	UW14	1,3,5-Trinitrobenzene	1.380	ug/l
		04-jun-1990	UW14	Nitramine (Tetryl)	0.754	ug/l
TNT-02-MWC	53.9	04-jun-1990	SD20	Lead	2.930	ug/l

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POSITIVE GROUNDWATER RESULTS - ROUND 2 - TNT LEACHING BEDS AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
TNT-02-MWC	53.9	04-jun-1990	SD22	Arsenic	5.120	ug/l
		04-jun-1990	UW14	Nitramine (Tetryl)	0.813	ug/l
	54.0	04-jun-1990	99	Total dissolved solids	726000.000	ug/l
		04-jun-1990	SS10	Barium	8.800	ug/l
		04-jun-1990	SS10	Calcium	8420.000	ug/l
		04-jun-1990	SS10	Chromium	9.060	ug/l
		04-jun-1990	SS10	Sodium	170000.000	ug/l
		04-jun-1990	TT10	Chloride	77000.000	ug/l
		04-jun-1990	TT10	Sulfate	233000.000	ug/l
		04-jun-1990	UW18	2-(2-N-Butoxyethoxy) ethanol (TIC)	4000.000	ug/l
		04-jun-1990	UW18	Bis (2-ethylhexyl) phthalate	14.500	ug/l
		04-jun-1990	UW18	Benzothiazole	9.000	ug/l
		04-jun-1990	UW18	Unknown 559 (TIC)	20.000	ug/l
		04-jun-1990	UW18	Unknown 575 (TIC)	10.000	ug/l
		04-jun-1990	UW18	Unknown 595 (TIC)	30.000	ug/l
		04-jun-1990	UW18	Unknown 598 (TIC)	9.000	ug/l
		04-jun-1990	UW18	Unknown 614 (TIC)	70.000	ug/l
		04-jun-1990	UW18	Unknown 634 (TIC)	20.000	ug/l
TNT-03-MWA	52.7	08-jun-1990	99	Total dissolved solids	808000.000	ug/l
		08-jun-1990	SD22	Arsenic	7.890	ug/l
		08-jun-1990	SS10	Barium	34.000	ug/l
		08-jun-1990	SS10	Calcium	27000.000	ug/l
		08-jun-1990	SS10	Sodium	220000.000	ug/l
		08-jun-1990	TT10	Chloride	46000.000	ug/l
		08-jun-1990	TT10	Sulfate	102000.000	ug/l
		08-jun-1990	UW14	1,3,5-Trinitrobenzene	13.000	ug/l
		08-jun-1990	UW14	2,4-Dinitrotoluene	6.190	ug/l
		08-jun-1990	UW14	Cyclonite (RDX)	34.200	ug/l
TNT-04-MWA	53.7	08-jun-1990	99	Total dissolved solids	940000.000	ug/l
		08-jun-1990	SD21	Selenium	3.620	ug/l
		08-jun-1990	SD22	Arsenic	5.650	ug/l
		08-jun-1990	SS10	Barium	35.500	ug/l
		08-jun-1990	SS10	Calcium	46000.000	ug/l
		08-jun-1990	SS10	Sodium	220000.000	ug/l
		08-jun-1990	TT10	Chloride	180000.000	ug/l
		08-jun-1990	TT10	Sulfate	243000.000	ug/l
		08-jun-1990	UW14	1,3,5-Trinitrobenzene	3.380	ug/l
		08-jun-1990	UW14	2,4,6-Trinitrotoluene	1.030	ug/l
		08-jun-1990	UW14	2,4-Dinitrotoluene	10.300	ug/l
TNT-05-MWA	58.5	07-jun-1990	99	Total dissolved solids	716000.000	ug/l
		07-jun-1990	SD21	Selenium	3.510	ug/l
		07-jun-1990	SD22	Arsenic	17.000	ug/l
		07-jun-1990	SS10	Barium	40.200	ug/l
		07-jun-1990	SS10	Calcium	47000.000	ug/l
		07-jun-1990	SS10	Sodium	170000.000	ug/l
		07-jun-1990	SS10	Zinc	25.100	ug/l
		07-jun-1990	TT10	Chloride	66000.000	ug/l
		07-jun-1990	TT10	Sulfate	138000.000	ug/l

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POSITIVE GROUNDWATER RESULTS - ROUND 2 - TNT LEACHING BEDS AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
TNT-05-MWA	58.5	07-jun-1990	UW14	1,3,5-Trinitrobenzene	6.470	ug/l
TNT-06-MWA	54.6	06-jun-1990	99	Total dissolved solids	1530000.000	ug/l
		06-jun-1990	SB01	Mercury	0.251	ug/l
		06-jun-1990	SD20	Lead	7.050	ug/l
		06-jun-1990	SD21	Selenium	6.820	ug/l
		06-jun-1990	SD22	Arsenic	5.650	ug/l
		06-jun-1990	SS10	Barium	52.500	ug/l
		06-jun-1990	SS10	Calcium	70000.000	ug/l
		06-jun-1990	SS10	Sodium	370000.000	ug/l
		06-jun-1990	SS10	Zinc	23.300	ug/l
		06-jun-1990	TT10	Chloride	240000.000	ug/l
		06-jun-1990	TT10	Sulfate	400000.000	ug/l
		06-jun-1990	UW14	1,3,5-Trinitrobenzene	2.340	ug/l
		06-jun-1990	UW14	2,4-Dinitrotoluene	0.850	ug/l
TNT-07-MWA	56.1	06-jun-1990	99	Total dissolved solids	802000.000	ug/l
		06-jun-1990	SD20	Lead	6.620	ug/l
		06-jun-1990	SD22	Arsenic	9.810	ug/l
		06-jun-1990	SS10	Barium	17.600	ug/l
		06-jun-1990	SS10	Calcium	18500.000	ug/l
		06-jun-1990	SS10	Chromium	9.500	ug/l
		06-jun-1990	SS10	Sodium	240000.000	ug/l
		06-jun-1990	TT10	Chloride	93000.000	ug/l
		06-jun-1990	TT10	Sulfate	176000.000	ug/l
		06-jun-1990	UH20	Chloroform	0.523	ug/l
		06-jun-1990	UH20	Trichloroethene	2.480	ug/l
		06-jun-1990	UW14	1,3,5-Trinitrobenzene	4.980	ug/l
		06-jun-1990	UW14	2,4-Dinitrotoluene	2.560	ug/l
TNT-07-MWB	56.0	06-jun-1990	99	Total dissolved solids	814000.000	ug/l
		06-jun-1990	SD20	Lead	9.000	ug/l
		06-jun-1990	SD22	Arsenic	7.890	ug/l
		06-jun-1990	SS10	Barium	15.500	ug/l
		06-jun-1990	SS10	Calcium	31000.000	ug/l
		06-jun-1990	SS10	Chromium	7.810	ug/l
		06-jun-1990	SS10	Sodium	220000.000	ug/l
		06-jun-1990	TT10	Chloride	110000.000	ug/l
		06-jun-1990	TT10	Sulfate	203000.000	ug/l
		06-jun-1990	UH18	2-(2-N-Butoxyethoxy) ethanol (TIC)	2000.000	ug/l
		06-jun-1990	UH18	Benzothiazole	4.000	ug/l
		06-jun-1990	UH18	Unknown 595 (TIC)	8.000	ug/l
TNT-07-MWC		06-jun-1990	99	Total dissolved solids	760000.000	ug/l
		06-jun-1990	SD20	Lead	8.790	ug/l
		06-jun-1990	SD22	Arsenic	5.650	ug/l
		06-jun-1990	SS10	Barium	28.100	ug/l
		06-jun-1990	SS10	Calcium	76000.000	ug/l
		06-jun-1990	SS10	Sodium	150000.000	ug/l
		06-jun-1990	SS10	Zinc	47.300	ug/l
		06-jun-1990	TT10	Chloride	99000.000	ug/l
		06-jun-1990	TT10	Sulfate	211000.000	ug/l

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POSITIVE GROUNDWATER RESULTS - ROUND 2 - TNT LEACHING BEDS AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
TNT-07-MWC	56.0	06-jun-1990	UM18	2-(2-N-Butoxyethoxy) ethanol (TIC)	3000.000	ug/l
		06-jun-1990	UM18	Benzothiazole	4.000	ug/l
		06-jun-1990	UM18	Unknown 559 (TIC)	5.000	ug/l
		06-jun-1990	UM18	Unknown 595 (TIC)	20.000	ug/l
		06-jun-1990	UM18	Unknown 598 (TIC)	20.000	ug/l
		06-jun-1990	UM18	Unknown 614 (TIC)	10.000	ug/l
		06-jun-1990	UM18	Unknown 634 (TIC)	5.000	ug/l
		06-jun-1990	UM18	Unknown 643 (TIC)	40.000	ug/l
TNT-08-MWA	55.3	07-jun-1990	99	Total dissolved solids	778000.000	ug/l
		07-jun-1990	SD20	Lead	2.170	ug/l
		07-jun-1990	SD22	Arsenic	10.100	ug/l
		07-jun-1990	SS10	Barium	46.000	ug/l
		07-jun-1990	SS10	Calcium	18900.000	ug/l
		07-jun-1990	SS10	Sodium	200000.000	ug/l
		07-jun-1990	SS10	Zinc	26.000	ug/l
		07-jun-1990	TT10	Chloride	52000.000	ug/l
		07-jun-1990	TT10	Sulfate	239000.000	ug/l
		07-jun-1990	UM20	Trichloroethene	9.330	ug/l
		07-jun-1990	UW14	1,3,5-Trinitrobenzene	0.885	ug/l
TNT-09-MWA	55.0	06-jun-1990	99	Total dissolved solids	736000.000	ug/l
		06-jun-1990	SD20	Lead	10.700	ug/l
		06-jun-1990	SD22	Arsenic	4.900	ug/l
		06-jun-1990	SS10	Barium	56.300	ug/l
		06-jun-1990	SS10	Calcium	75000.000	ug/l
		06-jun-1990	SS10	Sodium	140000.000	ug/l
		06-jun-1990	TT10	Chloride	43000.000	ug/l
		06-jun-1990	TT10	Sulfate	280000.000	ug/l
		06-jun-1990	UM20	Trichloroethene	1.050	ug/l
		06-jun-1990	UW14	1,3,5-Trinitrobenzene	3.810	ug/l
TNT-10-MWA	56.0	03-jun-1990	99	Total dissolved solids	1010000.000	ug/l
		03-jun-1990	99	Total dissolved solids	932000.000	ug/l
		03-jun-1990	SD20	Lead	3.800	ug/l
		03-jun-1990	SD20	Lead	2.280	ug/l
		03-jun-1990	SD22	Arsenic	10.200	ug/l
		03-jun-1990	SD22	Arsenic	10.600	ug/l
		03-jun-1990	SS10	Barium	49.400	ug/l
		03-jun-1990	SS10	Barium	49.800	ug/l
		03-jun-1990	SS10	Calcium	65000.000	ug/l
		03-jun-1990	SS10	Calcium	64000.000	ug/l
		03-jun-1990	SS10	Chromium	213.000	ug/l
		03-jun-1990	SS10	Chromium	223.000	ug/l
		03-jun-1990	SS10	Sodium	270000.000	ug/l
		03-jun-1990	SS10	Sodium	220000.000	ug/l
		03-jun-1990	TT10	Chloride	77000.000	ug/l
		03-jun-1990	TT10	Chloride	77000.000	ug/l
		03-jun-1990	TT10	Sulfate	179000.000	ug/l
		03-jun-1990	TT10	Sulfate	177000.000	ug/l
		03-jun-1990	UM18	Unknown 538 (TIC)	8.000	ug/l
		03-jun-1990	UM18	Unknown 538 (TIC)	8.000	ug/l

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POSITIVE GROUNDWATER RESULTS - ROUND 2 - TNT LEACHING BEDS AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
TNT-10-MWA	56.0	03-jun-1990	UM20	1,2-Dichloroethane	50.300	ug/l
		03-jun-1990	UM20	1,2-Dichloroethane	70.400	ug/l
		03-jun-1990	UM20	Benzene	5.940	ug/l
		03-jun-1990	UM20	Carbon tetrachloride	95.200	ug/l
		03-jun-1990	UM20	Carbon tetrachloride	95.200	ug/l
		03-jun-1990	UM20	Chloroform	513.000	ug/l
		03-jun-1990	UM20	Chloroform	513.000	ug/l
		03-jun-1990	UM20	Chlorobenzene	6.730	ug/l
		03-jun-1990	UM20	Toluene	7.840	ug/l
		03-jun-1990	UM20	Trichloroethene	476.000	ug/l
		03-jun-1990	UM20	Trichloroethene	571.000	ug/l
TNT-10-MWB	56.8	03-jun-1990	99	Total dissolved solids	830000.000	ug/l
		03-jun-1990	SD20	Lead	2.820	ug/l
		03-jun-1990	SD22	Arsenic	12.800	ug/l
		03-jun-1990	SS10	Barium	19.100	ug/l
		03-jun-1990	SS10	Calcium	61000.000	ug/l
		03-jun-1990	SS10	Sodium	180000.000	ug/l
		03-jun-1990	SS10	Zinc	176.000	ug/l
		03-jun-1990	TT10	Chloride	100000.000	ug/l
		03-jun-1990	TT10	Sulfate	231000.000	ug/l
		03-jun-1990	UM18	2-(2-N-Butoxyethoxy) ethanol (TIC)	2000.000	ug/l
		03-jun-1990	UM18	Unknown 598 (TIC)	70.000	ug/l
		03-jun-1990	UM20	Trichloroethene	0.838	ug/l
TNT-10-MWC	55.9	03-jun-1990	99	Total dissolved solids	640000.000	ug/l
		03-jun-1990	SD20	Lead	2.930	ug/l
		03-jun-1990	SD22	Arsenic	9.380	ug/l
		03-jun-1990	SS10	Barium	32.100	ug/l
		03-jun-1990	SS10	Calcium	61000.000	ug/l
		03-jun-1990	SS10	Sodium	130000.000	ug/l
		03-jun-1990	TT10	Chloride	60000.000	ug/l
		03-jun-1990	TT10	Sulfate	202000.000	ug/l
TNT-11-MWA	59.2	07-jun-1990	99	Total dissolved solids	2090000.000	ug/l
		07-jun-1990	SD21	Selenium	7.990	ug/l
		07-jun-1990	SD22	Arsenic	9.910	ug/l
		07-jun-1990	SS10	Barium	18.100	ug/l
		07-jun-1990	SS10	Calcium	130000.000	ug/l
		07-jun-1990	SS10	Sodium	570000.000	ug/l
		07-jun-1990	TT10	Chloride	180000.000	ug/l
		07-jun-1990	TT10	Sulfa[illegible]	700000.000	ug/l
		07-jun-1990	UM20	Carbo[illegible]trachloride	19.000	ug/l
		07-jun-1990	UM20	Chloroform	41.000	ug/l
		07-jun-1990	UM20	Trichloroethene	190.000	ug/l
		07-jun-1990	UW14	1,3,5-Trinitrobenzene	0.867	ug/l
TNT-12-MWA	50.3	07-jun-1990	99	Total dissolved solids	1150000.000	ug/l
		07-jun-1990	SD22	Arsenic	17.700	ug/l
		07-jun-1990	SS10	Barium	25.100	ug/l
		07-jun-1990	SS10	Calcium	39000.000	ug/l
		07-jun-1990	SS10	Sodium	290000.000	ug/l

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POSITIVE GROUNDWATER RESULTS - ROUND 2 - TNT LEACHING BEDS AREA SITE

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
TNT-12-MWA	50.3	07-jun-1990	TT10	Chloride	82000.000	ug/l
		07-jun-1990	TT10	Sulfate	400000.000	ug/l
		07-jun-1990	UM20	Chloroform	0.749	ug/l
		07-jun-1990	UM20	Trichloroethene	0.819	ug/l
		07-jun-1990	UW14	1,3,5-Trinitrobenzene	1.120	ug/l
		07-jun-1990	UW14	2,4-Dinitrotoluene	0.769	ug/l
TNT-13-MWA	52.2	07-jun-1990	99	Total dissolved solids	918000.000	ug/l
		07-jun-1990	SB01	Mercury	0.526	ug/l
		07-jun-1990	SD20	Lead	9.440	ug/l
		07-jun-1990	SD22	Arsenic	9.380	ug/l
		07-jun-1990	SS10	Barium	45.600	ug/l
		07-jun-1990	SS10	Calcium	32000.000	ug/l
		07-jun-1990	SS10	Sodium	210000.000	ug/l
		07-jun-1990	TT10	Chloride	60000.000	ug/l
		07-jun-1990	TT10	Sulfate	228000.000	ug/l
		07-jun-1990	UM20	Chloroform	0.533	ug/l
		07-jun-1990	UM20	Trichloroethene	9.520	ug/l
TNT-14-MWA	49.5	03-jun-1990	99	Total dissolved solids	938000.000	ug/l
		03-jun-1990	SD20	Lead	3.040	ug/l
		03-jun-1990	SD21	Selenium	52.200	ug/l
		03-jun-1990	SD22	Arsenic	27.300	ug/l
		03-jun-1990	SS10	Barium	46.200	ug/l
		03-jun-1990	SS10	Calcium	33000.000	ug/l
		03-jun-1990	SS10	Sodium	260000.000	ug/l
		03-jun-1990	TT10	Chloride	71000.000	ug/l
		03-jun-1990	TT10	Sulfate	137000.000	ug/l
		03-jun-1990	UW14	1,3,5-Trinitrobenzene	13.500	ug/l
TNT-15-MWA	52.0	02-jun-1990	99	Total dissolved solids	1320000.000	ug/l
		02-jun-1990	SD20	Lead	3.800	ug/l
		02-jun-1990	SD21	Selenium	7.370	ug/l
		02-jun-1990	SD22	Arsenic	7.140	ug/l
		02-jun-1990	SS10	Barium	37.800	ug/l
		02-jun-1990	SS10	Calcium	57000.000	ug/l
		02-jun-1990	SS10	Sodium	270000.000	ug/l
		02-jun-1990	TT10	Chloride	210000.000	ug/l
		02-jun-1990	TT10	Sulfate	280000.000	ug/l
		02-jun-1990	UM18	2-(2-N-Butoxyethoxy) ethanol (TIC)	40.000	ug/l
		02-jun-1990	UW14	Cyclonite (RDX)	6.720	ug/l
TNT-16-MWA	56.7	02-jun-1990	99	Total dissolved solids	692000.000	ug/l
		02-jun-1990	SD20	Lead	2.280	ug/l
		02-jun-1990	SD22	Arsenic	8.740	ug/l
		02-jun-1990	SS10	Barium	22.600	ug/l
		02-jun-1990	SS10	Calcium	65000.000	ug/l
		02-jun-1990	SS10	Sodium	100000.000	ug/l
		02-jun-1990	TT10	Chloride	66000.000	ug/l
		02-jun-1990	TT10	Sulfate	220000.000	ug/l

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Extractable Organics

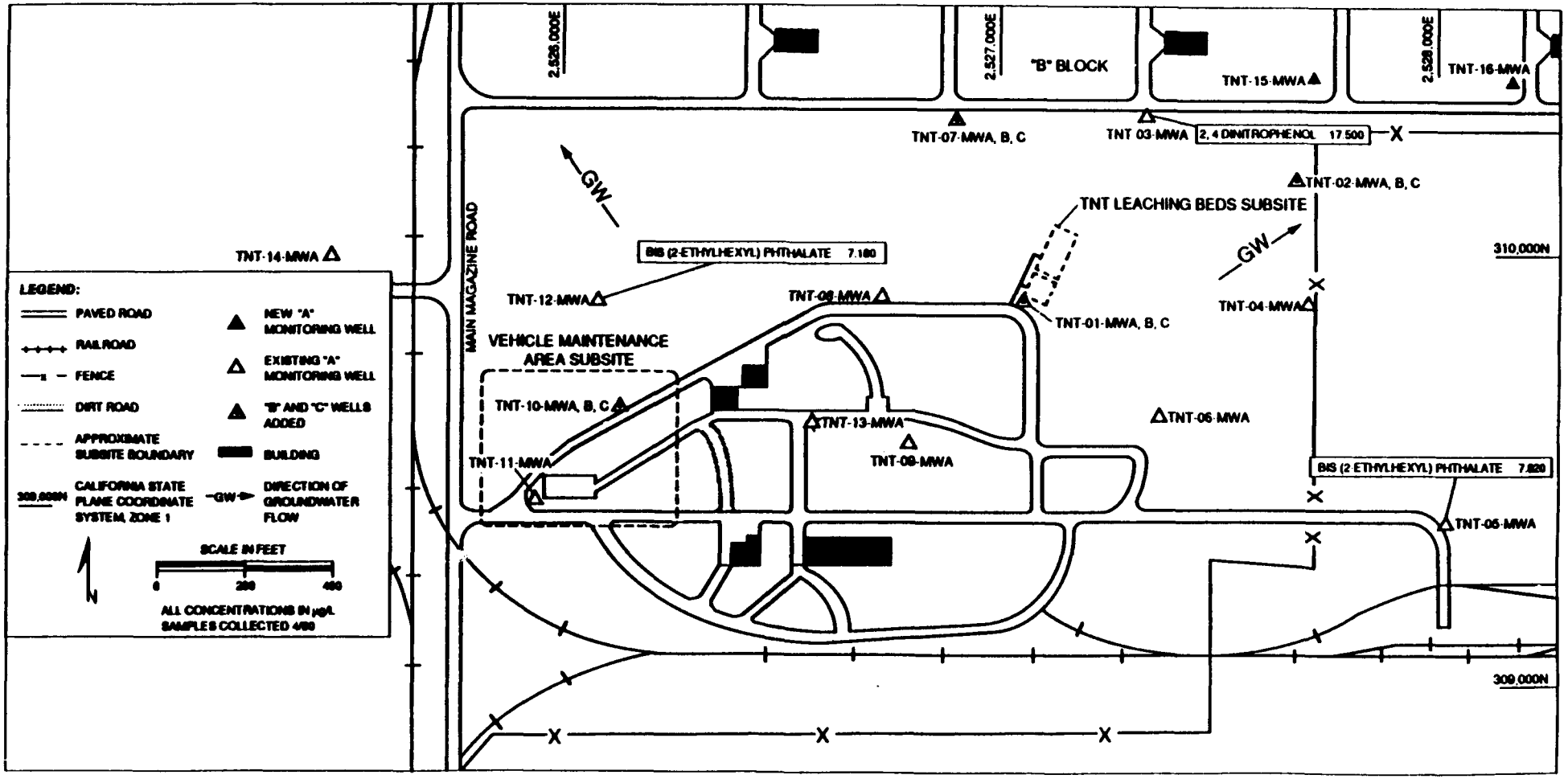
Bis(2-ethylhexyl)phthalate, 2,4 DNT, and 2,4-dinitrophenol were the only extractable organics detected in wells at the TNT Leaching Beds Area monitoring wells (Figures 6-28 and 6-29). Round 1 results show that bis(2-ethylhexyl)phthalate was detected in two "A" zone wells and one "B" zone well, at concentrations ranging from 4.810 to 7.820 μg/L. 2,4-Dinitrophenol was detected in TNT-03-MWA (17.500 μg/L). The distribution of 2,4 DNT is discussed under the explosives heading. Round 2 groundwater results indicate bis(2-ethylhexyl)phthalate in two "B" zone wells and one "C" zone well at concentrations ranging from 4.550 μg/L to 14.500 μg/L.

VOCs

Four VOCs were detected in Round 1 groundwater samples at the site: TCE, 1,2-DCA, chloroform, and carbon tetrachloride (Figure 6-30 through 6-32). Two additional compounds, chlorobenzene and toluene, were detected in Round 2 groundwater samples (Table 6-8).

TCE was detected in nine (56 percent) of the "A" zone wells during Round 1. TCE concentrations exceed the California MCL (5 μg/L) in samples from four wells sampled during Round 1: TNT-01-MWA (26.700 μg/L), TNT-08-MWA (7.430 μg/L), TNT-10-MWA 952.000 μg/L), and TNT-11-MWA (114.000 μg/L). Round 2 groundwater results indicate TCE above the MCL in the same four wells: TNT-01-MWA (29.500 μg/L), TNT-08-MWA (9.330 μg/L), TNT-10-MWA (476.000 μg/L), and TNT-11-MWA (190 μg/L).

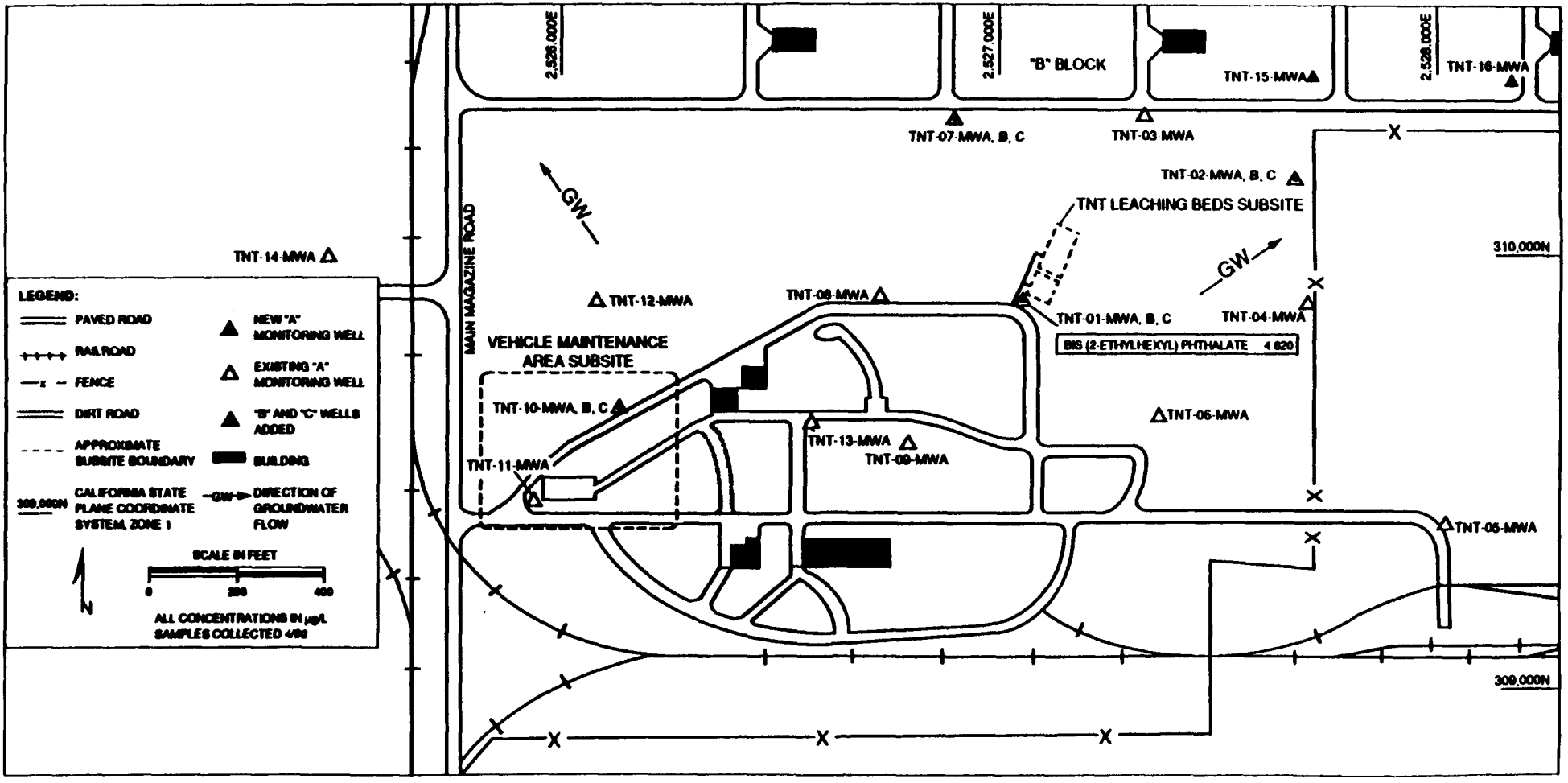
Carbon tetrachloride was detected in five (31 percent) "A" zone wells during Round 1. Concentrations for two of these wells exceed the carbon tetrachloride MCL (0.5 μg/L): TNT-10-MWA (190.000 μg/L) and TNT-11-MWA (11.400 μg/L). Round 2 results verify the presence of carbon tetrachloride in these two wells. 1,2-DCA was detected in two wells during Round 1 (13 percent). The MCL (0.5 μg/L) was exceeded only in TNT-10-MWA (101.000 μg/L). Round 2 results indicate that 1,2-DCA is present in TNT-10-MWA at



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EXTRACTABLE ORGANIC COMPOUND CONCENTRATIONS FROM "A" ZONE WELLS: TNT LEACHING BEDS AREA

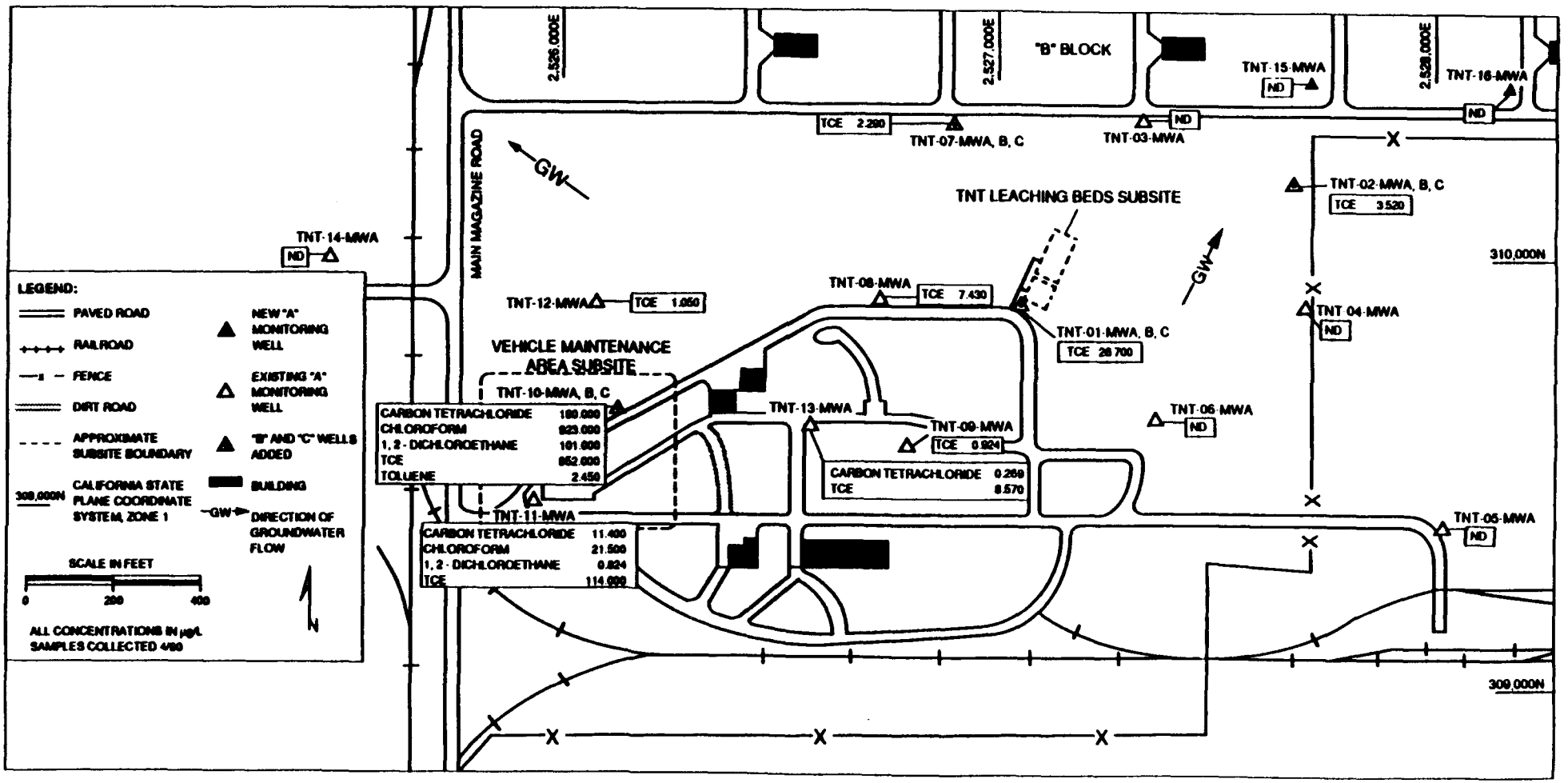
FIGURE 6-28



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EXTRACTABLE ORGANIC COMPOUND CONCENTRATIONS FROM "B" ZONE WELLS: TNT LEACHING BEDS AREA

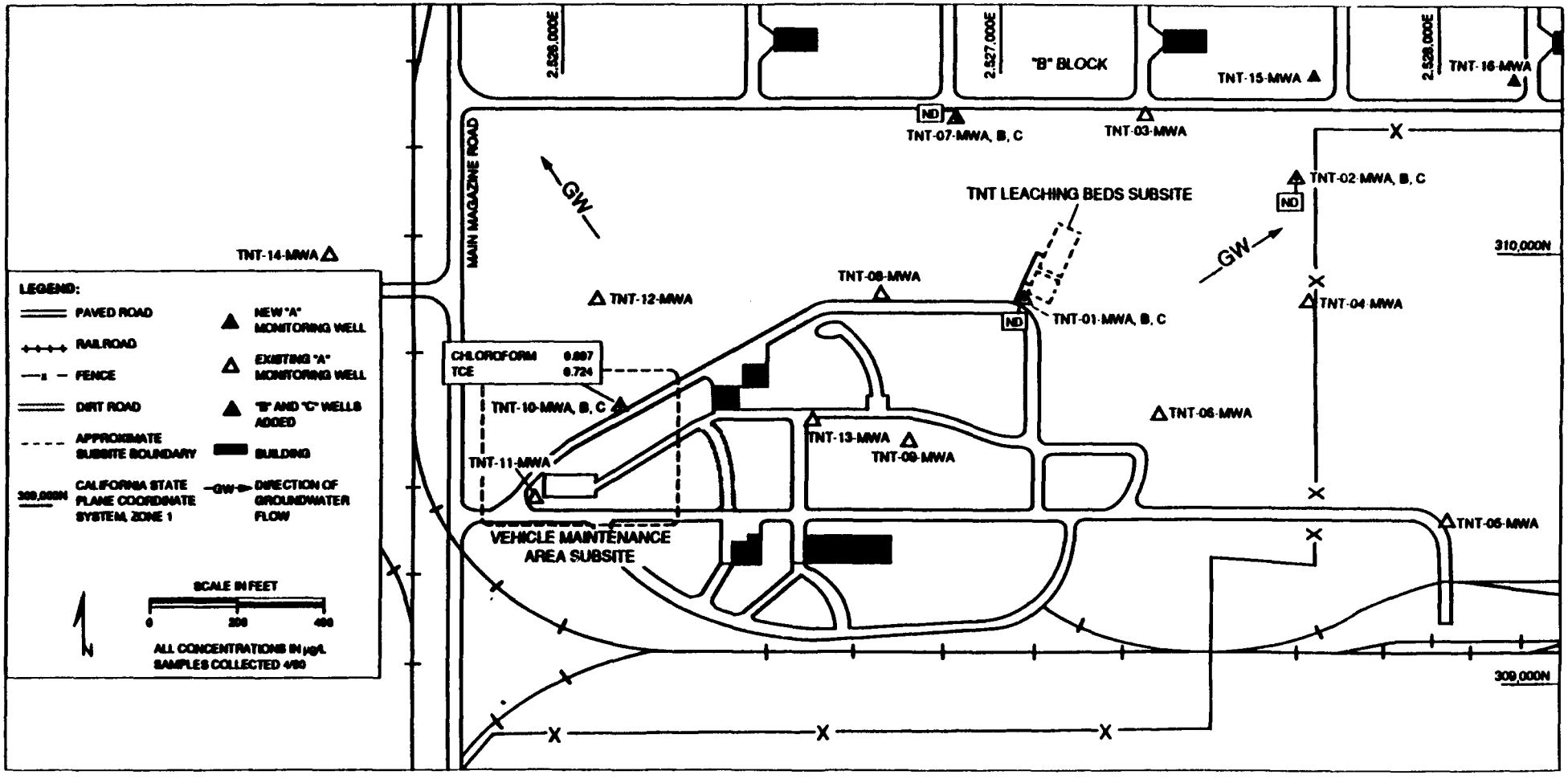
FIGURE 6-29



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VOC CONCENTRATIONS FROM "A" ZONE WELLS: TNT LEACHING BEDS AREA

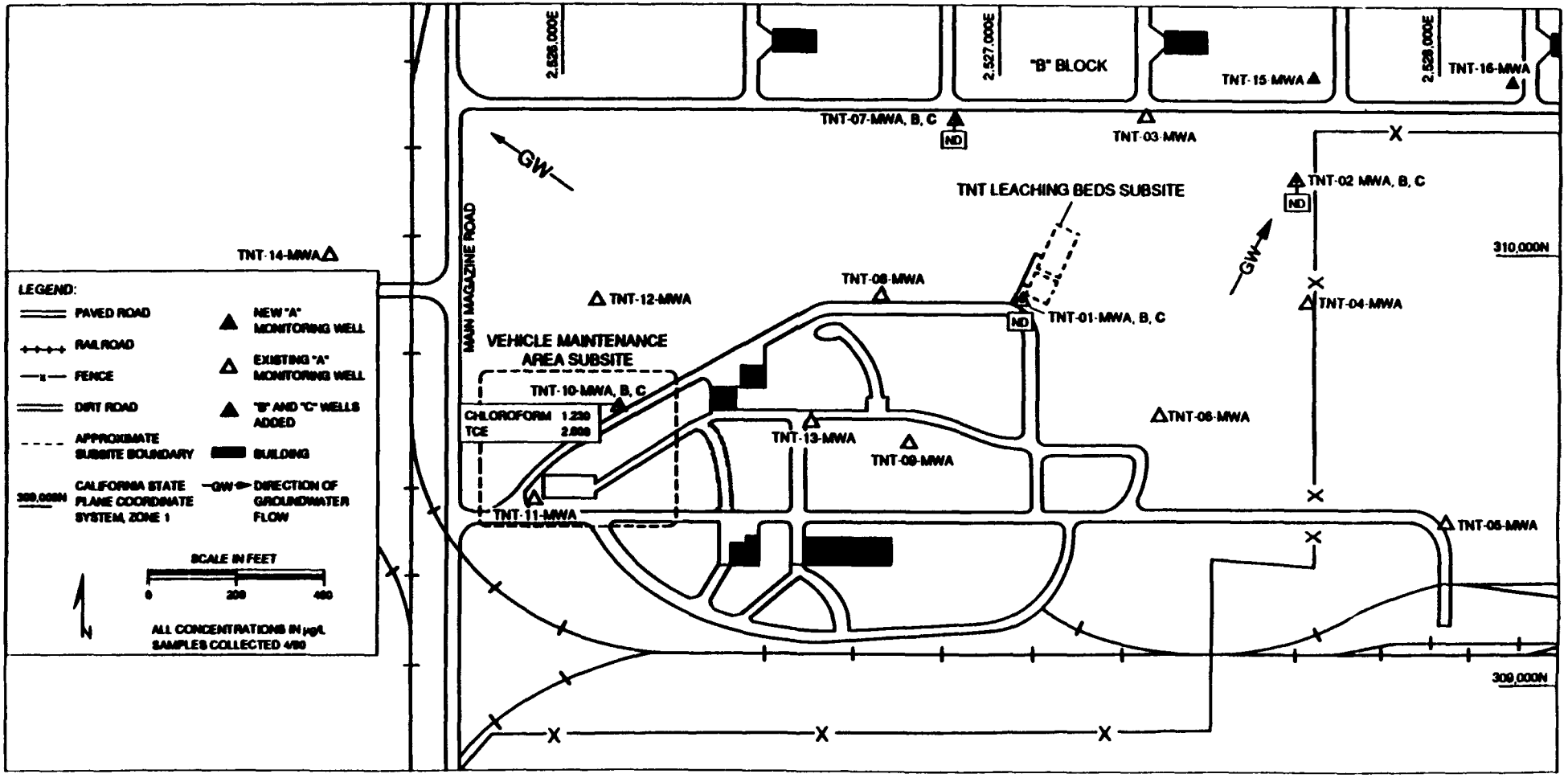
FIGURE 6-30



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VOC CONCENTRATIONS FROM "B" ZONE WELLS:
TNT LEACHING BEDS AREA

FIGURE 6-31



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VOC CONCENTRATIONS FROM "C" ZONE WELLS: TNT LEACHING BEDS AREA

FIGURE 6-32

50.300 μg/L. Chloroform was also detected in TNT-10-MWA exceeding the MCL (100 μg/L) at 910 μg/L (Round 1) and 513 μg/L (Round 2).

No significant VOC contamination was detected in "B" and "C" zone wells. Round 1 data indicates chloroform (0.697 μg/L) and TCE (0.724 μg/L) in TNT-10-MWB, and chloroform (1.230 μg/L) and TCE (2.000 μg/L) in TNT-10-MWC. MCLs were not exceeded in any "B" or "C" zone wells.

Groundwater plume maps (Figures 6-33 through 6-35) show the estimate of the areal distribution of total VOCs, TCE and carbon tetrachloride in groundwater. The surface area of the plume is estimated to be 1,100,000 square feet. The estimated mass of TCE in groundwater and adsorbed to aquifer materials in the 0- to 50-foot layer is estimated to be about 770 pounds. Table 6-23 lists the parameters used to calculate the mass value. Presented below is the general mass calculation formula used to calculate mass value.

$$V = Z \cdot A$$

$$C_L = \textit{arithmetic average of } C_1 \text{ \& } C_2$$

$$M_L = C \cdot V \cdot 0$$

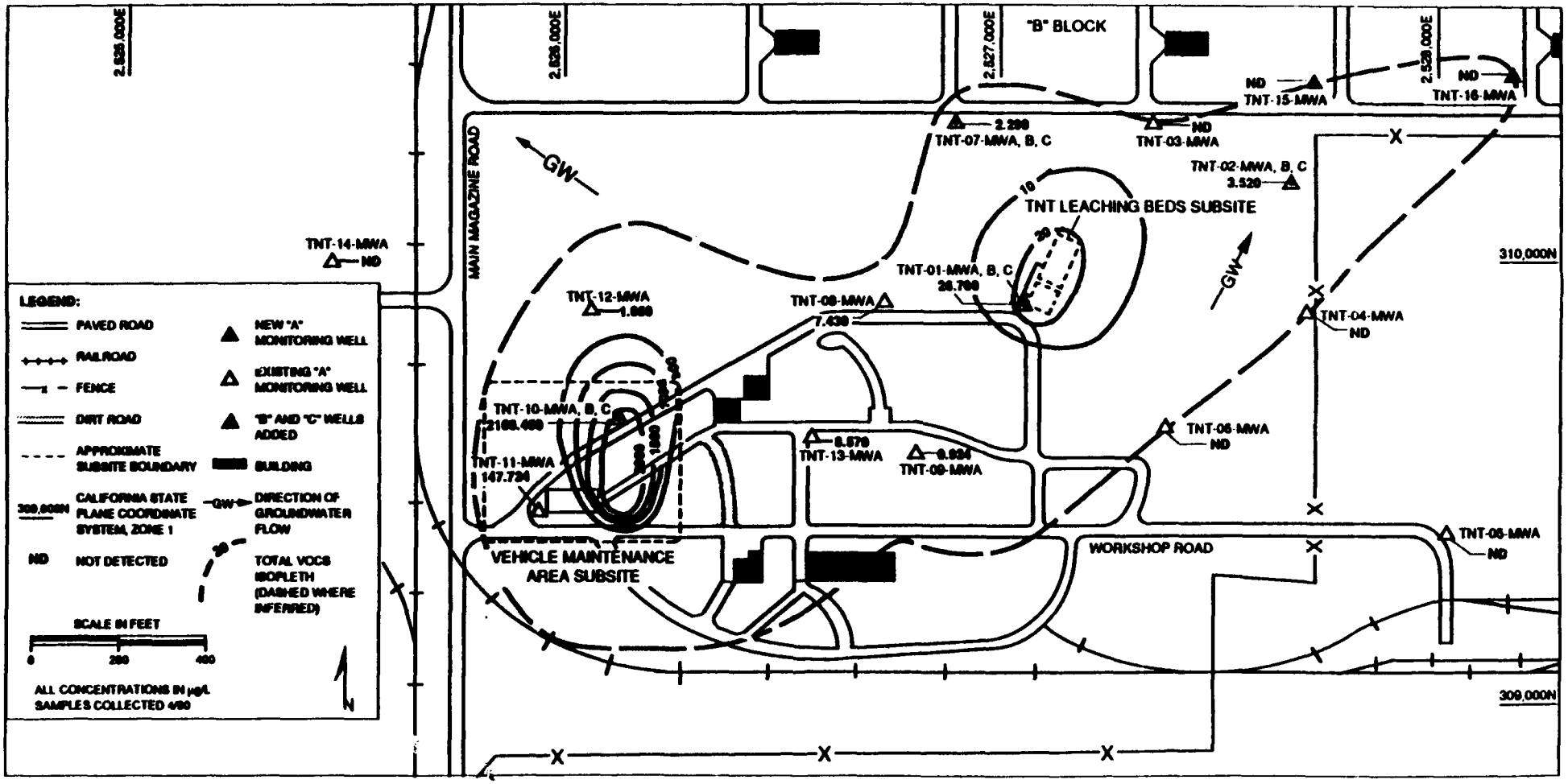
$$\left(\frac{\mu g}{L}\right)\left(ft^3\right)\left(28.317\ \frac{L}{ft^3}\right)\left(\frac{g}{1{,}000{,}000\ \mu g}\right) \rightarrow g$$

$$C_s = C_L \cdot K_D$$

$$M_s = C_s \cdot \rho_b \cdot V$$

$$\left(\frac{\mu g}{kg}\right)\left(\frac{kg}{L}\right)\left(ft^3\right)\left(28.317\frac{L}{ft^3}\right)\left(\frac{g}{1{,}000{,}000\ \mu g}\right) \rightarrow g$$

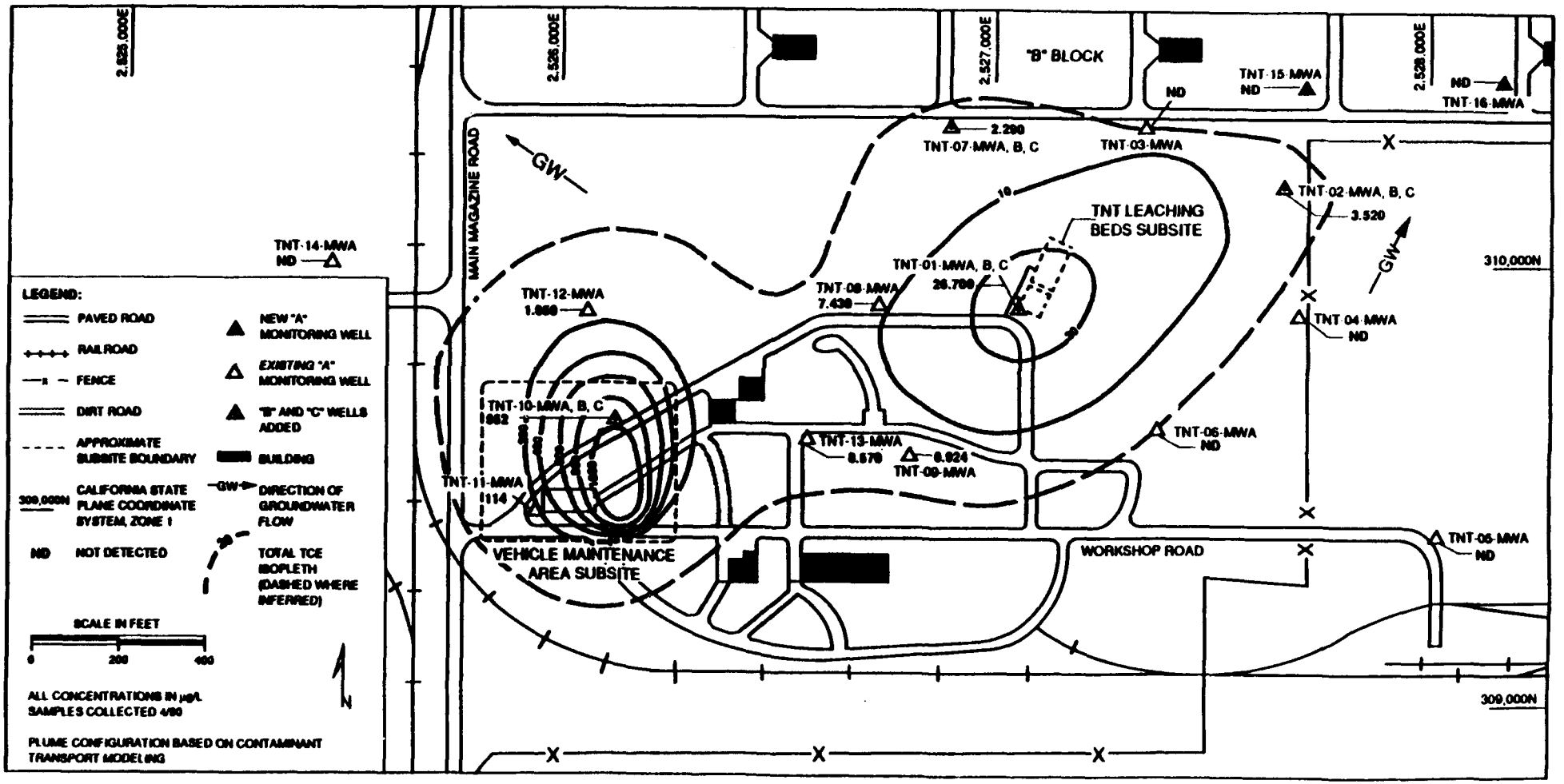
A = area



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TOTAL VOCS GROUNDWATER PLUME IN "A" ZONE WELLS:
TNT LEACHING BEDS AREA

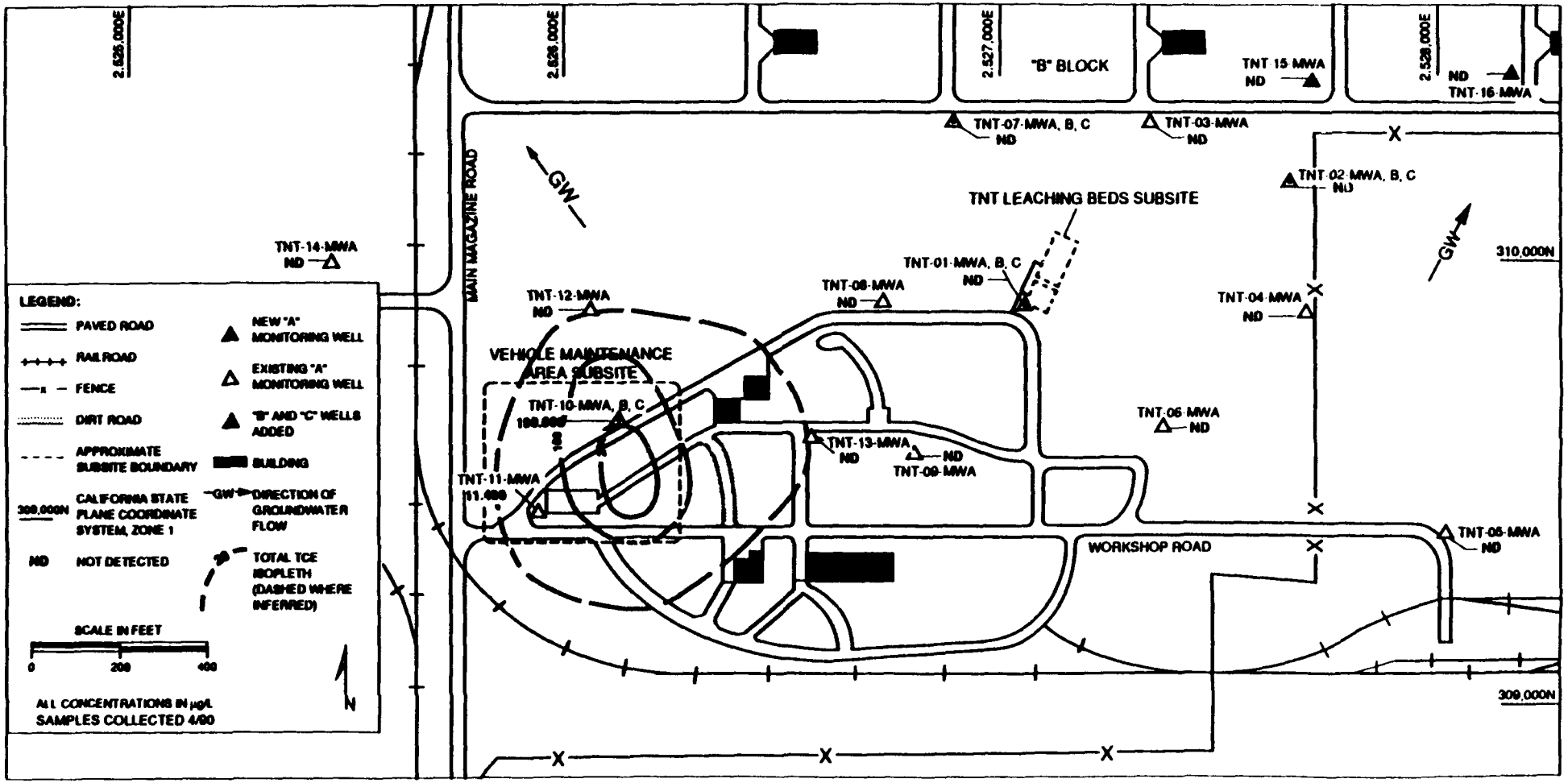
FIGURE 6-33



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TCE GROUNDWATER PLUME IN "A" ZONE WELLS: TNT LEACHING BEDS AREA

FIGURE 6-34



SIERRA ARMY DEPOT

CARBON TETRACHLORIDE GROUNDWATER PLUME IN "A" ZONE WELLS: TNT LEACHING AREA

FIGURE 6-35

TABLE 6-23

ESTIMATED MASS OF TCE IN CONTAMINATION AREA

Concentration Range (µg/l)	Exp. Average Conc'n (µg/l)	Area (ft^2)	Thickness (ft)	Volume (ft^3)	Aqueous Mass (g)	Solid Phase Conc'n (µg/kg)	Solid Phase Mass (g)	Aqueous Mass (lb)	Solid Phase Mass (lb)	Total Mass (lb)
1 - 200	100	940,047	50	47,002,350	23,957	61.42	147,146	53	324	377
10 - 20	15	338,613	50	16,930,650	1,294	9.21	7,950	3	18	20
200 - 400	300	48,498	50	2,424,900	3,708	184.26	22,774	8	50	58
400 - 600	500	39,845	50	1,992,250	5,077	307.10	31,185	11	69	80
600 - 800	700	29,375	50	1,468,750	5,240	429.94	32,187	12	71	83
800 - 1,030	915	41,627	50	2,081,350	9,707	561.99	59,620	21	131	153
Total		1,438,005			48,984		300,862	108	663	771
Porosity- 0.18		log Kow (TCE)-1	2.29	Kd (TCE) - 0.614201049					Total Mass (lbs)	771
foc- 0.005										
Density (kg/l)- 1.8										

Z	=	depth
C_1	=	concentration one
C_2	=	concentration two
V	=	volume
M_L	=	aqueous phase mass
M_s	=	sorbed mass
σ_b	=	bulk density
M_T	=	total mass
C_L	=	aqueous concentration
C_s	=	solid phase concentration

The following assumptions were made to estimate the TCE mass in groundwater:

- Effective porosity = 0.18
- Estimated organic carbon content = 0.005
- Density = 1.8 kg/L
- Log Kow (TCE) = 2.29
- Kd (TCE) = 0.614
- Linear horizontal decay
- Vertical TCE concentration is constant in the 0- to 50-foot layer

(Derivation of Kd values are presented in Appendix O).

The TCE plume consist of two lobes (Figure 6-34). The highest concentrations in the western lobe are located near the Vehicle Maintenance Area Subsite. This plume is apparently moving slowly downgradient in a north-northwest direction. The eastern lobe of the TCE plume is centered around the TNT Leaching Beds Subsite. It is moving slowly downgradient in a northeastern direction. The source of the eastern lobe for the TCE plume appears to be the TNT Leaching Beds Subsite. This conclusion is supported by the soil data which showed very low levels of TCE in soil borings from these beds (Table 6-16) indicating that they may have been a TCE source. No correlation between site stratigraphy and TCE distribution was observed.

The shape and distribution of the total VOCs and carbon tetrachloride plumes (Figures 6-33 and 6-35) closely approximate the western lobe of the TCE plume.

Inorganics

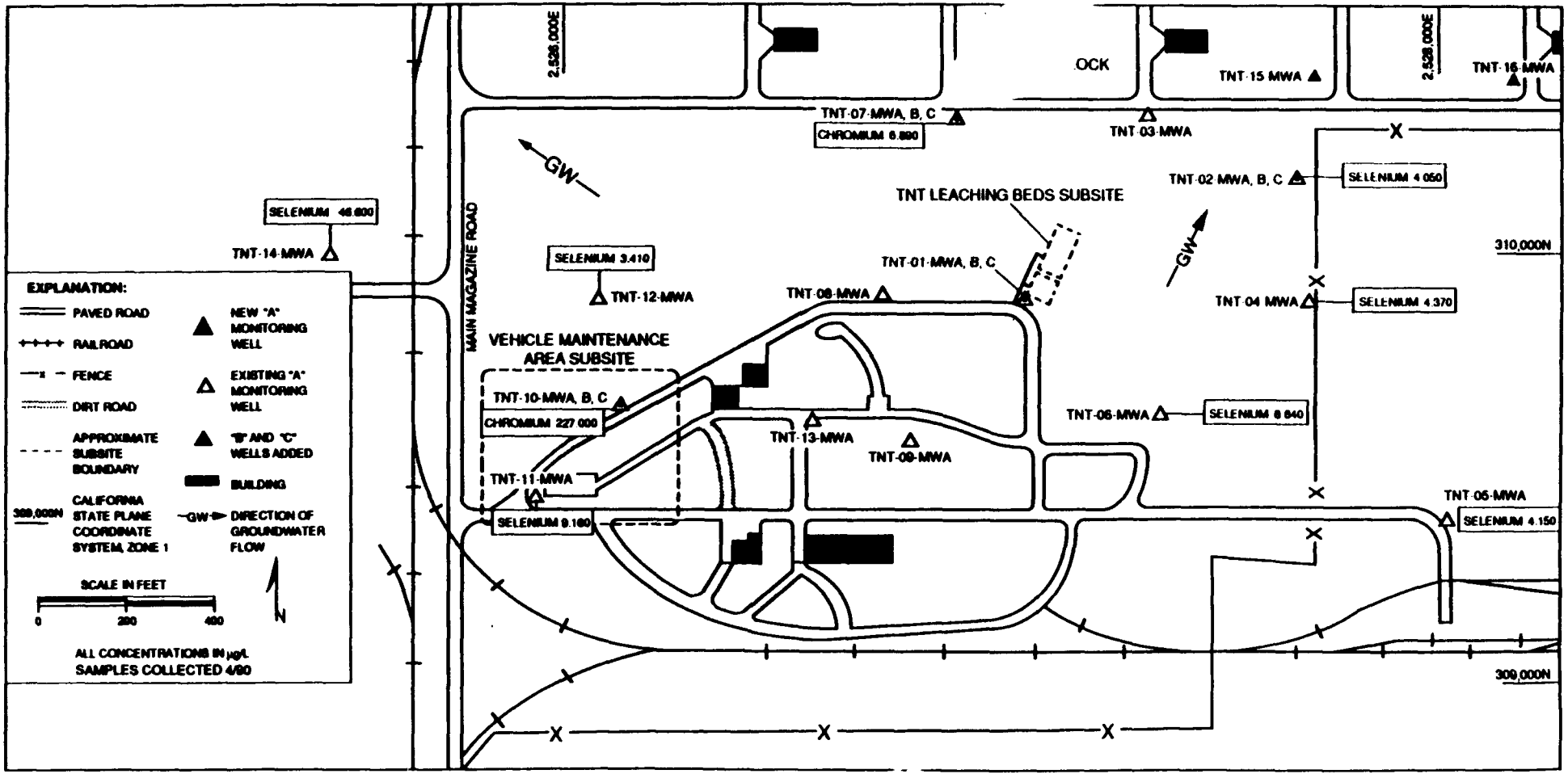
Several metals were detected in "A" zone wells at the TNT Leaching Beds Area. Round 1 or 2 sampling results indicate two metals, selenium and chromium, were detected above the California MCLs. Chromium was detected in TNT-07-MWA (6.890 μg/L, Round 1; 7.810 μg/L, Round 2) and TNT-10-MWA (227 μg/L, Round 1; 223.000 μg/L, Round 2) (Figure 6-36). The chromium MCL (50 μg/L) was exceeded in the latter well. This well also contained high VOC concentrations. It is assumed that the chromium present in this well is the result of activities from the Vehicle Maintenance Area subsite. Selenium was detected in eight of 16 water table wells. The MCL for selenium (10 μg/L) was exceeded in TNT-14-MWA (46.600 μg/L, Round 1; 52.200 μg/L, Round 2). A soil source for selenium was not identified; therefore, the selenium values detected at this site may represent anomalously high background levels.

Other metals detected in the "A" zone wells included arsenic, barium, lead, and mercury. State MCLs were not exceeded for these compounds and their value are considered to represent background levels.

Arsenic, barium, and zinc were detected in all four "B" zone wells (Figure 6-37). Cadmium was also detected in TNT-10-MWB (12.9 μg/L, Round 1) located northeast of the Vehicle Maintenance Area Subsite. Arsenic and barium were detected in all four "C" zone wells (Figure 6-38). Chromium was present in TNT-02-MWC (11.800 μg/L, Round 1; 9.060 μg/L, Round 2) which is located northeast of the TNT Leaching Beds. Zinc was detected in TNT-07-MWC (32.700 μg/L, Round 1; 47.300 μg/L, Round 2).

Explosives

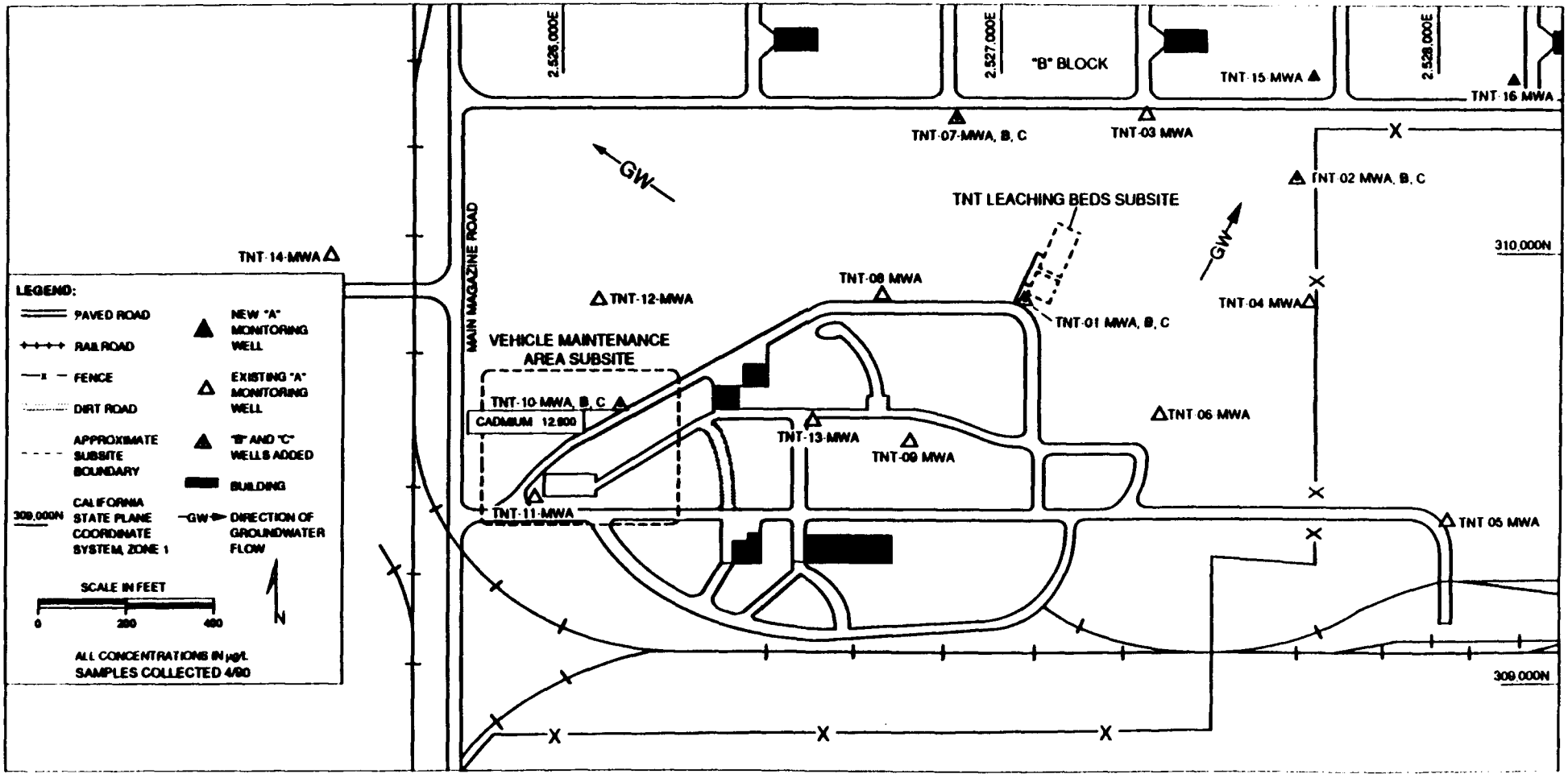
Round 1 groundwater sampling results indicate that explosive compounds were detected in 10 (63 percent) and 13 (81 percent) of the "A" zone wells at the TNT Leaching Beds Subsite (Figure 6-39) during Rounds 1 and 2, respectively. 1,3,5-TNB was detected in eight (50 percent) and 12 (75 percent) of the "A" zone wells during Rounds 1 and 2, respectively. Concentrations ranged from 0.867 to 1100.000 μg/L. 2,4-DNT was detected in five (31



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METAL CONCENTRATIONS FROM "A" ZONE WELLS: TNT LEACHING BEDS AREA

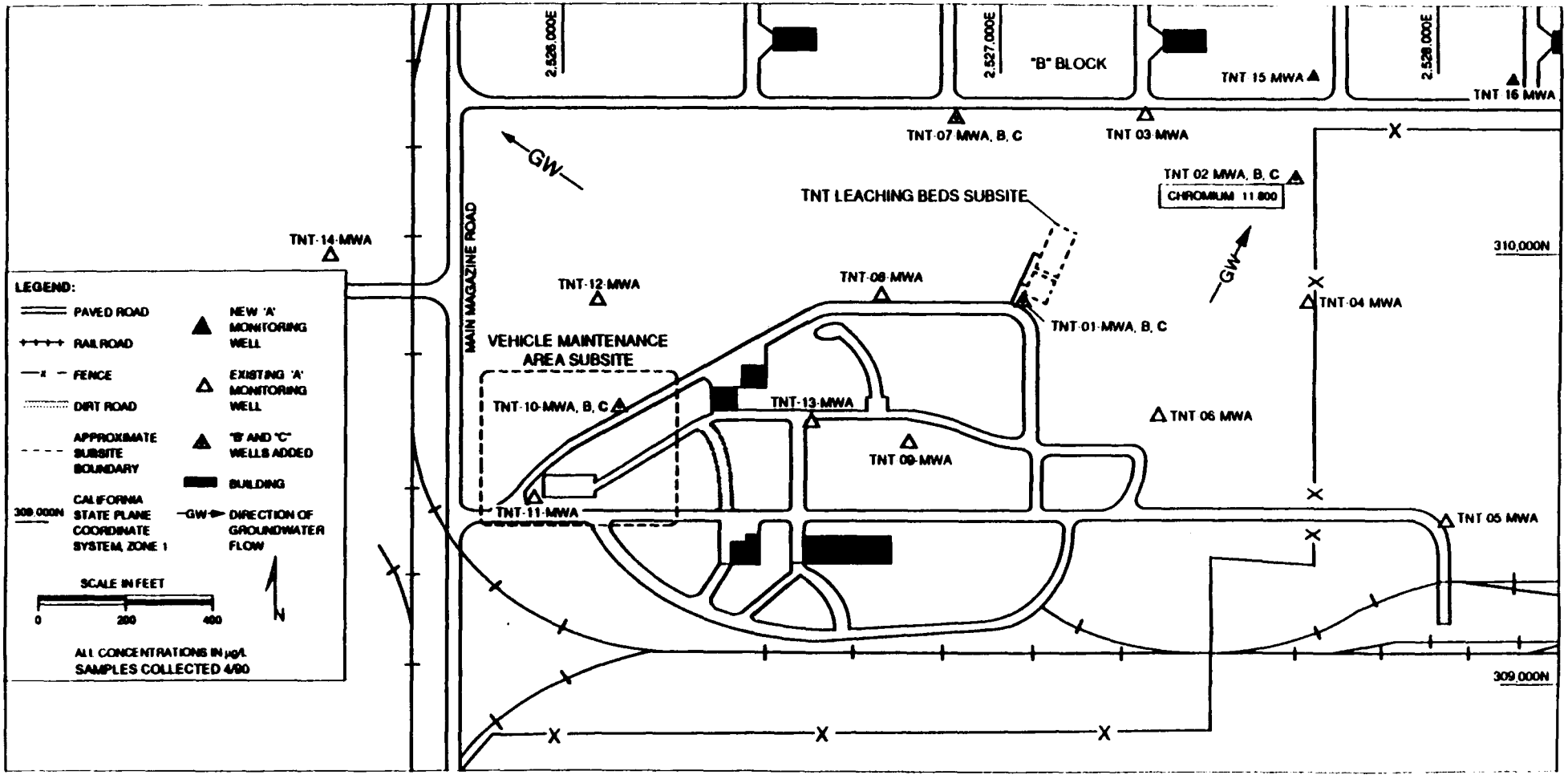
FIGURE 6-36



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METAL CONCENTRATIONS FROM "B" ZONE WELLS: TNT LEACHING BEDS AREA

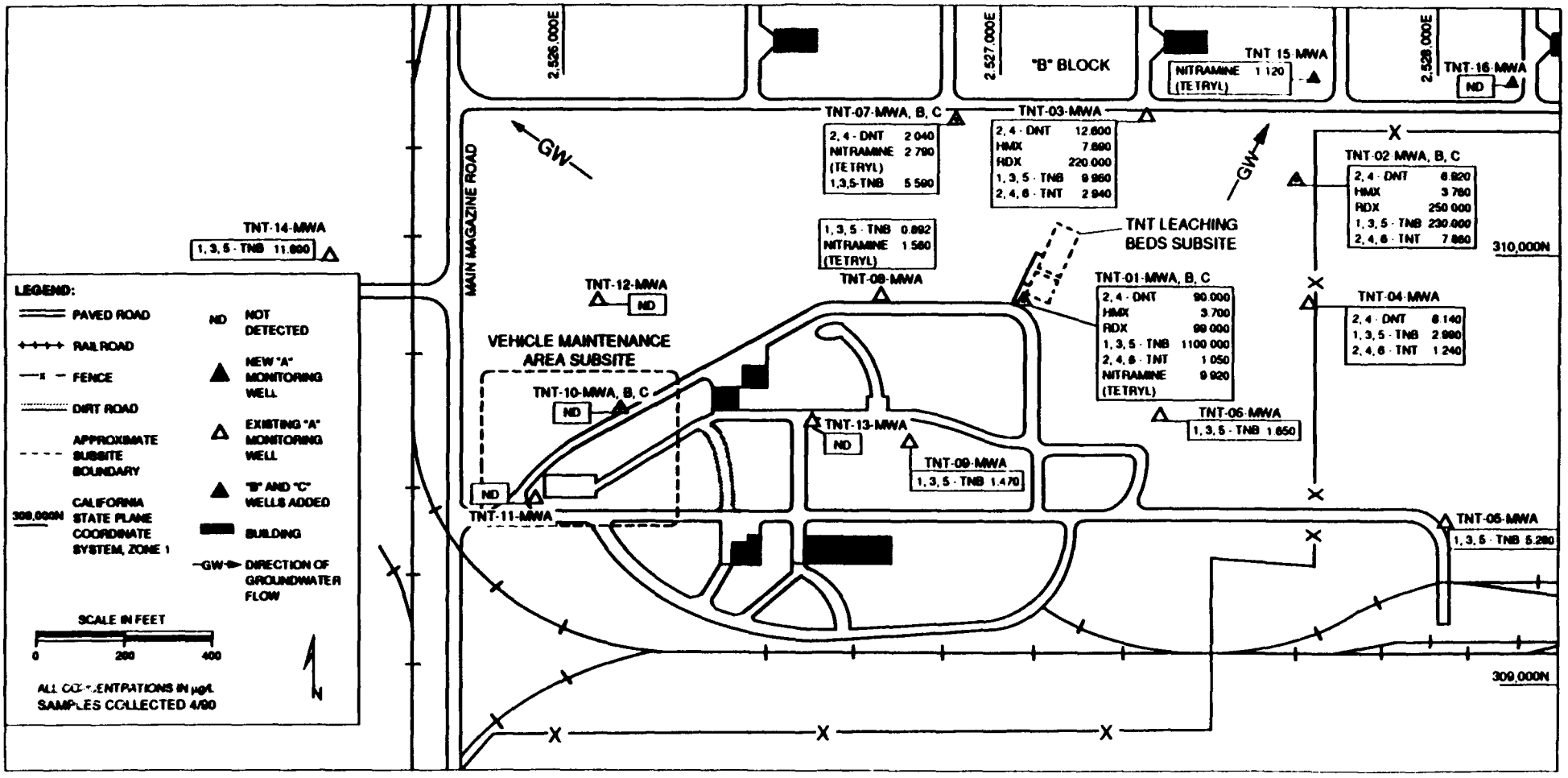
FIGURE 6-37



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METAL CONCENTRATIONS FROM "C" ZONE WELLS: TNT LEACHING BEDS AREA

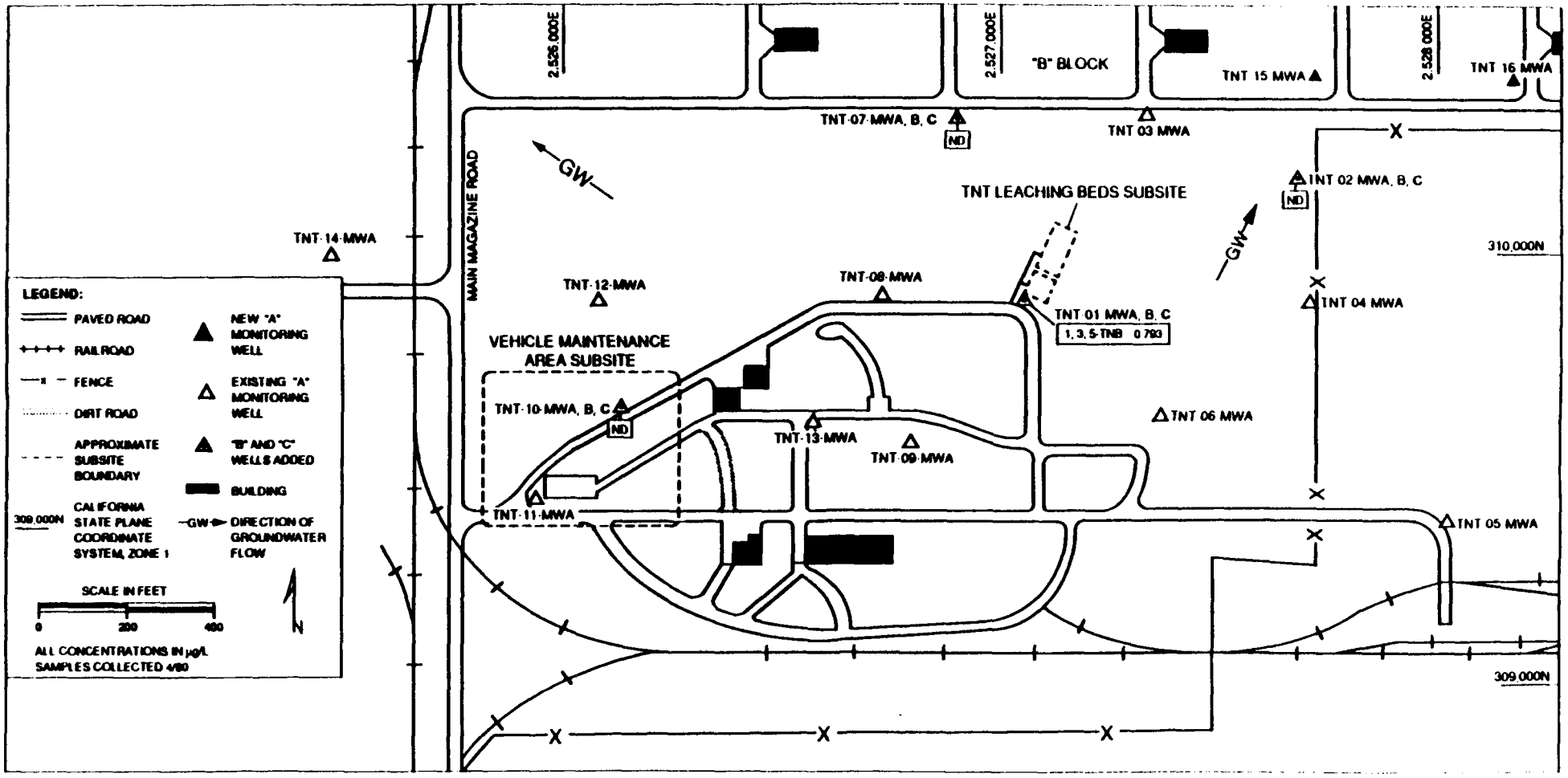
FIGURE 6-38



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EXPLOSIVE COMPOUND CONCENTRATIONS FROM "A" ZONE WELLS:
TNT LEACHING BEDS AREA

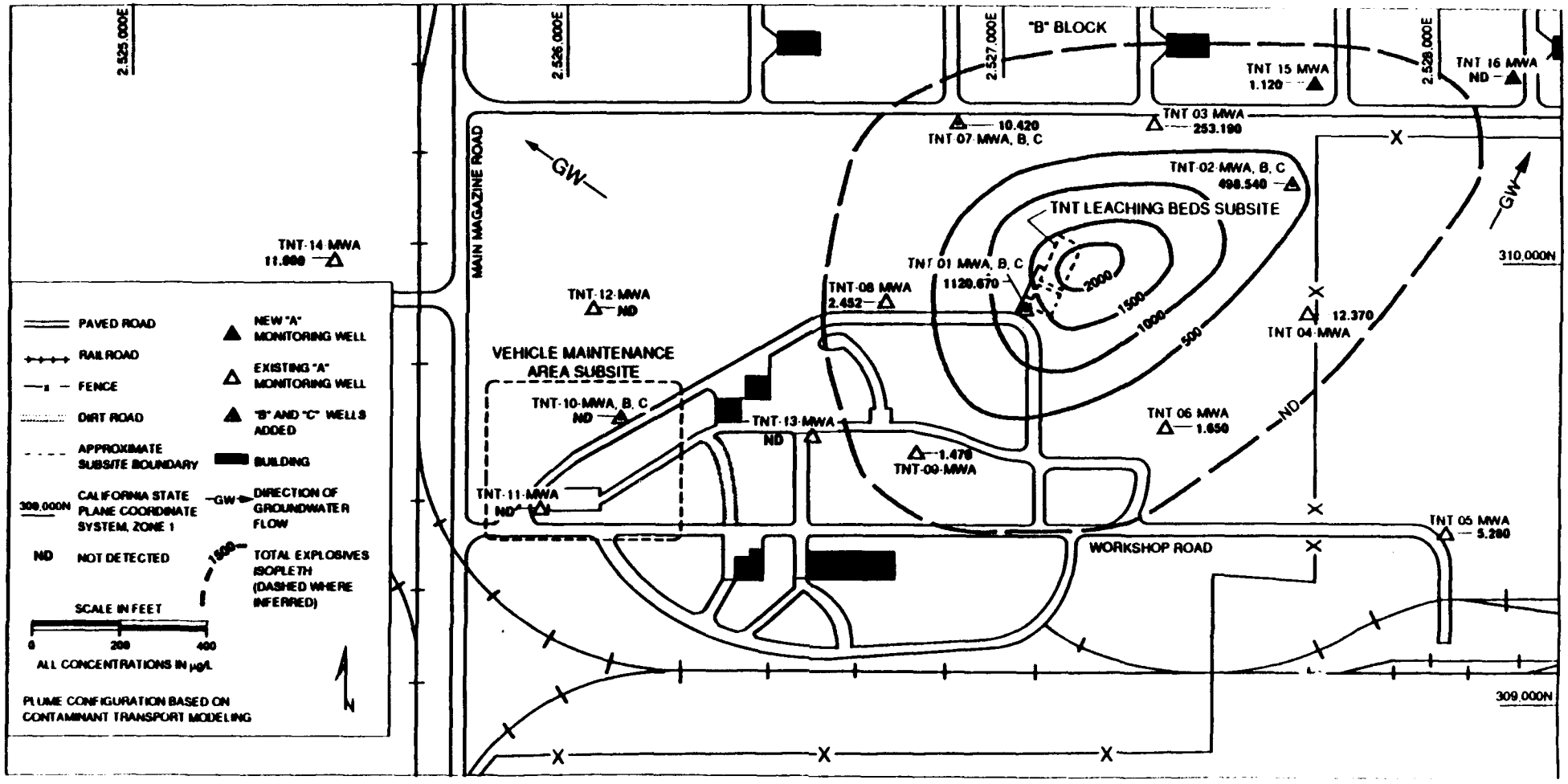
FIGURE 6-39



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EXPLOSIVE COMPOUND CONCENTRATIONS FROM "C" ZONE WELLS: TNT LEACHING BEDS AREA

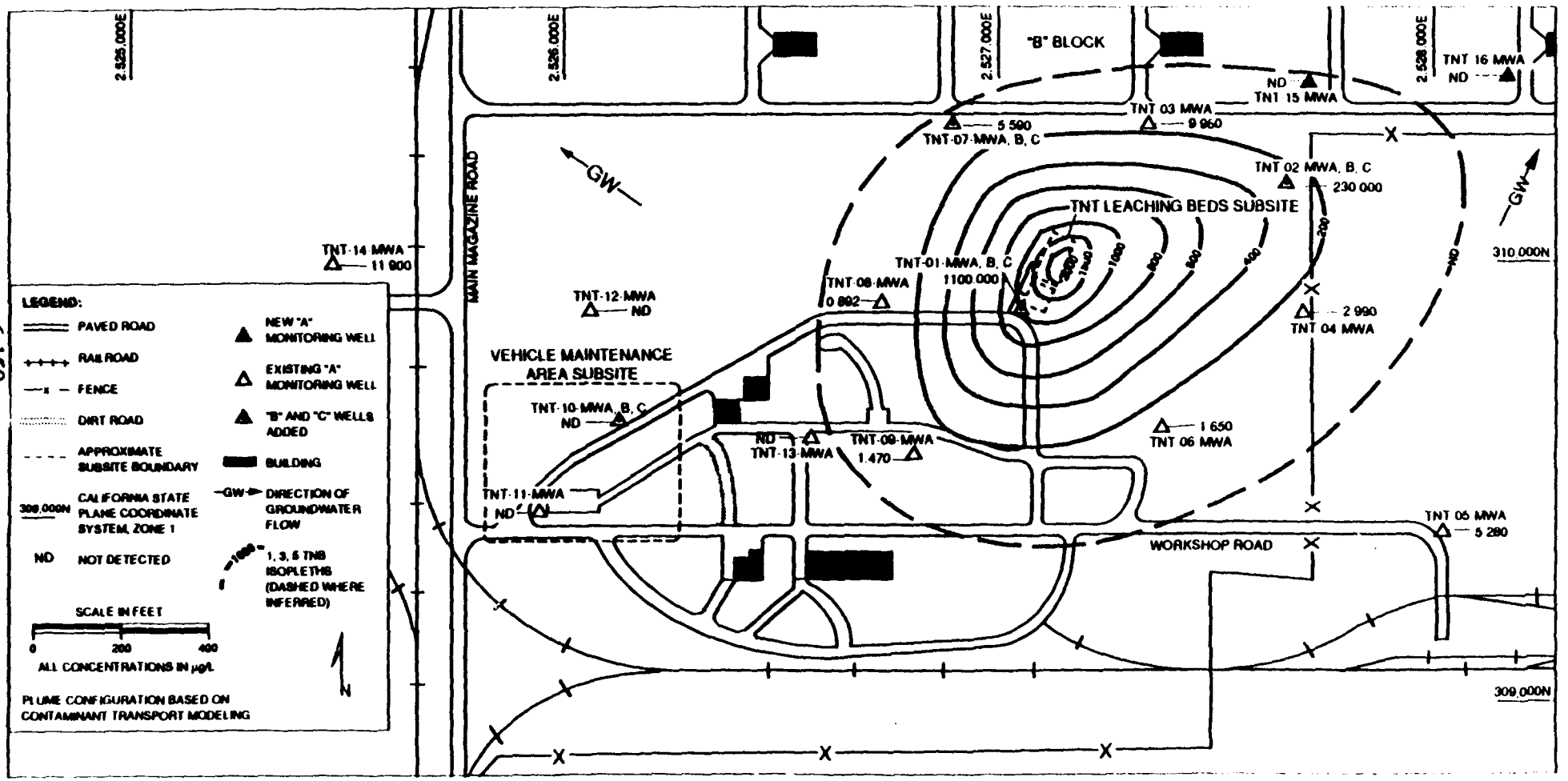
FIGURE 6-40



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TOTAL EXPLOSIVES GROUNDWATER PLUME IN "A" ZONE WELLS: TNT LEACHING BEDS AREA

FIGURE 6-41



SIERRA ARMY DEPOT

1, 3, 5 TNB GROUNDWATER PLUME IN "A" ZONE WELLS: TNT LEACHING BEDS AREA

FIGURE 6-42

TABLE 6-24

ESTIMATED MASS OF 1,3,5-TNB IN CONTAMINATION AREA

Concentration Range (µg/l)	Linear Average Conc'n (µg/l)	Area (ft^2)	Thickness (ft)	Volume (ft^3)	Aqueous Mass (g)	Solid Phase Conc'n (µg/kg)	Solid Phase Mass (g)	Aqueous Mass (lb)	Solid Phase Mass (lb)	Total Mass (lb)
1 - 200	70	768,864	50	38,443,200	13,716	15.4	30,176	30	67	97
200 - 400	300	211,246	50	10,562,300	16,151	66	35,532	36	78	114
400 - 600	500	130,797	50	6,539,850	16,667	110	36,667	37	81	118
600 - 800	700	79,406	50	3,970,300	14,166	154	31,165	31	69	100
800 - 1,000	900	51,379	50	2,568,950	11,785	198	25,926	26	57	83
1,000 - 1,500	1,250	25,631	50	1,281,550	8,165	275	17,963	18	40	58
1,500 - 2,000	1,750	11,410	50	570,500	5,089	385	11,195	11	25	36
2,000 - 2,500	2,100	2,795	50	139,750	1,496	462	3,291	3	7	11
Total		1,281,528			72,484		159,466	160	352	615
Porosity- 0.18 foc- 0.005 Density (kg/l)- 1.8		log Kow (TNB)-	1.73		Kd (TNB) - 0.22				Total Mass (lbs)	615

from surface soil samples and soil borings, are clearly a source of the groundwater contamination.

Extrapolations of plume movement using the MOC 2-D model were made for periods of 15 and 30 years with hydraulic conductivities of 5 or 10 feet/day. Horizontally isotropic conditions were utilized conservatively since these produced the largest potential extent of contamination. Although preferential permeability pathways may exist at the site, data was insufficient to delineate them. Therefore, a constant hydraulic conductivity across the site was used for modeling purposes.

TCE

Figure 6-43 presents an interpretation of current TCE plume at the TNT Leaching Beds Area. The plume dimensions are fairly well constrained by numerous non-detect values near the outer perimeter (Figure 6-34).

Figures 6-44 through 6-45 depict the modeled movement of TCE. The figures indicate limited plume movement from the current location for a period of 30 years into the future. Simulated TCE concentrations for 15 years at K=10 ft/day were identical to concentrations at 30 years with K=5 ft/day. No mass-loading from the unsaturated zone was simulated since TCE was not found in any soil samples at depths extending to the water table. Simulated TCE concentrations diminish over time as the plume is diluted by surrounding groundwater.

Model simulations indicate that the leading edge of the plume will migrate approximately 116 feet northwards in 30 years at a hydraulic conductivity of 5 feet/day, and that the peak concentration will diminish from approximately 1100 μg/L to 850 μg/L in the same period. At K=10 feet/day, the 1 μg/L contour migrates about 216 feet in 30 years, with the peak concentration contour dropping to 718 μg/L.

Plume migration, or, more accurately, lack of plume migration, is illustrated in Figure 6-46 showing concentrations of north-south cross sections through the centers of the plumes

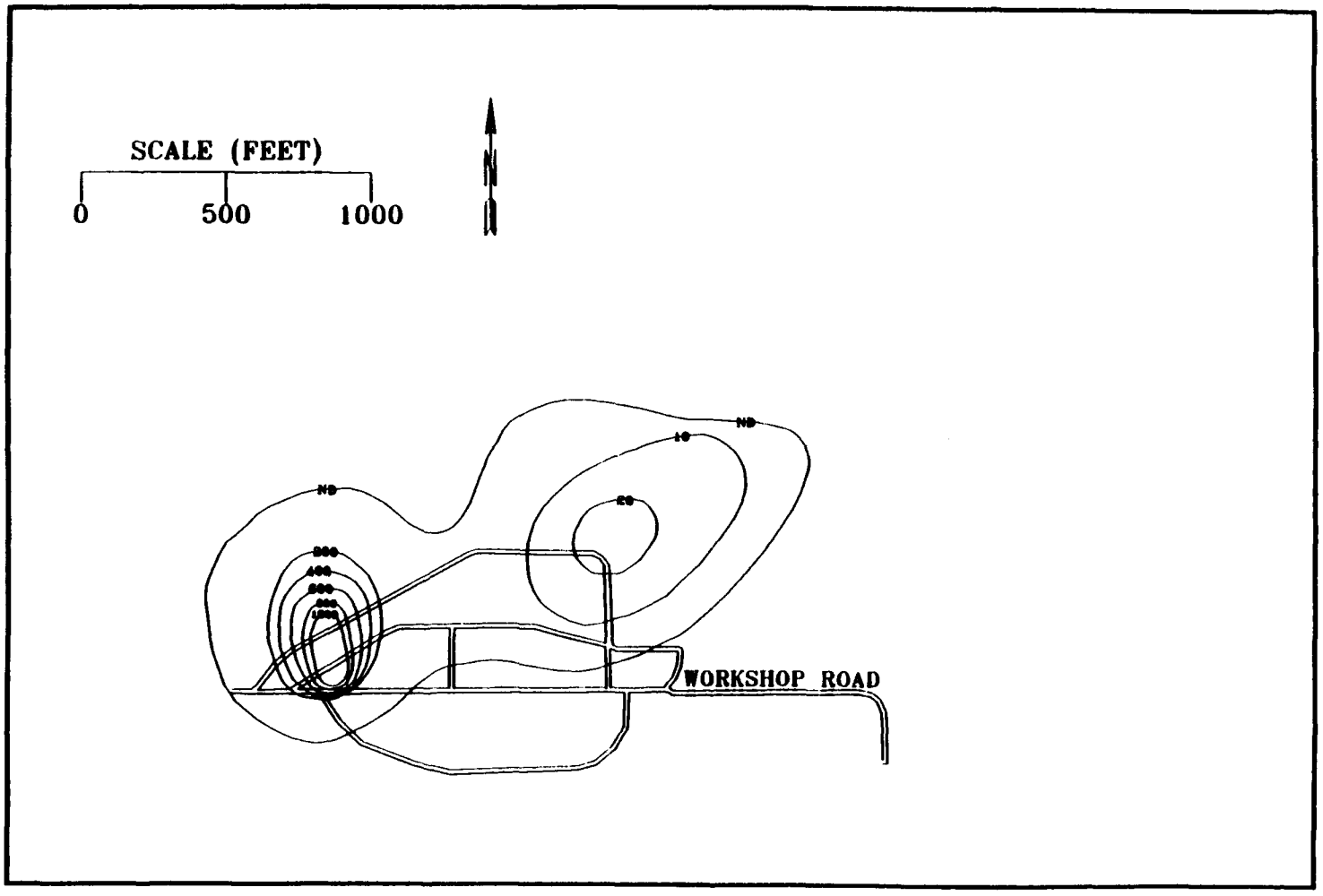
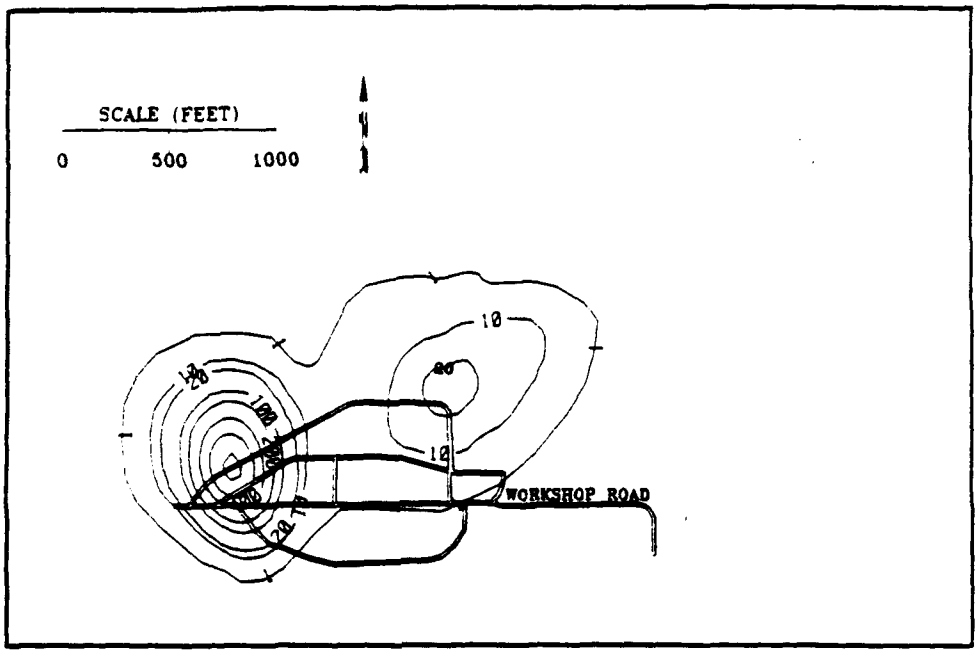
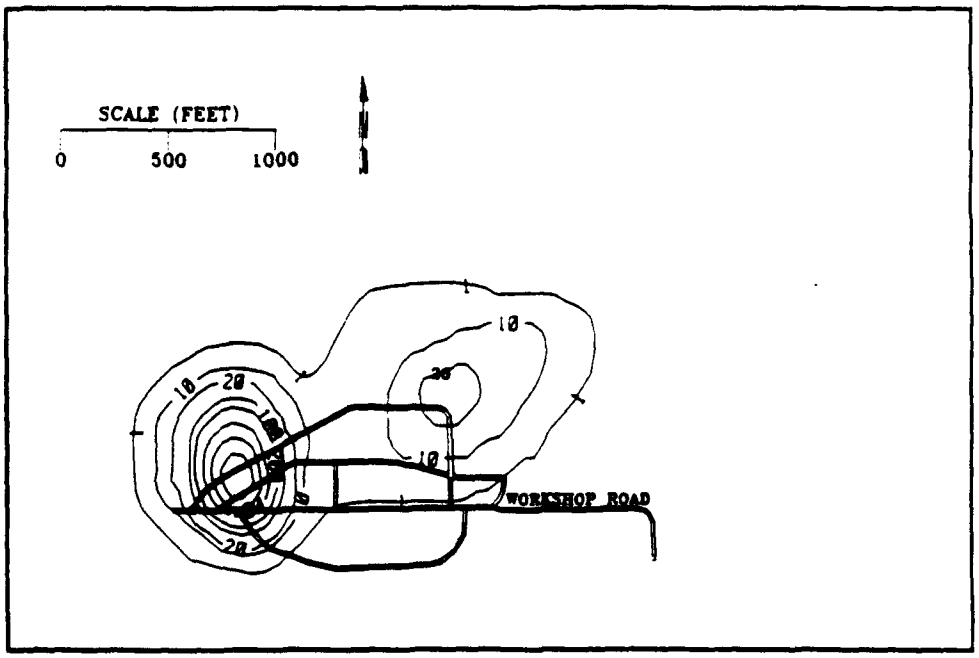


FIGURE 6-43: 1990 TCE CONCENTRATIONS AT TNT SITE (ug/l)



SIMULATED TCE CONCENTRATIONS: TNT SITE
YEAR 2020. K=5 FT/DAY. ZMAX=850



SIMULATED TCE CONCENTRATIONS: TNT SITE
YEAR 2005. K=5 FT/DAY. ZMAX=936

FIGURE 6-44

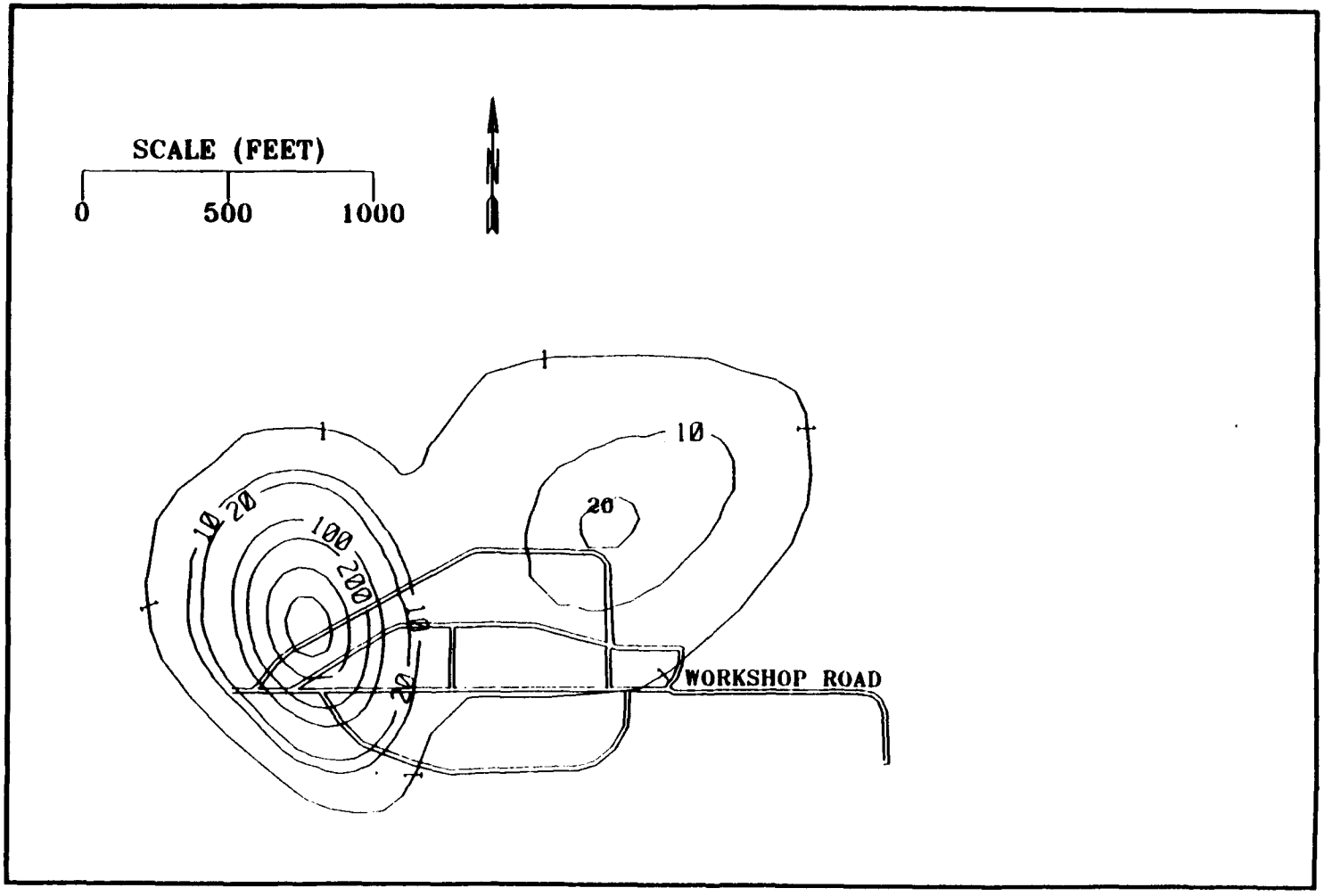


FIGURE 6-45: SIMULATED TCE CONCENTRATIONS: TNT SITE
YEAR 2020, K=10 FT/DAY, ZMAX=718

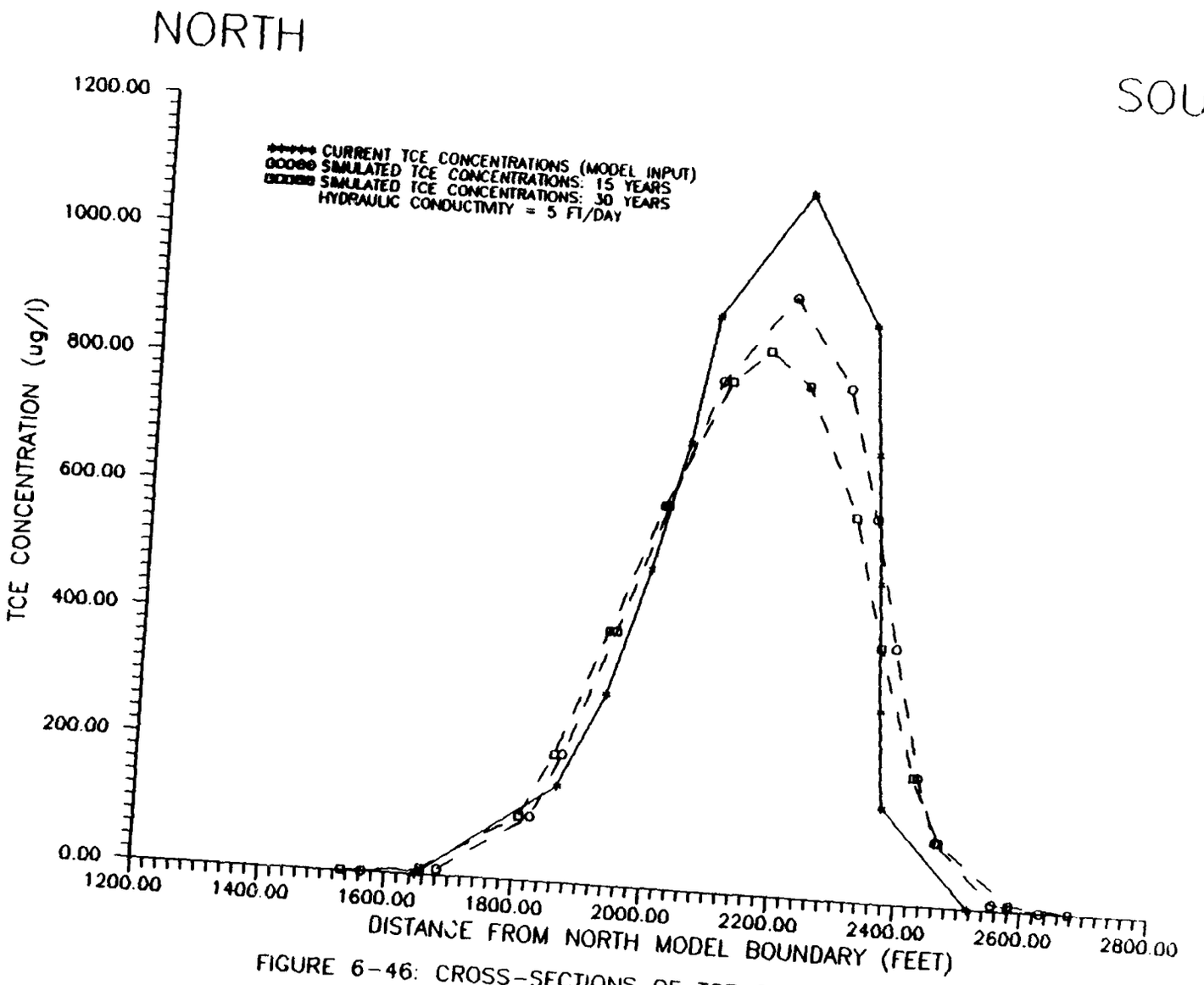


FIGURE 6-46: CROSS-SECTIONS OF TCE CONCENTRATIONS (TNT SITE)

(Figures 6-43 and 6-44). The rapid drop in peak concentration is partly a function of the model, since input had to be discretized into what were sometimes crude approximations of a continuous variation in concentration. In addition, a high concentration over a small area will rapidly disperse with time. TCE modeling indicates that movement in groundwater is negligible over a period of 30 years.

The apparent groundwater divide between the two lobes of the plume may preclude mixing between them. However, because of the extremely shallow gradient on the site (.001), and subsequent pore velocities on the order of 0.025 feet/day, molecular diffusion is thought to be an important factor in solute migration. Although the centers of contaminant concentrations migrate a short distance downgradient (northwards), because of diffusion the modeled plume expands an almost equal distance upgradient. The low hydraulic gradient is considered to be the primary factor limiting plume migration at this site.

Model Sensitivity

Aquifer parameters were considered to most strongly influence TCE migration were systematically varied to determine sensitivity of the model to these factors. These included hydraulic conductivity, dispersivity, distribution coefficient, storage coefficient, and effective porosity. Parameters were individually varied from maximum to minimum reasonable values for this site. All other parameters were kept at values considered to be the best estimates for the TNT Leaching Beds Site. Plume diameter (1 μg/L contour) and maximum TCE concentration were used to evaluate the effects of variations in these parameters (Table 6-25).

Variations in hydraulic conductivity have the greatest effect on plume diameter and maximum concentration. Dispersion and distribution coefficient were also important. The maximum extent of TCE (north-south diameter through center of concentration of western lobe) after 15 years was approximately 1,370 feet, less than 300 feet greater than the simulated plume extent using the assumed conductivity of 5 feet/day. Peak TCE concentration was 619 μg/L in this scenario (K=30 ft/day), versus 936 μg/L for K=5 ft/day after 15 years. These estimates of model parameters are thus considered to be conservative. Error in estimation of

TABLE 6-25

SUMMARY OF MODEL SENSITIVITY ANALYSIS FOR TCE

Run	Aquifer Parameters* K	DL	KD	S&n	Plume Diam.** (feet)	Max. Conc. (μg/l)	Comments
TCE 15-5	5	130	0.634	0.18	1,095	936	Assumed parameters, R=7.3
TCE 15-10	10				1,125	850	
TCEHCHI	30				1,370	619	Most significant factor
TCEDHI		260			1,140	848	
TCEKDLO			0.134		1,230	774	R=2.3
TCEKDHI			0.8		1,000	974	R=3.6

* Only changes from previous RUN are shown
** North-south extent through max. concentration
K = Hydraulic conductivity (ft/day)
DL = Longitudinal dispersivity (feet)
KD = Distribution coefficient
R = Retardation factor

these model parameters was believed to have only minor impacts on TCE migration and would likely not affect potential remediation alternatives.

TNB

Figure 6-47 presents modeled TNB concentration contours, using the MOC model, at the TNT Leaching Beds Area.

Figure 6-48 presents modeled extrapolations of TNB movement with no mass-loading. As with TCE, the centers of concentration migrate a short distance downgradient, while diffusion enlarged the plume concentrically, and dilution reduces concentrations over time. Cross sections of these simulated plumes convey the limited movement of TNB (Figure 6-49).

Mass-loading

TNB was found to be prevalent in the soil column above the groundwater plume. It was considered important to simulate mass-loading of TNB into groundwater from the unsaturated zone as part of the TNB groundwater modeling.

Simulated plumes were virtually identical after 15 years (Figures 6-50 and 6-51). This is believed to be due to the extremely low flux of solvent (water) through the site. With an annual precipitation of about 4 inches per year, SIAD is one of the most arid areas in the country. A low recharge rate of five percent further decreased flux through the unsaturated zone.

It is postulated that the original TNB plume was created because large quantities of water were used when the shell washout facility and leaching beds were active. This substantially increased the flux through the vadose zone. When this activity was discontinued, the effects of mass-loading of TNB from the unsaturated zone diminished. Therefore, plume contours continue to diminish regardless of loading from the vadose zone.

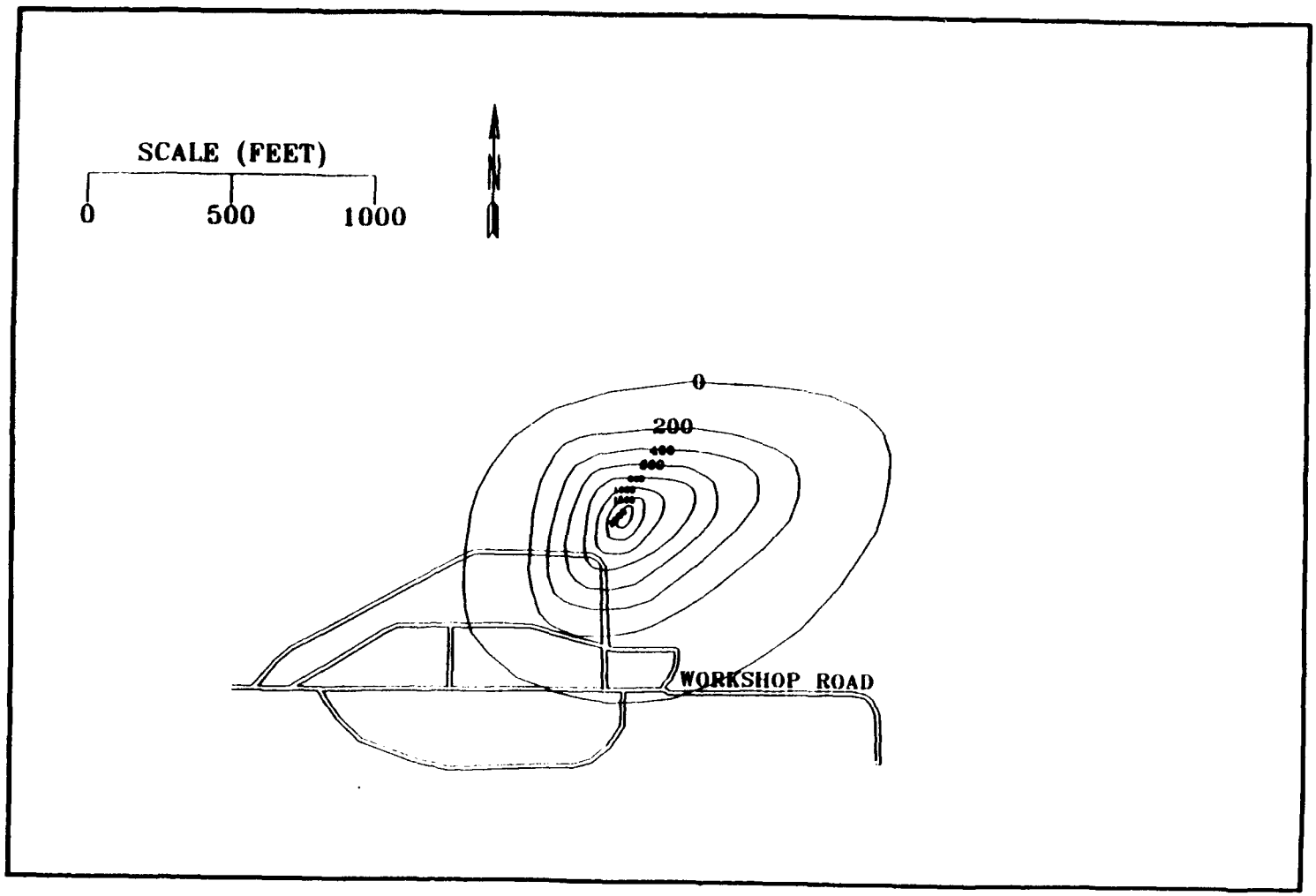
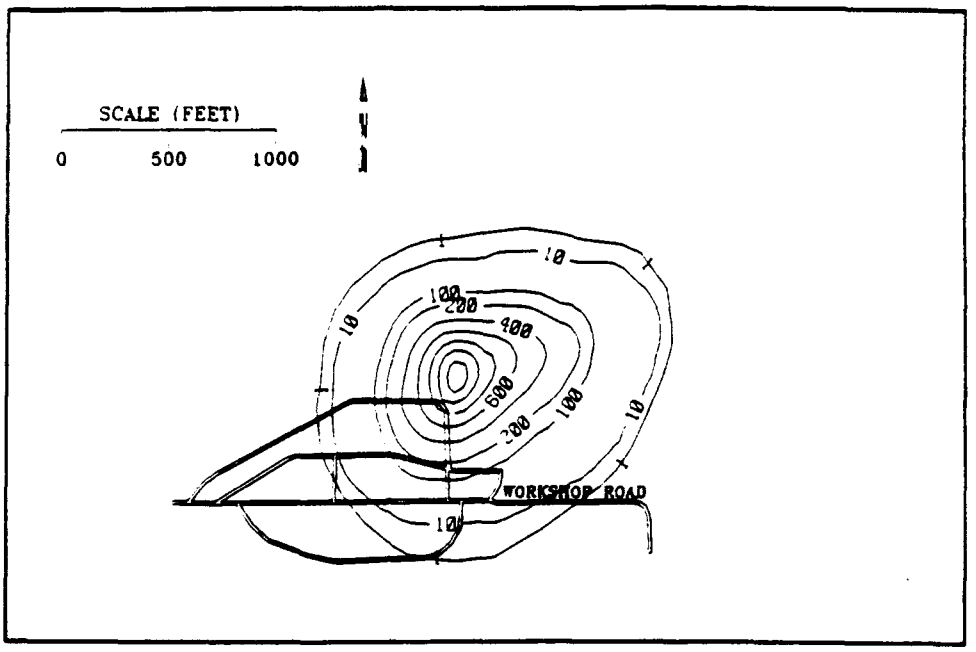
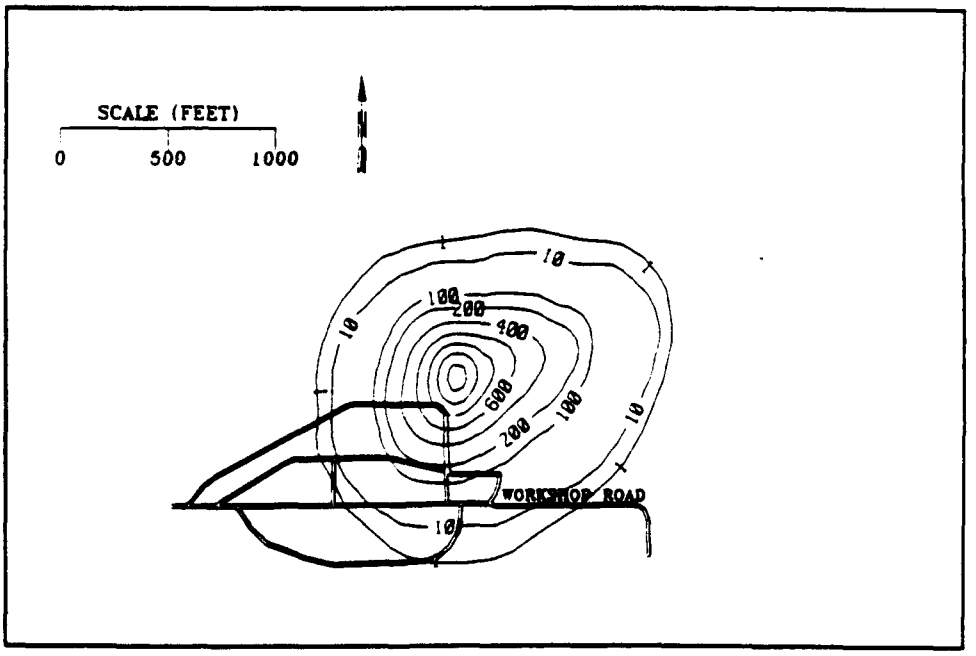


FIGURE 6-47: 1990 TNB CONCENTRATIONS AT TNT SITE (ug/l)



SIMULATED TNT CONCENTRATIONS WITHOUT MASS-LOADING. TNT SITE
YEAR 2020, K=5 FT/DAY, ZMAX=1072



SIMULATED TNB CONCENTRATIONS WITHOUT MASS-LOADING TNT SITE
YEAR 2005, K=5 FT/DAY, ZMAX=1299
FIGURE 6-48

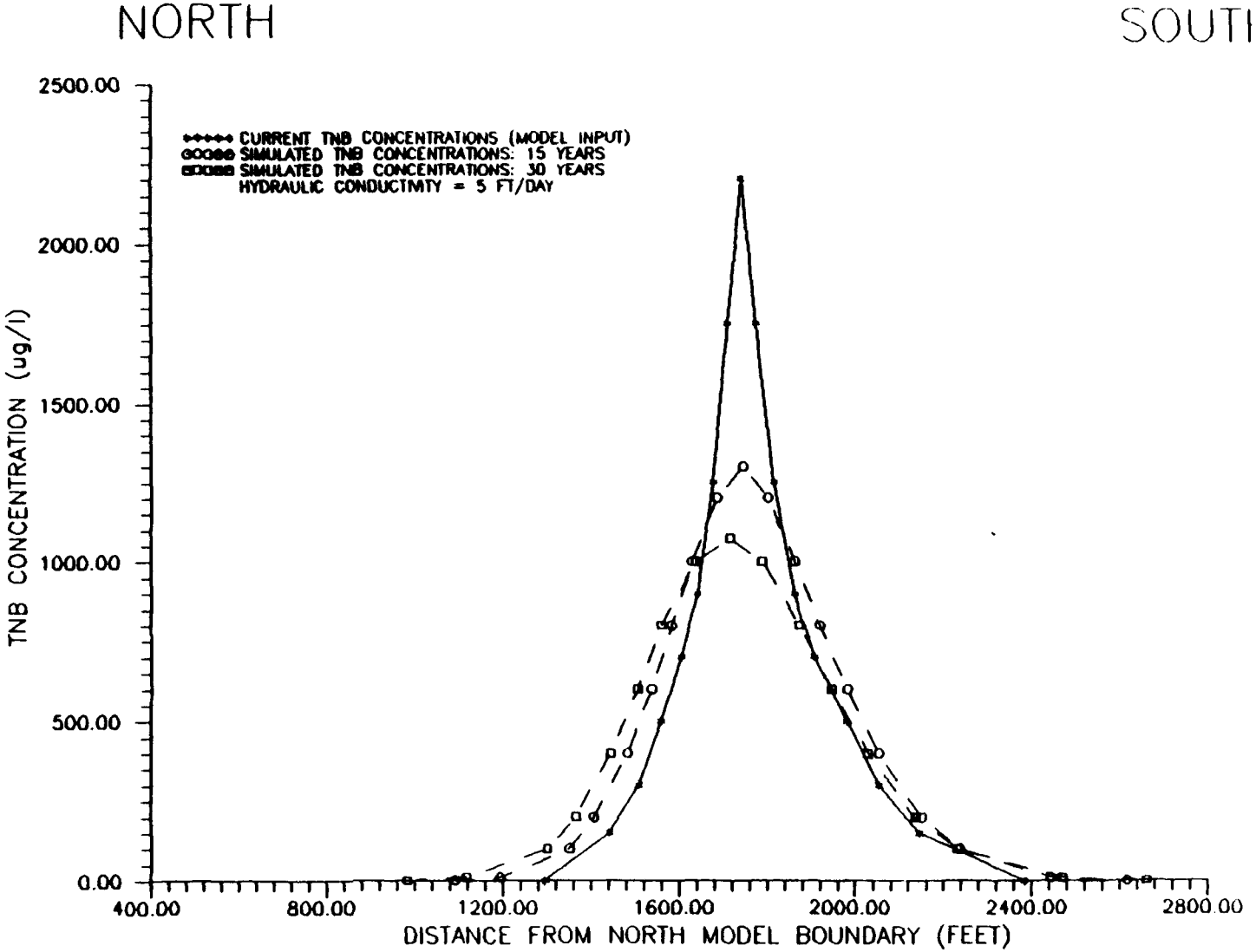


FIGURE 6-49: CROSS-SECTIONS OF TNB CONCENTRATIONS (TNT SITE)

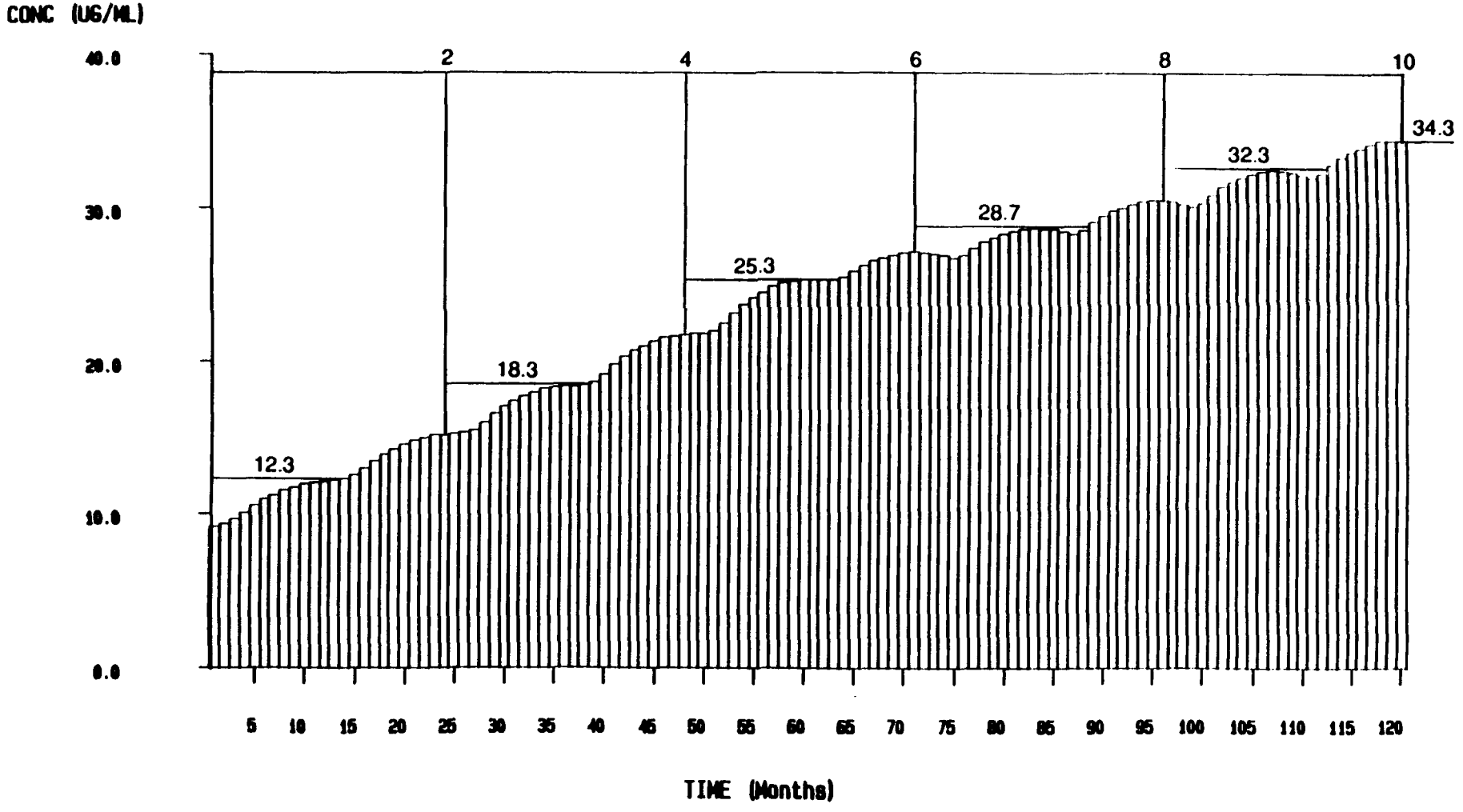
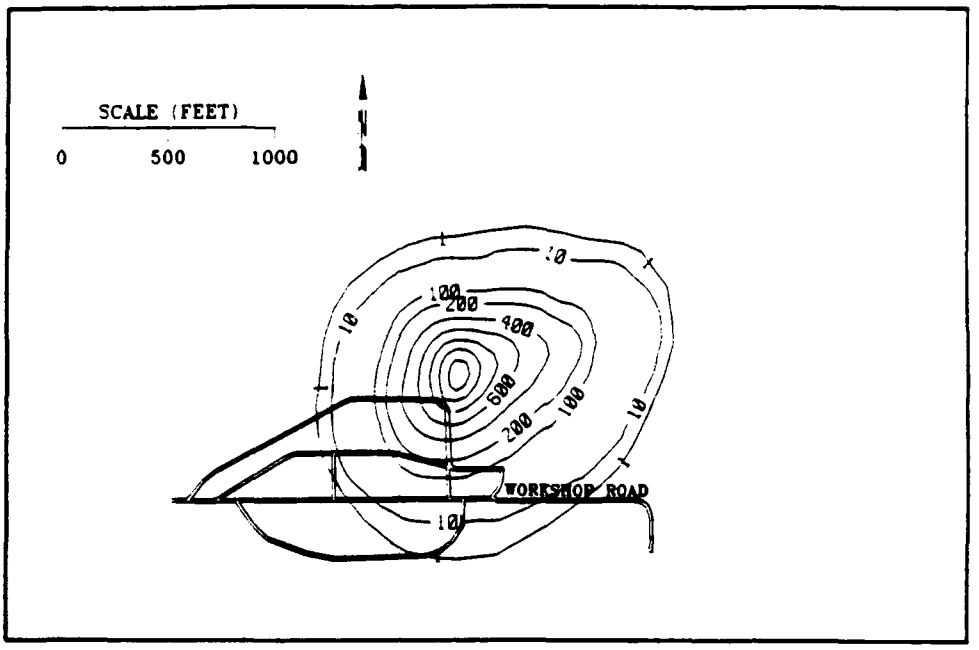
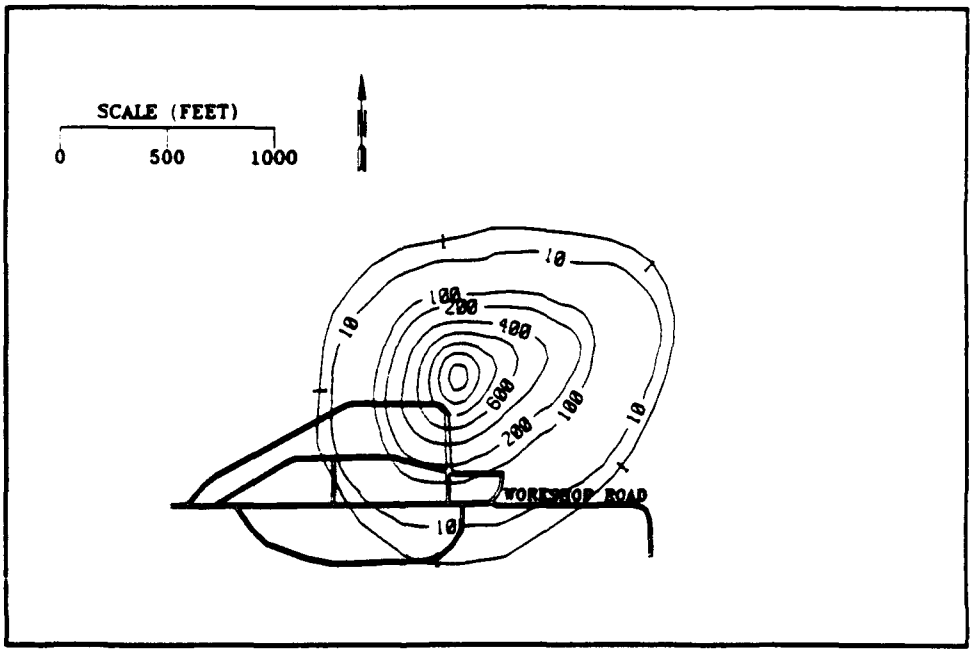


FIGURE 6-50: SIMULATED 1,3,5 TNB CONCENTRATION AT WATER TABLE FROM YEAR 1990 THRU 2000 SHOWING TIME STEPS (YEARS) AND AVERAGE CONCENTRATION (mg/L) FOR MOC MODEL INPUT



SIMULATED TNB CONCENTRATIONS W/MASS-LOADING
YEAR 2005, K=5 FT/DAY, ZMAX=1324



SIMULATED TNB CONCENTRATIONS WITHOUT MASS-LOADING: TNT SITE
YEAR 2005, K=5 FT/DAY, ZMAX=1299

FIGURE 6-51

Model Sensitivity

As with TCE, aquifer parameters considered to most strongly influence TNB migration were varied to determine model sensitivity to these factors (hydraulic conductivity, dispersivity, distribution coefficient, storage coefficient, and effective porosity). Mass-loading of TNB from the unsaturated zone was simulated in all sensitivity runs, since this was considered to be a likely occurrence. Plume diameters and maximum TNB concentrations from different model runs appear in Table 6-26.

Parameters which most affected TNB distribution concentration were hydraulic conductivity, dispersion, and distribution coefficient. The north-south TNB extent was 2,130 feet after 15 years at a hydraulic conductivity of 30 feet/day (six times the assumed conductivity value). Plume diameter is 1,524 feet when conductivity was equal to 5 ft/day. Peak concentrations were 738 and 1,324 μg/L respectively. It is noted in that mass-loading increases plume diameter by only nine feet, and the peak concentration by 25 μg/L after 15 years at the ambient flux. Estimates of model parameters were thus considered to be conservative. Error in estimation of these model parameters are believed to have only minor influences on TNB migration and would not likely affect potential remediation alternatives.

6.2.5.5 TNT Leaching Beds Area Summary

Since two distinct areas of contamination exist at this site, the TNT Leaching Beds Area site has been divided into two subsites: the TNT Leaching Beds Subsite and the Vehicle Maintenance Area Subsite.

Explosive compounds are the primary soil contaminants at the TNT Leaching Beds Subsite. Explosives were detected in 100 percent of the surface soils and 98 percent of the subsurface soils at the TNT Leaching Beds. 1,3,5-TNB had the highest frequency of occurrence (93 percent of subsurface soils). Therefore, this compound was selected for vadose zone (SESOIL) modeling.

TABLE 6-26

SUMMARY OF MODEL SENSITIVITY ANALYSIS FOR 1,3,5-TNB

RUN	Aquifer Parameters* K	DL	KD	S&n	Plume Diam. (feet)	Max. Conc. (μg/l)	Comments
TNB 15-5*	5	130	0.22	0.18	1,515	1,299	Assumed actual parameters, no M-L, R=3.2
TNB 15-10	10				1,680	1.071	No mass-loading
LTNB 15-5	5				1,524	1,324	Assumed parameters
LTNB 15-10	10				1,680	1,104	
TNBHCHI	30				2,130	738	Most significant factor
TNBDHI		260			1,740	1,113	Significant factor
TNBDLO		50			1,380	1,546	
TNBKDHI			0.8		1,350	1,565	Organic carbon = 0.01, R=9.0
TNBKDLO			0.035		1,725	1,080	Organic carbon = .001, R=1.35
TNBSNHI				0.3	1,470	1,367	Minor factor
TNBSNLO				0.05	1,575	1,282	

* Only changes from previous RUN are shown
** North-south extent through max. concentration
K = Hydraulic conductivity (ft/day)
DL = Longitudinal dispersivity (feet)
KD = Distribution coefficient
S = Storage coefficient
n = Effective porosity
M-L = Mass-loading (M-L simulated when not stated otherwise)
R = Retardation factor

The mass of total explosives in the vadose zone was estimated to be 22,099 pounds. The mass in the 0- to 2.5-foot interval is estimated to be about 20,570 pounds, or 93 percent of the total mass in the vadose zone. The mass of 1,3,5-TNB in the vadose zone beneath the TNT Leaching Beds is estimated to be 1,160 pounds, or 5 percent of the total explosives mass. The 1,3,5-TNB mass in the 0- to 2.5-foot interval is estimated to be about 240 pounds, or 21 percent of the 1,3,5-TNB mass in the vadose zone. The fact that 1,3,5-TNB is more evenly distributed throughout the vadose zone than other potential explosive compounds is indicative of the greater mobility of this contaminant. Vadose zone modeling suggests that the average concentration of 1,3,5-TNB at the soil-water interface will increase from 3 ppm to 6 ppm between 1990 to 2000.

Groundwater plumes of explosive contaminants were identified in the area of the TNT Leaching Beds. These plumes are traveling slowly downgradient in a northeasterly direction. The mass of 1,3,5-TNB in the groundwater is estimated to be about 620 pounds. 1,3,5-TNB has been modeled in the groundwater in order to predict future movement of the total explosives plume. Modeling results indicate that this plume is relatively immobile.

A bilobate VOC plume was also identified in the groundwater at this site. The eastern lobe of the plume is comprised of TCE and is also centered around the TNT Leaching Beds Subsite. The TCE source at this subsite is postulated to be random dumping into the TNT leaching beds. The western lobe has a maximum TCE concentration of 1,030 μg/L. This lobe is oriented in a northwesterly direction. The total mass of TCE in the groundwater estimated to be about 770 pounds. Carbon tetrachloride and chloroform were also detected in the western plume, although at much lower levels than TCE. No TCE breakdown products were detected, suggesting that little degradation of TCE is occurring at this site. Modeling results of TCE groundwater movement suggests that the plume is relatively immobile.

The TCE source of the western lobe of the groundwater plume is assumed to be the Vehicle Maintenance Area Subsite. This assumption is based on the groundwater and soil gas data. Borings were placed to coincide with locations of TCE in elevated soil gas. No TCE was

detected in any of these borings, suggesting the source of the elevated TCE levels in soil gas are coming from the groundwater.

6.2.6 Potable Supply Wells

No analytes were detected above background levels in supply wells 02, 08, or 09 (Tables 6-27 and 6-28). Potable Well No. 05 was shut down during both Rounds 1 and 2 of groundwater sampling and could not be sampled.

6.3 SUMMARY OF SITE CONTAMINATION

This section summarizes the SIAD Phase I RI contamination assessment. Contaminants detected and frequency of occurrence are presented in Table 6-29.

6.3.1 Abandoned Landfill

A soil gas survey indicated the presence of TCE and carbon tetrachloride in the northern portion of this site. The soil gas in the northwestern portion corresponded to the presence of TCE in the groundwater at this location. It was not determined if the TCE in soil gas resulted from groundwater or soil contamination.

Geophysical anomalies corresponded to surface metal debris, 2- to 6-inch-thick ash zones, or discreet 4- to 9-foot deep trenches. Trenches were comprised primarily of household garbage such as bottles, cans and ash.

Dioxin/furan was detected in a sample from the 5-foot interval of a trench. Heptachlor was detected in two of 53 samples at low levels 70 feet above the water table. No other extractable organic compound was detected in soil at this site. Phenols were detected but their presence was not confirmed by GC/MS. VOCs (TCE, acetone, and toluene) were detected in 11 percent of the soil samples from this site. TCE was not found at depths greater than 15 feet. A single inorganic constituent, lead, was detected at levels above background.

POSITIVE GROUNDWATER RESULTS - ROUND 1 - POTABLE SUPPLY WELLS

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
PSW-02	120.0	07-may-1990	99	Total dissolved solids	850000.000	ug/l
		07-may-1990	99	Total dissolved solids	680000.000	ug/l
		07-may-1990	SD20	Lead	3.580	ug/l
		07-may-1990	SD20	Lead	2.820	ug/l
		07-may-1990	SD22	Arsenic	5.970	ug/l
		07-may-1990	SD22	Arsenic	5.970	ug/l
		07-may-1990	SS10	Barium	28.400	ug/l
		07-may-1990	SS10	Barium	22.400	ug/l
		07-may-1990	SS10	Calcium	100000.000	ug/l
		07-may-1990	SS10	Calcium	100000.000	ug/l
		07-may-1990	SS10	Sodium	87000.000	ug/l
		07-may-1990	SS10	Sodium	12000.000	ug/l
		07-may-1990	SS10	Zinc	61.600	ug/l
		07-may-1990	SS10	Zinc	61.600	ug/l
		07-may-1990	TT10	Chloride	60000.000	ug/l
		07-may-1990	TT10	Chloride	60000.000	ug/l
		07-may-1990	TT10	Sulfate	380000.000	ug/l
		07-may-1990	TT10	Sulfate	370000.000	ug/l
		07-may-1990	UM18	1,2-Epoxycyclohexene (TIC)	2.000	ug/l
		07-may-1990	UM18	1,2-Epoxycyclohexene (TIC)	2.000	ug/l
		07-may-1990	UM18	2-Cyclohexen-1-ol (TIC)	2.000	ug/l
		07-may-1990	UM18	2-Cyclohexen-1-ol (TIC)	2.000	ug/l
		07-may-1990	UM18	2-Cyclohexen-1-one (TIC)	2.000	ug/l
		07-may-1990	UM18	2-Cyclohexen-1-one (TIC)	1.000	ug/l
		07-may-1990	UM18	Unknown 537 (TIC)	7.000	ug/l
		07-may-1990	UM18	Unknown 537 (TIC)	8.000	ug/l
		07-may-1990	UM18	Unknown 555 (TIC)	2.000	ug/l
		07-may-1990	UM18	Unknown 555 (TIC)	4.000	ug/l
		07-may-1990	UM18	Unknown 557 (TIC)	3.000	ug/l
		07-may-1990	UM18	Unknown 557 (TIC)	4.000	ug/l
		07-may-1990	UM18	Unknown 563 (TIC)	10.000	ug/l
		07-may-1990	UM18	Unknown 563 (TIC)	10.000	ug/l
		07-may-1990	UM18	Unknown 599 (TIC)	1.000	ug/l
PSW-08		07-may-1990	99	Total dissolved solids	740000.000	ug/l
		07-may-1990	SD20	Lead	4.770	ug/l
		07-may-1990	SD22	Arsenic	7.460	ug/l
		07-may-1990	SS10	Barium	35.200	ug/l
		07-may-1990	SS10	Calcium	84000.000	ug/l
		07-may-1990	SS10	Sodium	71000.000	ug/l
		07-may-1990	SS10	Zinc	43.400	ug/l
		07-may-1990	TT10	Chloride	44000.000	ug/l
		07-may-1990	TT10	Sulfate	310000.000	ug/l
		07-may-1990	UM18	1,2-Epoxycyclohexene (TIC)	2.000	ug/l
		07-may-1990	UM18	2-Cyclohexen-1-ol (TIC)	2.000	ug/l
		07-may-1990	UM18	2-Cyclohexen-1-one (TIC)	1.000	ug/l
		07-may-1990	UM18	Unknown 537 (TIC)	9.000	ug/l
		07-may-1990	UM18	Unknown 555 (TIC)	1.000	ug/l
		07-may-1990	UM18	Unknown 563 (TIC)	9.000	ug/l

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

POSITIVE GROUNDWATER RESULTS - ROUND 1 - POTABLE SUPPLY WELLS

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
PSW-09	120.0	07-may-1990	99	Total dissolved solids	340000.000	ug/l
		07-may-1990	SD20	Lead	1.950	ug/l
		07-may-1990	SD22	Arsenic	3.200	ug/l
		07-may-1990	SS10	Barium	55.300	ug/l
		07-may-1990	SS10	Calcium	28000.000	ug/l
		07-may-1990	SS10	Sodium	50100.000	ug/l
		07-may-1990	TT10	Chloride	17100.000	ug/l
		07-may-1990	TT10	Sulfate	57100.000	ug/l
		07-may-1990	UM18	Unknown 537 (TIC)	6.000	ug/l

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

POSITIVE GROUNDWATER RESULTS - ROUND 2 - POTABLE SUPPLY WELLS

Site	Depth (ft)	Sample Date	Test Method	Compound	Concentration	Units
PSW-02	120.0	07-jun-1990	99	Total dissolved solids	732000.000	ug/l
		07-jun-1990	99	Total dissolved solids	754000.000	ug/l
		07-jun-1990	SD20	Lead	3.470	ug/l
		07-jun-1990	SD20	Lead	3.250	ug/l
		07-jun-1990	SD21	Selenium	4.370	ug/l
		07-jun-1990	SD22	Arsenic	3.940	ug/l
		07-jun-1990	SD22	Arsenic	3.410	ug/l
		07-jun-1990	SS10	Barium	39.100	ug/l
		07-jun-1990	SS10	Barium	25.500	ug/l
		07-jun-1990	SS10	Calcium	110000.000	ug/l
		07-jun-1990	SS10	Calcium	110000.000	ug/l
		07-jun-1990	SS10	Copper	8.260	ug/l
		07-jun-1990	SS10	Sodium	72000.000	ug/l
		07-jun-1990	SS10	Sodium	71000.000	ug/l
		07-jun-1990	SS10	Zinc	51.500	ug/l
		07-jun-1990	TF18	Cyanide	11.300	ug/l
		07-jun-1990	TT10	Chloride	66000.000	ug/l
		07-jun-1990	TT10	Chloride	66000.000	ug/l
		07-jun-1990	TT10	Sulfate	293000.000	ug/l
		07-jun-1990	TT10	Sulfate	300000.000	ug/l
		07-jun-1990	UM18	Unknown 558 (TIC)	6.000	ug/l
		07-jun-1990	UM18	Unknown 564 (TIC)	10.000	ug/l
		07-jun-1990	UM18	Unknown 564 (TIC)	10.000	ug/l
PSW-08		07-jun-1990	99	Total dissolved solids	666000.000	ug/l
		07-jun-1990	SD20	Lead	3.900	ug/l
		07-jun-1990	SD22	Arsenic	4.800	ug/l
		07-jun-1990	SS10	Barium	37.700	ug/l
		07-jun-1990	SS10	Calcium	97000.000	ug/l
		07-jun-1990	SS10	Sodium	79000.000	ug/l
		07-jun-1990	SS10	Zinc	50.300	ug/l
		07-jun-1990	TT10	Chloride	44000.000	ug/l
		07-jun-1990	TT10	Sulfate	289000.000	ug/l
		07-jun-1990	UM18	Unknown 538 (TIC)	5.000	ug/l
		07-jun-1990	UM18	Unknown 539 (TIC)	4.000	ug/l
		07-jun-1990	UM18	Unknown 564 (TIC)	8.000	ug/l
PSW-09		07-jun-1990	99	Total dissolved solids	310000.000	ug/l
		07-jun-1990	SD20	Lead	1.950	ug/l
		07-jun-1990	SD22	Arsenic	4.370	ug/l
		07-jun-1990	SS10	Barium	60.600	ug/l
		07-jun-1990	SS10	Calcium	31000.000	ug/l
		07-jun-1990	SS10	Sodium	50800.000	ug/l
		07-jun-1990	TF18	Cyanide	11.200	ug/l
		07-jun-1990	TT10	Chloride	16900.000	ug/l
		07-jun-1990	TT10	Sulfate	50000.000	ug/l

Notes: (TIC) indicates a tentatively identified compound.
'>' indicates actual concentration is greater than the upper certified limit.

TABLE 6-29

SUMMARY OF ANALYTICAL DATA
(Page 1 of 7)

Site	Matrix	Contaminant	Concentration Range	No. of Detects[a]	Total No. of Samples	California MCL
Abandoned Landfill	Soil	Lead	425 µg/g	1	53	NA
"	"	Heptachlor	0.007 to 0.011 µg/g	2	53	NA
"	"	Acetone	0.03 µg/g	1	53	NA
"	"	Toluene	0.0009 to 0.002 µg/g	3	53	NA
"	"	TCE	0.003 to 0.02 µg/g	2	53	NA
"	"	TCFM	0.02 µg/g	1	53	NA
"	"	Dioxin/Furan	.0008978 µg/g[b]	1	4	NA
"	Groundwater		0.288 µg/L			
"	"	Chloroform	1.1 µg/L	2	3	NA
"	"	TCE	40.9 µg/L	1	3	5.0 µg/L
Construction Debris Landfill/ Chemical Burial Site						
	Soil	TCFM	0.008 µg/g	2	61	NA

TABLE 6-29

SUMMARY OF ANALYTICAL DATA
(Page 2 of 7)

Site	Matrix	Contaminant	Concentration Range	No. of Detects[a]	Total No. of Samples	California MCL
"	"	Bis-2(ethylhexyl) phthalate	2.0 µg/g,	1	61	NA
"	"	Chlordane	0.063 to 0.582 µg/g	2	61	NA
"	"	Heptachlor	0.008 µg/g	1	61	NA
"	"	OCDD	0.000062 to 0.001 µg/g	3	5	NA
"	Groundwater	TCE	6.73 µg/L	1	2	5.0 µg/L
DRMO Trench Area	Soil	Acetone	0.02 µg/g	1	113	NA
"	"	Benzene	0.96 µg/g	1	113	NA
"	"	Chlorobenzene	2.45 µg/g	1	113	NA
"	"	Chloroform	0.071 µg/g	1	113	NA
"	"	1,2-DCE	0.101 µg/g	1	113	NA
"	"	1,1-DCE	0.15 µg/g	1	113	NA
"	"	1,2-Dichloropropane	0.06 µg/g	1	113	NA
"	"	Ethyl Benzene	5.38 µg/g	1	113	NA
"	"	Methylene Chloride	0.015 to 0.706 µg/g	4	113	NA

TABLE 6-29

SUMMARY OF ANALYTICAL DATA
(Page 3 of 7)

Site	Matrix	Contaminant	Concentration Range	No. of Detects[a]	Total No. of Samples	California MCL
"	"	1,1,2,2-Tetrachloro-ethene	1.50 µg/g	1	113	NA
"	"	Tetrachloroethene	1.70 µg/g	1	113	NA
"	"	Toluene	0.0008 to 33.0 µg/g	7	113	NA
"	"	1,1,1-Trichloro-ethane	1.44 µg/g	1	113	NA
"	"	Trichloroethene	0.006 to 31.4 µg/g	6	113	NA
"	"	Xylenes	29.1 µg/g	1	113	NA
"	"	Dichlorobenzene, total	230 µg/g	1	113	NA
"	"	Bis(2-ethylhexyl) phthalate	0.92 to >13 µg/g	5	113	NA
"	"	1,2 Dichlorobenzene	82 µg/g	1	113	NA
"	"	1,4 Dichlorobenzene	20 µg/g	1	113	NA
"	"	Phenol	0.66 to 1.8 µg/g	2	113	NA
"	"	Aldrin	0.059 µg/g	1	113	NA
"	"	DDD, PP'	2.25 µg/g	1	113	NA

TABLE 6-29

SUMMARY OF ANALYTICAL DATA
(Page 4 of 7)

Site	Matrix	Contaminant	Concentration Range	No. of Detects[a]	Total No. of Samples	California MCL
"	"	DDE, PP'	0.025 μg/g	1	113	NA
"	"	DDT, PP'	0.014 to 2.56 μg/g	2	113	NA
"	"	Heptachlor	.008 μg/g	1	113	NA
"	Groundwater	TCE	4.18 to 26.0 μg/L	3	3	5.0 μg/L
"	"	Bis(2-ethylhexyl) phthalate	4.6 μg/L	1	3	NA
TNT Leaching Beds Area Soil	Surface	2,4-DNT	8.26 to 19.8 μg/g	2	8	NA
"	"	HMX	7.03 to 22.7 μg/g	3	8	NA
"	"	RDX	112 to 1,270 μg/g	4	8	NA
"	"	1,3,5-TNB	1.41 to 124 μg/g	8	8	NA
"	"	2,4,6-TNT	7.78 to 11,600 μg/g	8	8	NA
TNT Leaching Beds Area	Soil	2,4 DNT	0.465 to 1.95 μg/g	20	133	NA

TABLE 6-29

SUMMARY OF ANALYTICAL DATA
(Page 5 of 7)

Site	Matrix	Contaminant	Concentration Range	No. of Detects[a]	Total No. of Samples	California MCL
"	"	HMX	0.690 to 14.9 µg/g	28	133	NA
"	"	RDX	0.644 to 59.2 µg/g	53	133	NA
"	"	Tetryl	0.751 µg/g	1	133	NA
"	"	1,3,5-TNB	0.837 to 48.9 µg/g	76	133	NA
"	"	2,4,6-TNT	0.477 to 26.2 µg/g	37	133	NA
"	"	Toluene	0.0009 µg/g	1	57	NA
"	"	TCE	0.004 to 0.03 µg/g	1	57	NA
"	Groundwater	Chromium	6.89 to 226 µg/L	6	24	50 µg/L
"	"	Selenium	3.4 to 46.6 µg/L	8	24	10 µg/L
"	"	Arsenic	5.63 to 31.4 µg/L	24	24	50 µg/L
"	"	Trans-1,3-dichloro-propene	5.00 µg/L	1	24	NA

TABLE 6-29

SUMMARY OF ANALYTICAL DATA
(Page 6 of 7)

Site	Matrix	Contaminant	Concentration Range	No. of Detects[a]	Total No. of Samples	California MCL
"	"	Carbon tetrachloride	0.269 to 240 µg/L	6	24	0.5 µg/L
"	"	Chloroform	0.70 to 910 µg/L	4	24	NA
"	"	1,2-dichloroethane	0.82 to 130 µg/L	2	24	0.5 µg/L
"	"	Toluene	2.50 µg/L	1	24	NA
"	"	Methylene chloride	8.5 µg/L	1	24	NA
"	"	TCE	0.92 to 1,030 µg/L	11	24	5.0 µg/L
"	"	Bis(2-ethylhexyl) phthalate	4.8 to 7.8 µg/L	3	24	NA
"	"	2,4-Dinitrophenol	17 µg/L	1	24	NA
"	"	2,4-Dinitrotoluene	6.8 to 88 µg/L	3	24	NA
"	Groundwater	2,4-Dinitrotoluene[d]	2.04 to 89.9 µg/L	5	24	NA
"	"	HMX	3.70 to 7.69 µg/L	3	24	NA

TABLE 6-29

SUMMARY OF ANALYTICAL DATA
(Page 7 of 7)

Site	Matrix	Contaminant	Concentration Range	No. of Detects[a]	Total No. of Samples	California MCL
"	"	RDX	90.4 to 253 µg/L	3	24	NA
"	"	Tetryl	1.1 to 9.7 µg/L	4	24	NA
"	"	1,3,5-Trinitrobenzene	0.793 to 1,080 µg/L	11	24	NA
"	"	2,4,6-Trinitrotoluene	1.05 to 7.86 µg/L	4	24	NA

[a] Above background for metals
[b] Total dioxin/furan
[c] Value based on GC/MS analysis
[d] Value based on HPLC analysis

NA - Not Applicable

TCE (41.000 μg/L) was detected [above the MCL (5.0 μg/L)] from ALF-02-MWA, located in the northwestern portion of the site in an area where elevated levels of TCE were detected in soil gas. No soil samples were collected from this area and a TCE source was not identified. Chloroform was also detected in ALF-03-MWA.

Selenium was detected above the MCL (10 μg/L) in two monitoring wells. A selenium soil source was not identified, therefore selenium in groundwater may represent natural background levels.

6.3.2 Chemical Burial Site/Construction Debris Landfill

TCE soil gas was detected at low levels in the southern portion of this area and is apparently related to the soil gas detected in the Abandoned Landfill. TCE in soil gas corresponds to TCE present in groundwater.

No significant geophysical anomalies were registered. Three test pits were excavated at the Chemical Burial Site and 3 to 4 feet of fill material was uncovered. No drums or visible chemical residue were encountered.

Dioxin/furan compounds were detected in three of five samples collected from the 5-foot interval. The highest concentration was 0.001 μg/g of octa-dioxin.

Extractable organic compounds, at low levels, were detected in 7 percent of the samples (Table 6-28). All contaminants were found 35- to 40-foot above the water table. Phenols were detected but their presence was not confirmed by GC/MS. Trichlorofluoromethane was the only VOC detected and was identified in only 5 percent of the soil samples. No inorganic constituents were identified above background levels.

TCE was detected in CCB-02-MWA at 6.760 μg/L which is above the MCL (5.0 μg/L). The TCE in this well may be part of a TCE plume originating in the northwestern portion of the Abandoned Landfill. The extent of TCE in groundwater could not be fully defined due to a lack of data.

6.3.3 DRMO Trench Area

A geophysical survey and excavation of test pits were performed to locate and characterize a buried trench that reportedly existed about 50 feet west of the open DRMO trench. The reportedly buried trench was not located as result of either of these investigations. A burn and debris area was discovered about 120 feet southwest of the open trench, and four test pits were excavated. The burn zone overlying native soil was found to be only 2 to 4 inches thick. No samples were collected from this burn zone.

Ten percent of the soil samples contained extractable organic compound levels exceeding detection limits. The highest concentrations were detected in the 15-foot interval sample from DMO-11-SB. This boring was drilled adjacent to the trench at an angle, so that the 15-foot sample roughly corresponds to 5 feet below the trench. Strong affinity of the detected compounds for soil may explain why they have not migrated to the groundwater.

VOCs were detected in 11 percent of the soil samples. TCE was detected at low levels in soils directly above the water table, suggesting that this contaminant has migrated vertically to the groundwater. Fifteen individual VOCs were detected in the 15-foot interval sample from DMO-11-SB (Table 6-28). Lower concentrations of TCE and methylene chloride were detected at the 25-foot interval in this boring.

TCE was detected in all three monitoring wells at this site. In two wells TCE concentrations (Table 6-28) were above the MCL (5.0 μg/L). The groundwater with the highest TCE concentration was the downgradient well, suggesting contaminant movement in a southerly direction. A groundwater TCE plume map could not be constructed due to a lack of data.

6.3.4 TNT Leaching Beds

A soil gas survey indicated the presence of TCE, carbon tetrachloride, chloroform, and hydrocarbons in the vicinity of a concrete pad located in the western portion of the site. Highest VOC concentrations were detected in samples collected adjacent to the pad, suggesting this area is a contaminant source.

Explosives compounds were detected in all eight surface soils samples collected from the TNT Leaching Beds Area. Metals were not identified at levels above what are considered background.

TCE was detected in only two subsurface soil samples collected from the TNT leaching beds. The source of the TCE is considered to be random dumping of TCE either directly into the beds or into the concrete troughs that empty into the beds. Toluene was detected in one soil sample from the Vehicle Maintenance Area Subsite.

Explosives compounds were detected in 98 percent of the subsurface soil samples collected from the TNT Leaching Beds Subsite. 1,3,5-TNB was detected in 93 percent of the subsurface soil samples, making it the most widely distributed explosives compound. A SESOIL vadose zone contaminant transport model was used to simulate migration of 1,3,5-TNB from the years 1990 to 2000. Model results show that at the vadose/saturated zone interface, the concentrations of 1,3,5-TNB should increase from 3 μg/g to 6 μg/g. Three explosive compounds were detected at low levels in the 35-foot interval from the Vehicle Maintenance Area Subsite (Table 6-28).

Bis(2-ethylhexyl)phthalate and 2,4-dinitrophenol were the only extractable organic compounds detected in groundwater at this site.

TCE, 1,2-DCA, chloroform, and carbon tetrachloride were detected in groundwater. TCE was detected in nine of 16 "A" zone wells. Concentrations in four wells were above the MCL (5.0 μg/L).

A bilobate TCE groundwater plume exists at this site. The western lobe of the plume is centered around the Vehicle Maintenance Area Subsite. The eastern lobe of the plume is centered around the TNT Leaching Beds Subsite. Both are moving slowly downgradient in a northerly direction. Estimated TCE mass in groundwater is estimated to be about 770 pounds. 1,2-DCA, chloroform, and carbon tetrachloride groundwater plumes are not as extensive as the TCE plume and are only found in the western lobe of the VOC plume.

Explosive compounds were detected in ten "A" zone wells. 1,3,5-TNB was detected in eight of the "A" zone wells, making it the most widely distributed explosive compound in groundwater at this site. Total explosives and 1,3,5-TNB plume maps were constructed and show that both of these plumes are centered around the TNT Leaching Beds Subsite. These plumes are moving slowly downgradient in a northeasterly direction. Estimated 1,3,5-TNB mass in groundwater is 615 pounds.

MOC 2-D contaminant transport model results indicate that both the 1,3,5-TNB and TCE plumes are relatively immobile. The low hydraulic gradient is considered to be the primary factor limiting plume migration at this site.

Section 7

Public Health Evaluation

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7.0 PUBLIC HEALTH EVALUATION

The major objective of a health risk assessment is to assess the magnitude and probability of current or potential public health and environmental risk from chemical constituents identified by the RI field investigation and sampling program. This section addresses potential human health risks associated with the five SIAD Phase I RI sites; Section 8, Environmental Assessment, addresses potential environmental/ecological risks associated with the five sites. An overall site history and a summary of previous field investigations conducted at the five SIAD Phase I RI sites are detailed in Section 2 of this report.

7.1 INTRODUCTION

The central task of a Baseline Risk Assessment (BRA) is to identify the potential human health risks associated with the no-action alternative. Under this case, it is assumed that there is no attempt to mitigate or prevent human exposures to toxic substances. The BRA serves as a baseline case that provides for a health-based comparison of the relative effectiveness of various remediation strategies addressed in the feasibility study process. Pertinent information on the content and preparation of human health risk assessments is contained in the following documents: Guidance for Conducting Remedial Investigation and Feasibility Studies under CERCLA (USEPA, 1988), the Risk Assessment Guidance for Superfund, Vol. I Human Health Evaluation Manual (Part A) (USEPA, 1989a), The Exposure Factors Handbook (USEPA, 1989d), The California Site Mitigation Decision Tree Manual (CDHS, 1986), and the Risk Assessment Guidance for Superfund Human Health Risk Assessment, USEPA Region IX Recommendations (USEPA, 1989c).

7.1.1 Purpose and Objectives

The BRA provides an evaluation of the hazards posed by contaminants detected in the site environmental media (e.g., soils, groundwater, surface water, and air) and identifies those contaminants that potentially pose the greatest risks to human health based on their prevalence, concentration in environmental media, inherent toxicity, and applicable regulatory limits for different media. The basic goal is to screen the detected contaminants to determine

which substances should be the focus of the BRA. Once a relevant set of contaminants of potential concern is defined, an exposure assessment is prepared, beginning with an estimation of specific source terms (i.e., inputs to groundwater, soil, and air), and then simulation of the fate and transport of the contaminants in different media. Site-specific fate and transport information is detailed in Section 6.2, Contaminant Distribution.

The exposure assessment evaluates the pathways by which humans could potentially contact contaminants at a specific site within SIAD and adjacent land area. Exposure scenarios and assumptions are made to predict dose. Dose assessment predicts potential receptor point exposures. Dose-response functions are used to correlate exposure doses to health effects. Risks are calculated and characterized based on exposure doses. Each of the components of the risk assessment process involves uncertainties; some are difficult to quantify because of incomplete site data, and others result from a lack of complete understanding of the underlying disease process (e.g., multi-stage carcinogenesis).

7.1.2 Scope of the Baseline Risk Assessment

The five SIAD Phase I RI sites were sampled based on the reported data in the Master Environmental Plan (Benioff, et al, 1988) indicating sites, history, contamination levels and matrix. Information contained in the plan led to soil and groundwater sampling performed in accordance with the Sampling Design Plan (JMM, 1990) at the Abandoned Landfill, Chemical Burial Site/Construction Debris Landfill, DRMO Trench Area, and TNT Leaching Beds Site.

The nature of the specific sites and the contaminants at each site, as well as the remoteness of SIAD Phase I RI sites from human populations, reinforces the necessity to treat the sites either separately or as individual units.

For the purpose of this BRA, the five SIAD Phase I RI sites will be discussed as the following units:

- Abandoned Landfill
- Chemical Burial Site/Construction Debris Landfill
- DRMO Trench Area
- TNT Vehicle Maintenance Subsite
- TNT Leaching Beds Subsite

Since the Chemical Burial Site is contained entirely within the Construction Debris Landfill, the two are discussed together. The TNT Leaching Beds Area is divided into two subsites, the TNT Vehicle Maintenance Subsite and the TNT Leaching Beds Subsite, because distinct groundwater and soil contaminants occur at each.

The potential contaminants of concern, include inorganics, volatile organic compounds (VOCs), semivolatile organics (BNAs), and pesticides in soil and groundwater. Contaminants at the sites may include known carcinogens, compounds of known reproductive toxicity in animals, noncarcinogens, or compounds of unknown toxicity.

7.1.3 Organization of the Baseline Risk Assessment

This BRA follows the USEPA 1989 guidelines and the USEPA Region IX recommendation (USEPA, 1989). The sections of the BRA are organized as follows: 1) introduction; 2) identification of chemicals of potential concern; 3) exposure assessment; 4) toxicity assessment; 5) risk characterization; and 6) summary. Sites will be considered sequentially and as discrete units as described previously in this section.

7.2 IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

The following sections discuss contaminant data collected as part of the SIAD Phase I RI and previous field investigations. No previous investigations were undertaken at the Abandoned Landfill, Chemical Burial Site, or Construction Debris Landfill.

7.2.1 Data and Data Evaluation

Previous contaminant and environmental data were reviewed and are included in Section 2.0 of this document. Results of the SIAD Phase I RI investigation are detailed in Section 6.0 of this document.

7.2.2 Data Quality and QA/QC

Section 6.1 presents a detailed account of SIAD Phase I RI QA/QC criteria and resulting data quality (pages 6-2 to 6-11). All data was certified by the IRDMS data management system prior to inclusion in the report. All data fulfilling the requirements outlined in Tables 7-1 and 7-2 for data standards were included in the risk assessment.

7.2.3 Determination of Chemicals of Potential Concern

The list of chemicals of potential concern was refined by a preliminary screening process. Preliminary screening of the compounds detected during the SIAD Phase I RI field program was conducted based upon the prevalence, magnitude, and the relative toxicity/ carcinogenicity of the site-specific contaminants. Contaminant data presented in the Master Environmental Plan was considered where specific sites had been previously sampled (Benioff, et al, 1988). A sampling matrix and number of samples at each site are presented in Table 7-3. A summary of compounds detected and the frequency of detection for each site is presented in Section 6.0, Table 6-29.

Soil contaminant concentrations were compared to background values (Table 7-4), chemical-specific ARARs and to be considered (TBC) values (Section 3.0), and chemical specific toxicity to evaluate values that could pose a potential human health risk. Compounds exceeding these values were included in the list of chemicals of potential concern. Groundwater contaminant concentrations were compared to federal and state MCLs, and all contaminants exceeding MCL values for drinking water were carried into the additional screening process. Decision tables for each site/matrix are listed sequentially beginning with the Abandoned Landfill site in Appendix Q2. The list of chemicals of potential concern was

TABLE 7-1

CLP LABORATORY DATA QUALIFIERS AND THEIR POTENTIAL USE IN QUANTITATIVE RISK ASSESSMENT

Qualifier	Definition	Indicates: Uncertain Identity?	Indicates: Uncertain Concentration?	Include Data in Quantitative Risk Assessment?
Inorganic Chemical Data:[a]				
B	Reported value is < CRDL, but > IDL.	No	?	Yes
U	Compound was analyzed for, but not detected.	Yes	Yes	?
E	Value is estimated due to matrix interferences.	No	Yes	Yes
M	Duplicate injection precision criteria not met.	No	Yes	Yes
N	Spiked sample recovery not within control limits.	No	Yes	Yes
S	Reported value was determined by the Method of Standard Additions (MSA).	No	No	Yes
W	Post-digestion spike for furnace AA analysis is out of control limits, while sample absorbance is < 50% of spike absorbance.	No	Yes	Yes
*	Duplicate analysis was not within control limits.	No	Yes	Yes
+	Correlation coefficient for MSA was < 0.995.	No	Yes	Yes
Organic Chemical Data:[b]				
U	Compound was analyzed for, but not detected.	Yes	Yes	?
J	Value is estimated, either for a tentatively identified compound (TIC) or when a compound is present (spectral identification criteria are met, but the value is < CRQL).	No, for TCL chemicals; Yes, for TICs	Yes	?

TABLE 7-1 (Continued)

CLP LABORATORY DATA QUALIFIERS AND THEIR POTENTIAL USE IN QUANTITATIVE RISK ASSESSMENT

Qualifier	Definition	Indicates: Uncertain Identity?	Indicates: Uncertain Concentration?	Include Data in Quantitative Risk Assessment?
C	Pesticide results were confirmed by GC/MS.	No	No	Yes
B	Analyte found in associated blank as well as in sample.[c]	No	Yes	Yes
E	Concentration exceeds calibration range of GC/MS instrument.	No	No	Yes
A	Compound identified in an analysis at a secondary dilution factor.	No	No	Yes
X	Additional flags defined separately.	--	--	--

(a) Source: EPA 1989a.

(b) Source: EPA 1989a.

(c) See Section 5.5 for guidance concerning blank contamination, EPA, 1989a.

TABLE 7-2

VALIDATION DATA QUALIFIERS AND THEIR POTENTIAL USE IN QUANTITATIVE RISK ASSESSMENT

Qualifier	Definition	Indicates: Uncertain Identity?	Indicates: Uncertain Concentration?	Include Data in Quantitative Risk Assessment?
Inorganic and Organic Chemical Data:[a]				
U	The material was analyzed for, but not detected. The associated numerical value is the SQL.	Yes	Yes	?
J	The associated numerical value is an estimated quantity.	No	Yes	Yes
R	Quality control indicates that the data are unusable (compound may or may not be present). Re-sampling and/or re-analysis is necessary for verification.	Yes	Yes	No
Z	No analytical results (inorganic data only).	--	--	--
Q	No analytical result (inorganic data only).	--	--	--
N	Presumptive evidence of presence of material (tentative identification).[b]	Yes	Yes	?

-- = Not applicable.

(a) Source: EPA 1989a.

(b) Organic chemical data only.

TABLE 7-3

SIAD PHASE I RI

SAMPLING MATRIX AND NUMBER OF SAMPLES AT EACH SITE

Site	Matrix				
	Soil		Groundwater[a]		
	Soil Borings	Surface Soils	A Zone	B Zone	C Zone
ALF	4	0	3	--	--
CCB	5	0	2	--	--
DRMO	8	0	3	--	--
TNT					
Leaching Beds Subsite	8	8	13	9	9
Vehicle Maintenance Area Subsite	5	0	3	1	1

[a] A zone at the water table; B zone at 90-100; and C zone at >130 feet.

TABLE 7-4

SIAD PHASE I RI
SUMMARY OF BACKGROUND GROUNDWATER AND SOIL SAMPLING

Groundwater	Sample Code			Arithmetic Average	95th Percentile Confidence Interval
Chemical	PSW-02*14 µg/l	PSW-08*16 µg/l	PSW-09*17 µg/l	µg/l	µg/l
Arsenic	5.97	7.46	3.20	5.54	0.17 - 10.91
Barium	28.4	35.2	55.3	39.6	4.97 - 74.23
Lead	3.58	4.77	1.95	3.43	-0.09 - 6.95
Calcium	100,000	84,000	28,000	70,666	-23,327 - 164,659
Sodium	87,000	71,000	501,000	190,695	-483,221 - 864,611
Zinc	61.6	43.4	NR[b]	52.5	24.8 - 80.2
Chloride	60,000	44,000	17,100	40,366	-13,533 - 94,265
Sulfate	380,000	310,000	57,100	249,033	-173,287 - 671,385

Soils	Sample Code[a]			Arithmetic Average	95th Percentile Confidence Interval
Chemical	DSB-01-MWA µg/g	DSB-02-MWA µg/g	DSB-04-MWA µg/g	µg/g	µg/g
Arsenic	3.33	2.01	7.53	4.29	-2.87 - 11.45
Barium	348	440	316	368	208 - 528
Lead	7.78	8.5	18.5	11.59	-3.3 - 26.48
Vanadium	45.1	54.5	49.7	49.76	38.08 - 61.4
Zinc	--	--	79.9	--	--

[a] These samples were taken at the 1-foot depth of the boreholes at the three background locations.

[b] NR = Not reported

further refined based on acute, subchronic and chronic toxicity. Toxicity considerations were based on the ability of a compound to cause adverse human health effects such as acute toxicity, chronic non-carcinogenic systemic toxicity, and chronic carcinogenic effects. In general, for carcinogenic effects, chemicals that are known human carcinogens (Group A) and chemicals that are probable human carcinogens (Group B) were always considered. Chemicals that are considered rodent carcinogens or possible human carcinogens (Group C) were included or excluded from risk analysis (Table 7-5). Compounds with known or suspected reproductive toxicity were considered for each site as well. Compounds that were above background levels, were reproductive or carcinogenic contaminants, and fulfilled the above screening criteria were treated in the quantitative risk analysis.

The SIAD Phase RI sampling plan (Table 7-3) indicates that soil samples were taken from borings and surface locations. The surface soil samples were taken only in the TNT Leaching Beds Site. The Abandoned Landfill, Chemical Burial/Construction Debris Landfill, and the DRMO Trench sites were sampled at the 5-foot level. This issue was discussed with the California Department of Health Services and it was agreed that in the absence of surface soil samples, the 5-foot soil sample could be used as an approximation of the surface soil contaminant concentration (JMM, 1990).

7.2.3.1 Abandoned Landfill

Soil and groundwater samples taken during the SIAD Phase I RI indicated the presence of inorganics including VOCs, BNAs, pesticides and dioxins/dibenzofurans. Surface soils (5-foot samples) contained arsenic, cadmium, chromium, lead, zinc, phenols, and dioxins/dibenzofuran. Groundwater samples contained selenium, carbon tetrachloride, trichlorofluoromethane (TCFM), and TCE. Data and decision tables for the Abandoned Landfill site are contained in Tables Q2-1 to Q2-4 (Appendix Q2).

Soil samples from the Abandoned Landfill contained arsenic at a level of 11 μg/g; which was above the arsenic soil background value for SIAD. Since arsenic was detected above the background concentration and due to the known human carcinogenicity of arsenic, it was carried into quantitative risk analysis. A single soil sample contained 440 μg/g lead in a 5-

TABLE 7-5

EPA WEIGHT-OF-EVIDENCE CATEGORIES FOR POTENTIAL CARCINOGENS

EPA Category	Description of Group	Description of Evidence
Group A	Human Carcinogen	Sufficient evidence from epidemiology studies to support a causal association between exposure and human cancer.
Group B1	Probable Human Carcinogen	Limited evidence of carcinogenicity in humans from epidemiology studies.
Group B2	Probable Human Carcinogen	Sufficient evidence of carcinogenicity in animals, inadequate evidence of carcinogenicity in humans.
Group C	Possible Human Carcinogen	Limited evidence of carcinogenicity in animals; no data for humans.
Group D	Not Classified	Inadequate evidence of carcinogenicity in animals.
Group E	No Evidence of Carcinogenicity	No evidence of carcinogenicity in at least two adequate animal tests or in both epidemiology and animal studies.

foot sample, which was above the SIAD background range. Due to the known fetotoxicity of lead, it was carried into the BRA. Chromium (48.4 μg/g) and cadmium (6.18 μg/g) were each detected in one of four samples, and both metals were at concentrations greater than the background range for SIAD. The compounds were included in the risk analysis since they are known or suspected human carcinogens from short-term occupational/industrial exposure scenarios. The inclusion of both cadmium and chromium is conservative since the contaminant levels are marginally above the background, the data base is small (1/4) such that maximum detected values are utilized for risk calculation, and the toxicity (occupational carcinogens Class A and B) of these compounds via inhalation of fugitive dust is great. Inclusion of cadmium and chromium at the maximum detected values results in a conservative calculated risk at the Abandoned Landfill. High zinc levels (1,090 μg/g) in one out of four samples were reported and this was greater than the background range for SIAD. The presence of dioxins/dibenzofurans above detection limits for one of four surface (5-foot) samples with a combined congener level of greater than 1.6 ppb was of concern at the Abandoned Landfill. The majority of the compounds detected were the tetrachlorodibenzofurans, hepta-chlorodibenzofurans, and the hepta- and octa-chloro dibenzodioxins. Due to the level and toxicity of this class of compounds, they were included in the BRA. The presence of TCFM in one of four surface soils samples indicated that it might be significant. TCFM was not detected in travel or soil blanks so its presence could not be discounted due to laboratory contamination. Hence, it was carried to quantitative risk calculation. Zinc values were considered below the levels where significant toxicity would occur, the frequency of detection was low, and zinc is an essential nutrient. Hence, zinc was treated qualitatively in the BRA. Phenol (0.276 μg/g) was detected in surface (5-foot) soils at the Abandoned Landfill. Phenol in the soil was above background levels but the frequency of detection, the lower toxicity and the possibility that its presence is a normal background due to the methodology of detection suggests that phenol be treated qualitatively in the BRA.

Analysis of groundwater at the Abandoned Landfill indicated the presence of selenium (18.6 μg/L), chloroform (1.13 μg/L), 1,2-dichloroethene (0.621 μg/L), 1,1,2,2-tetrachloroethane (9.0 μg/L), and TCE (70.5 μg/L) in the shallow aquifer. The level of selenium in groundwater exceeds the state MCL value. Due to the potential reproductive toxicity of selenium, this compound was carried into the quantitative BRA. The presence of TCFM in

a single groundwater sample was treated qualitatively. The basis for this is that trihalomethanes have relatively low toxicity and TCFM was detected in both the method and travel groundwater blanks.

Based on the magnitude, frequency, and toxicity of the contaminants detected at the Abandoned Landfill, the following compounds were carried into the quantitative risk analysis: arsenic [soil (S)], cadmium(S), chromium(S), lead(S), selenium [groundwater (GW)], chloroform(GW), 1,1,2,2-tetrachloroethane(GW), TCE(GW), and dioxins/dibenzofurans(S).

7.2.3.2 Chemical Burial Site/Construction Debris Landfill

Soil and groundwater samples taken during the SIAD Phase I RI indicated the presence of organics including VOCs and pesticides at these sites. Surface soils (5 foot) were free of inorganic contaminants above background levels but contained the organic constituents TCFM (0.009 μg/g), chlordane (0.576 μg/g), heptachlor (0.007 μg/g), and heptachlor epoxide (0.006 μg/g). TCE was found to be the only groundwater contaminant (6.76 μg/L). Data and decision tables for the Chemical Burial Site/Construction Debris Landfill are listed in Table Q2-5 through Q2-8 (Appendix Q2).

The soil samples taken at the Chemical Burial Site/Construction Debris Landfill contained TCFM above the detection limits. TCFM was not found in soil methods or travel blanks so its presence could not be discounted. Likewise, phenol was detected above detection limits and could not be discounted due to its presence in method blanks. TCFM and phenol were carried at their maximum detected values into the risk calculation. Chlordane and heptachlor were detected in two of four soil samples at levels indicating potential hazard levels of these compounds. Based on published RfDs, the carcinogenic category of each compound, and the cancer potency of these compounds, they were carried into the quantitative risk analysis. Groundwater samples taken at the Chemical Burial Site/Construction Debris Landfill contained elevated levels of TCE (6.76 μg/L). This level of TCE exceeds the state MCL. The concentration and the toxicity of TCE indicate that it will be treated quantitatively in the BRA for this site.

Based on the magnitude, frequency, and toxicity of the contaminants detected at the Chemical Burial Site/Construction Debris Landfill, the following compounds were carried into the quantitative risk analysis: chlordane(S), heptachlor(S), heptachlor epoxide(S), phenol (S) and TCE(GW).

7.2.3.3 DRMO Trench Area

Soil and groundwater analyses for the SIAD Phase I RI detected the presence of inorganics and organics including VOCs, semivolatile organics, and pesticides. Surface soils (only one soil boring, DM0-11-5B, at 15 feet on the diagonal intersected near the base of the 12-foot-deep trench) contained arsenic above background levels. Soil organic contaminants consisted of chlorobenzene (24.5 μg/g); dichlorobenzene (230 μg/g); 1,2,-dichlorobenzene (82 μg/g); 1,4-dichlorobenzene (20 μg/g); ethylbenzene (5.4 μg/g); 1,2-DCA (0.07 μg/g); 1,1,2,2-tetra chloroethane (1.5 μg/g); 1,1,1-trichloroethane (1.44 μg/g); TCE (31.4 μg/g); PCE (1.7 μg/g); toiuene (33.0 μg/g); xylene (29.1 μg/g); DDT and DDD (2.2 and 2.5 μg/g); and DDE (0.024 μg/g). Groundwater contaminants consisted of selenium (11.8 μg/L) and TCE (19.6 μg/g). Data for the single positive soil samples, the groundwater samples and the decision tables are listed in Tables Q2-9 through Q2-12 (Appendix Q2).

The soil samples taken at the DRMO Trench Area contained chlorobenzenes and dichlorobenzenes at levels greater than the certified detection limit (Qualifier E). Reported values for 1,1,2,2-trichloroethane, chlorobenzene, 1,1,1-trichloroethane, TCE, PCE, toluene, xylene, and ethylbenzene exceeded the certified detection limit for each compound (Qualifier E). The values were reported to be >1.0 μg/g in the IRDMS data bank because they exceeded the certified reporting limit (see page 6-61). The values were quantified by ESE and these values confirmed the JMM data. The JMM data were used for risk calculations since there was supporting data for the levels detected (Benioff et al., 1988). Inclusion of this data provides a conservative approach to determining the chemicals of concern and for risk calculations. The levels of contaminants detected at this site confirmed the data reported in the MEP (Benioff, et al, 1988) where there were four soil samples taken along the base of the DRMO Trench Area at or near the trench surface.

Arsenic in the soil boring exceeded the background range for SIAD and was carried into the risk analysis based on its toxicity/carcinogenic potency. The pesticides DDT, DDD, DDE, and aldrin were sufficiently high to pose a potential hazard and were carried into the risk calculations. The high level of contaminants at the base of the DRMO Trench Area, the known and suspected toxicity of the compounds detected, and the combined frequency of detection required that these compounds be carried into the quantitative risk assessment (Benioff, et al, 1988).

Groundwater sampling at the DRMO Trench Area resulted in the detection of selenium, BEHP, and TCE. Both selenium and TCE exceed their respective state MCLs. Due to the level of detection and the toxicity of these compounds (suspected reproductive toxin and potential carcinogen), they were included in the risk calculations. BEHP in groundwater was suspect since it was detected in methods and travel blanks. Hence, it was not treated quantitatively at this site.

Based on magnitude, frequency of detection, and toxicity of the contaminants detected, the following compounds were carried into quantitative risk analysis at the DRMO Trench Area: arsenic(S), chlorobenzenes(S), dichlorobenzenes(S), 1,2-dichlorobenzene(S), 1,4-dichlorobenzene(S), ethylbenzene(S), 1,2-DCA(S), 1,1,2,2-tetra-chloroethane(S), 1,1,1-trichloroethane(S), TCE (S, GW), PCE(S), toluene(S), xylene(S), DDT and DDD(S), DDE(S), and selenium (GW).

7.2.3.4 TNT Vehicle Maintenance Area Subsite

Soil and groundwater analyses for the SIAD Phase I RI detected the presence of inorganics and organics in the groundwater and showed that the soil was free of organics and inorganics at above background levels. Groundwater contamination consisted of arsenic (31.4 μg/L), chromium (227 μg/L), carbon tetrachloride (190 μg/L), chloroform (923 μg/L), 1,2-DCA (101 μg/L), TCE (952 μg/L), toluene ($>$6.73 μg/L), and benzene ($<$5.94 μg/L). Data for the soil borings and groundwater samples, and the decision tables are listed in Tables Q2-13 through Q2-17 (Appendix Q2).

As noted above, soil samples at the surface (to depths of 5 feet) were free of inorganic and organic contaminants that might be site-specific. Hence, no soil contaminants were carried into the risk analysis for this site.

Groundwater samples at the TNT Vehicle Maintenance Area indicated the presence of inorganics and organics in the shallow zone. Chromium levels in the groundwater exceeded the state MCL while arsenic was below MCL levels. Both compounds were carried into risk analysis based on their toxicity. The VOCs carbon tetrachloride, chloroform, 1,2-DCA, and TCE exceeded the state MCL levels and were carried into the risk analysis. The groundwater sample numbers were sufficient to perform fate and transport modeling for TCE at this site (Appendix O). Toluene was not carried into the risk analysis based on its level of detection and toxicity. 1,3-Dichloropropene was not carried into the quantitative risk analysis since it was detected in methods blanks and sample blanks for this site.

Based on the screening for magnitude, frequency and toxicity of the contaminants detected at the TNT Vehicle Maintenance site, the following compounds were carried into the quantitative risk analysis: arsenic(GW), chromium(GW), benzene(GW), carbon tetrachloride (GW), chloroform(GW), 1,2-DCA(GW), and TCE(GW).

7.2.3.5 TNT Leaching Beds Subsite

Soil and groundwater samples taken during the SIAD Phase I RI indicated the presence of organics in the surface soil samples from the TNT Leaching Beds Subsite (at 0- to 1-foot) and the groundwater. Surface soils contained high levels of munitions compounds consisting of 2,4-dinitrotoluene (19 μg/g); HMX (23 μg/g); RDX (1,300 μg/g); 1,3,5-trinitrobenzene (120 μg/g); and 2,4,6-trinitrotoluene (12,000 μg/g). Groundwater contamination consisted of chloroform (0.523 μg/L); methylene chloride (8.49); TCE (7.43 μg/L); 2,4-dinitrophenol (17.5 μg/L); 2,4-dinitrotoluene (90.0 μg/L); HMX (3.76 μg/L); RDX (250 μg/L); tetryl (9.92 μg/L); 1,3,5-trinitrobenzene (1,100 μg/L); and 2,4,6-trinitrotoluene (7.9 μg/L). Groundwater metal contaminants included arsenic (31.4 μg/L); chromium (11.80 μg/L); mercury (0.526 μg/L); and selenium (52.2 μg/L). There were sufficient soil and groundwater samples to perform fate and transport modeling for 1,3,5-TNB (Appendix O).

Data and a list of the average and upper-bound 95th percentile values for soil and groundwater values are listed in Tables Q2-18 through Q2-20 (Appendix Q2). Since there were no soil or water standards for these compounds, decision tables (in Appendix Q2) indicate their presence but no action is indicated.

The surface soil samples at the TNT Leaching Beds Subsite indicate high contamination levels of munitions compounds at the site. There were sufficient sample numbers to perform statistical analysis of the data and develop both an average and upper-bound limit of each of the contaminants. There is limited chronic toxicity data on the TNT derivatives but RfDs were available, or could be calculated, for all of the contaminants. The compounds HMX and 1,3,5-trinitrobenzene are the most acutely toxic of these compounds and 2,4,6-TNT, 2,4-DNT, and RDX have calculated cancer potency factors. Based on magnitude, frequency, and toxicity, all of the soil-borne explosives compounds were carried into the risk analysis.

Groundwater samples taken at the TNT Leaching Beds Subsite contained elevated levels of 2,4-dinitrophenol, 2,4-dinitrotoluene, HMX, RDX, tetryl, 1,3,5-trinitrobenzene and 2,4,6-trinitrotoluene. There were sufficient sample numbers for statistical analysis yielding a mean- and upper-bound level of each contaminant. Since there are no drinking water standards for the explosives compounds, it was assumed that all of the compounds were suspect since their toxicity was defined. Hence, all of the explosives compounds detected in the groundwater were carried into the risk analysis. It should be noted that zone A was used to develop the most comparative approach to the risk assessment, despite its naturally occurring high salinity. The use of zone A groundwater as a potable source is extremely remote but was included at the request of DHS to explore the most conservative approach.

The screening of soil and groundwater contaminants detected at the TNT Leaching Beds Subsite indicated that the following compounds should be carried into the quantitative risk analysis: arsenic(GW); chromium(GW); mercury(GW); selenium(GW); carbon tetrachloride(GW); chloroform(GW); 1,2-DCA(GW); TCE(GW); 2,4-dinitrophenol(S), 2,4-dinitrotoluene(GW,S), HMX(GW,S), RDX(GW,S), tetryl(GW,S), 1,3,5-trinitrobenzene(GW, S), and 2,4,6-trinitrotoluene(GW,S).

7.2.3.6 Summary of Chemicals of Potential Concern

The summary of chemicals of potential concern, their site-specificity and the matrix in which they occur, are summarized in Table 7-6.

7.3 EXPOSURE ASSESSMENT

This section identifies and describes potential receptors associated with contaminants present at SIAD Phase I RI sites and reviews possible exposure pathways related to contaminants of potential concern.

7.3.1 Potential Receptors

The potential for human exposure to contaminants in soil at the five SIAD Phase I RI sites is minimal due to the limited access of civilian and SIAD personnel to the sites. The estimated 525 SIAD personnel are separated from the majority of the depot area by a fenced, guarded gate entry point. The Abandoned Landfill, Chemical Burial Site/Construction Debris Landfill, and DRMO Trench Area are located within the SIAD perimeter fence. The TNT Leaching Beds Area lies further to the north of the other sites and a second, guarded gate entry point controls access to this area. In addition, the base is routinely patrolled by military police units and helicopter patrols.

Based on the contaminant data associated with soil and groundwater sampling of the five SIAD Phase I RI sites and of the potable wells in Herlong, no significant contamination is currently believed to affect either the base residential or Herlong residential population. Due to the nature of the contamination at the sites, the only current, plausible exposure scenario involves intermittent civilian or base personnel contact with surface soils in the TNT Leaching Beds Subsite and the DRMO Trench Area. There is currently no contamination detected in groundwater at the potable Herlong wells. Factors limiting potential current exposure with site contaminants include: 1) no detected groundwater contamination of potable wells; 2) no residential use of SIAD aside from designated areas; 3) no regular activity involving soil contact; 4) lack of surface water or sediments; 5) no regular,

TABLE 7-6

SUMMARY OF CHEMICALS OF CONCERN IN ALL MEDIA SAMPLED

Site	Matrix	Contaminant	Concentration Range
Abandoned Landfill	Soil	Arsenic	7.1 to 21.0 μg/g
Abandoned Landfill	Soil	Chromium	24.4 to 48.4 μg/g
Abandoned Landfill	Soil	Lead	425 μg/g
Abandoned Landfill	Soil	Zinc	140.7 to 1,091 μg/g
Abandoned Landfill	Soil	Dioxins/Furans	0.00089 μg/g
Abandoned Landfill	Groundwater	Selenium	16.0 μg/L
Abandoned Landfill	Groundwater	Chloroform	0.32 to 1.1 μg/L
Abandoned Landfill	Groundwater	1,1,2,2-tetrachloroethane	9 μg/L
Abandoned Landfill	Groundwater	1,1,1-trichloroethene	40.9 μg/L
Construction Debris/Chemical Burial Site	Soil	Chlordane	0.59 to 1.04 μg/g
Construction Debris/Chemical Burial Site	Soil	Heptachlor	0.010 μg/g
Construction Debris/Chemical Burial Site	Soil	Heptachlor epoxide	0.010 μg/g
Construction Debris/Chemical Burial Site	Soil	Trichlorofluoromethane	0.01 μg/g
Construction Debris/Chemical Burial Site	Groundwater	Trichloroethene	6.75 μg/L
DRMO Trench	Soil	Arsenic	5.1 to 22.7 μg/g
DRMO Trench	Soil	Chlorobenzene	>1 μg/g
DRMO Trench	Soil	1,2-dichlorobenzene	76.6 μg/g
DRMO Trench	Soil	1,3-dichlorobenzene	--
DRMO Trench	Soil	1,4-dichlorobenzene	20 μg/g
DRMO Trench	Soil	1,2-dichloroethane	0.1 μg/g
DRMO Trench	Soil	1,1,1-Trichloroethane	0.006 to 31.4 μg/g
DRMO Trench	Soil	Tetrachloroethene	1.7 μg/g
DRMO Trench	Soil	Toluene	0.0008 to 33.0 μg/g
DRMO Trench	Soil	Xylene	29.1 μg/g
DRMO Trench	Soil	Aldrin	0.059 μg/g
DRMO Trench	Soil	DDD	2.25 μg/g
DRMO Trench	Soil	DDE	0.025 μg/g
DRMO Trench	Soil	DDT	0.014 to 2.56 μg/g
DRMO Trench	Soil	Heptachlor	0.008 μg/g
DRMO Trench	Groundwater	Selenium	11.8 μg/L
DRMO Trench	Groundwater	1,1,1-Trichloroethene	4.18 to 26.0 μg/L
TNT Sites	Soil	2,4-dinitrotoluene	8.26 to 19.8 μg/g

TABLE 7-6 (Continued)

SUMMARY OF CHEMICALS OF CONCERN IN ALL MEDIA SAMPLED

Site	Matrix	Contaminant	Concentration Range
TNT Sites	Soil	HMX	7.03 to 22.7 μg/g
TNT Sites	Soil	RDX	112 to 1,270 μg/g
TNT Sites	Soil	Tetryl	0.75 μg/g
TNT Sites	Soil	1,3,5-trinitrobenzene	1.44 to 124 μg/g
TNT Sites	Soil	2,4,6-trinitrotoluene	7.8 to 11,600 μg/g
TNT Sites	Groundwater	Arsenic	6.43 to 31.2 μg/L
TNT Sites	Groundwater	Chromium	6.07 to 227 μg/L
TNT Sites	Groundwater	Mercury	0.255 to 0.402 μg/L
TNT Sites	Groundwater	Selenium	4.05 to 46.4 μg/L
TNT Sites	Groundwater	Carbon tetrachloride	0.27 to 240 μg/L
TNT Sites	Groundwater	Chloroform	0.70 to 910 μg/L
TNT Sites	Groundwater	1,2-dichloroethane	0.82 to 130 μg/L
TNT Sites	Groundwater	1,1,1-Trichloroethene	0.92 to 1,030 μg/L
TNT Sites	Groundwater	2,4-dinitrophenol	17 μg/L
TNT Sites	Groundwater	2,4-dinitrobenzene	6.8 to 88 μg/L
TNT Sites	Groundwater	HMX	3.7 to 7.69 μg/L
TNT Sites	Groundwater	RDX	90.4 to 253 μg/L
TNT Sites	Groundwater	Tetryl	1.1 to 9.7 μg/L
TNT Sites	Groundwater	1,3,5-trinitrobenzene	0.795 to 1,080 μg/L
TNT Sites	Groundwater	2,4,6-trinitrotoluene	1.05 to 7.86 μg/L

uncontrolled access to the sites; 6) no sports activities such as hunting or fishing are allowed on base; 7) areas are restricted by base commander as "off limits"; and 8) ambient outdoor air quality is good and average wind direction is towards the northeast, away from the residential population of Herlong and the SIAD residents. In addition, there are no recreational facilities inside the perimeter fence, no hiking, hunting, or fishing allowed and the area is patrolled regularly. There are no military activities at these sites that would lead to contaminant contact.

The potential human receptors are identified in Table 7-7. As noted, nearby resident civilians and base personnel are potential receptors for soil surface and ground water exposure. The present human receptors include only the adult military base and civilian personnel (male and female) that have access to the base through the guarded gate and access point at the South end of the base. The individual that would be exposed would likely be a casual visitor to the site and spend only a short time at the site.

The possibility of base inactivation and land reuse could result in adults (male and female) and children as potential residential future human receptors. They would be exposed to contaminated soil (ingestion) and groundwater. The other potential future receptor would be the construction worker who is digging a trench through the contaminated site. The potential future receptors are summarized in Table 7-8.

7.3.2 Current and Future Potential Exposure Pathways

In order for the potential receptors to experience any risk from contaminants present at SIAD, they must come in physical contact with the contaminants. This can include drinking water, breathing air, eating food, dermal contact, or incidental ingestion of soil containing the contaminants. When a contaminant can move from its source into contact with a receptor, it is said that there is a complete exposure pathway.

The area is not farmed or grazed, so current exposure through food does not occur. There are no buildings with basements, so VOCs in soil will not concentrate in buildings. Soil boring data indicates low levels ($< 10\ \mu g/g$) of VOCs in soil down to a depth of 15 feet. In

TABLE 7-7

SIAD PHASE I RI
CURRENT POTENTIAL EXPOSURE PATHWAYS

Environmental Medium	Potential Receptors	Potential Exposure Routes	Potentially Significant Pathway
Groundwater			
Shallow Aquifer	Nearby resident civilian and base personnel.	Ingestion, inhalation and dermal contact with potable water.	No. Shallow water not used for potable purposes.
	Nearby resident civilian and base personnel.	Consumption of crops irrigated with water from current contaminated groundwater.	No. Shallow aquifer not used for these purposes.
Surface Water			
Standing or running surface water	Nearby base and civilian personnel.	Dermal contact during infrequent times of precipitation.	No. Soil nature and lack of rainfall preclude possible surface water.
Soils			
Surface Soils	Base and civilian personnel.	Ingestion, inhalation and dermal contact with surface soils and dusts.	Yes. Infrequent casual visitor to sites.
	Nearby residents.	Ingestion, inhalation and dermal contact with surface soils and dusts.	No. Base is restricted to public access.

TABLE 7-8
SIAD PHASE I RI
FUTURE POTENTIAL PATHWAYS

Environmental Medium	Potential Receptors	Potential Exposure Routes	Potentially Significant Pathway
Groundwater			
Shallow Aquifer	Residential user on the site.	Ingestion, inhalation, and dermal contact with potable water from currently contaminated groundwater.	Yes. Shallow aquifer utilized for residential potable water. Deep aquifer is more likely potable supply source.
	Residential user on the site.	Consumption of crops irrigated with water from current contaminated groundwater.	Yes. Only if shallow aquifer is utilized to irrigate produce.
Surface Water			
Standing or running surface water	Nearby residents.	Dermal contact during infrequent times of precipitation.	No. Lack of significant surface water or runoff.
Soils			
Surface Soils	Residential user on the site.	Ingestion, inhalation, and dermal contact with surface soils from currently contaminated area.	Yes. Surface soils are ingested and dust is inhaled.
	Remedial worker/construction worker.	Ingestion, inhalation, and dermal contact with contaminated surface soils.	Yes. Surface soils contact presents a potential pathway during construction and/or remediation.

general, the total amount of exposure to contaminated soil by inhalation of particulates is limited. As an example, an individual who breathes air containing the National Ambient Air Quality Standard short-term limit on particulates of 150 $\mu g/m^3$ (representing fairly dusty conditions) is exposed to a total of 3 mg of particulates in 24 hours, using a breathing rate of 20 m^3/day. In comparison, the value recommended for incidental ingestion of soil by adults is 100 mg/day (USEPA, 1989b). Thus, the pathway of inhalation of particulates is of most concern when contaminants are present that are more toxic by inhalation than the oral route (such as cadmium, and chromium which are carcinogenic only by inhalation) (USEPA, 1990a), or when such a route can expose an off-site population that is not expected to come into direct contact with the source of contamination at the site. Off-site inhalation exposure is not expected at SIAD due to the location of the contaminated sites and the prevailing winds.

Both on-site and off-site soil could be expected to be contaminated with the explosives chemicals at the TNT Leaching Beds Subsite. Human exposure to contaminated soil could occur via incidental ingestion. No data of suitable quality for quantitative risk assessment were located for concentrations of chemicals in off-site soil. Benioff, et al, (1988) report the results of analysis of a single sample taken in April 1984 from a location approximately 60 feet to the east of the site, which had a concentration of 2,4,6-TNT that was about 0.5 percent of the concentrations found in the beds themselves (76 ppm versus up to 16,000 ppm). Based on this limited information, the surface soil onsite appears to be considerably more contaminated than the soil off-site. Therefore, pathways involving contact with off-site soil are expected to be quantitatively less important than those involving contact with on-site soil and will be treated qualitatively in Section 7.6.

7.3.3 Current Exposure Scenarios

The only exposure pathway which may be currently complete involves a person occasionally walking/working/playing in or around the different contaminated sites. This person could directly inhale contaminated dust at all of the sites except the DRMO trench (which is 10 to 15 feet below the ground surface). A person could also indirectly ingest the dust by getting it on his or her hands, followed by eating food without washing. Thus, complete exposure

pathways currently only involve contaminated surface soil. The groundwater is not known to be used, which eliminates groundwater and deep soil (through contaminant migration to groundwater) as potential exposure media (Benioff et al., 1988).

7.3.4 Future Exposure Scenarios

Some of the exposure scenarios dismissed in the previous section may present a future concern. If SIAD were decommissioned, a potential future residential scenario could exist.

If a residential housing development were built, residents might install a private well to obtain water for domestic purposes such as drinking water and showering. Both adults and children would then be exposed. During the building of houses (or utility lines to serve the houses), construction workers could be exposed to contaminated dust. As SIAD has poor soil for farming and grazing, significant contaminant exposure to contaminants through food is unlikely and is not further analyzed. Houses only rarely have basements in California, so exposure to VOCs through vapors migrating into a house is not further considered either. As noted earlier, VOCs in soils down to 15 feet are less than 10 $\mu g/g$.

The lack of vegetation in the leaching beds most likely results from the very high concentration of contaminants in the surface soil. Therefore, considerable treatment of the soil would be required for any productive gardening, and thus the soil in which any produce would actually grow would no longer be unremediated surface soil.

7.3.5 Quantification of Exposure

This section quantitatively analyzes potential human exposures from the pathways that were deemed complete and significant in the previous section. In general, the "reasonable maximum exposure" is evaluated in this section. Under a reasonable maximum exposure scenario, one tries to estimate the maximum exposure that a single receptor is likely to encounter. The intent is to conservatively quantify a exposure that is still within the range of possible exposures.

The exposure levels at the Abandoned Landfill, Chemical Burial Site/Construction Debris Landfill, and DRMO Trench Area were the maximum detected values at each site. This is equivalent to a maximum exposed individual. The use of the maximum detected value provides conservative estimation of potential site contamination. Within the TNT Leaching Beds site, average and reasonably maximally exposed (RME) exposures were calculated since the data permitted statistical treatment.

For the adult, child, and construction worker, exposure assumptions were based on USEPA default valves since no environmental/site conditions suggested modification of these basic assumptions (e.g., body weight, drinking rate, breathing rate).

Due to the relatively small sampling size at all of the sites except the TNT Leaching Beds site, the maximum detected environmental matrix concentration is used regardless of exposure scenario as agreed by California DHS (JMM, 1990). For all sites except for the TNT Leaching Beds site, samples taken at a depth of 5 feet are assumed to represent surface soils as agreed to by California DHS (JMM, 1990). Soil samples from the TNT Leaching Beds site are surface soil samples (taken from the top few inches of soil).

7.3.6 Exposure Assumptions for Current Scenarios

As noted above, the scenario in which a person occasionally walks/works/plays around one of the sites, referred to as the casual visitor scenario, applies in part to all of the sites. This scenario supposes that a person is assumed to spend one hour around a site twice a month, for a period of 20 years. It is assumed that the person is exposed to the contaminants through two pathways: 1) direct ingestion of the soil and 2) inhalation of windblown dust.

For direct soil ingestion, the USEPA (1989) assumes that an adult ingests 100 mg of soil per day. The contaminant dose ingested during the visit is the product of the quantity of soil ingested and the contaminant concentration. It is assumed that a person ingests one tenth of that amount, or 10 mg, while present at a site. This assumption is based on duration of exposure and the frequency of the visit (1 hour twice a month). Due to the small number of data points available, the maximum contaminant concentration in surface soil was used to

represent contaminant-specific concentrations in ingested soil. For the Abandoned Landfill, this corresponded to a sample (ALF-03-SB) collected at a depth of five feet. For the Chemical Burial Site, this corresponded to a sample (CCB-01-SB) collected at 5 feet. As previously stated, samples collected within 5 feet of the surface are considered representative of surface soil concentration. Using single samples as source concentrations effectively treats these sites as hot spots, rather than evaluating them as complete sites. Use of the maximum concentration datum as a representative of the actual concentration of contaminants, provides a health protective approach for exposure assessment for the data sets at the ALF, CCB, and DRMO Trench.

For the TNT Leaching Beds Subsite, both average and upper bound values for contaminants were used for exposure assessment. The surface soil at this site was contaminated with explosives compounds. There were no surface soil contaminants in the Vehicle Maintenance Subsite.

The soil ingestion exposure dose was calculated by Equation 1:

Equation 1:

$$Dose = \frac{IR \times F \times C}{BW} \times \frac{1mg}{1{,}000\ \mu g} \times \frac{1g}{1{,}000\ mg}$$

where:

Dose	=	average daily intake (mg/kg/day)
IR	=	Soil ingestion rate (mg/day)
F	=	Frequency of days of exposure to contaminants (dimensionless)
B_w	=	Body weight (kg)
C	=	Concentration in soil (μg/g)

Inputs for Equation 1 are found in Table 7-9, while the exposure doses are compiled in Table 7-10. The resulting exposure doses for the different sites have been estimated as average daily doses averaged over a year. These doses directly apply to chronic, threshold-related

TABLE 7-9

SOIL INGESTION DOSE PARAMETERS - CASUAL VISITOR

Parameter	Value Used	Rationale
Ingestion Rate IR (mg/day)	10	One tenth of recommended value for daily adult ingestion rate, based on an assumed site visit duration of 1 hour (USEPA, 1989).
Frequency, F (dimensionless)	0.067	Corresponds to a site visit twice per month, or once every fifteen days.
Contaminant Concentrations, (μg/g)	____	See Table 7-10.
Body Weight, BW (kg/I.C.)	70	Average adult body weight (USEPA, 1989b).

TABLE 7-10

SOIL INGESTION DOSE - CASUAL VISITOR

Contaminant	Soil Concentration µg/g	Dose mg/kg/day
Chemical Burial Site		
Trichlorofluoromethane	0.009	8.6 E-11
Chlordane	1.03	9.8 E-09
Heptachlor	0.007	6.7 E-11
Abandoned Landfill		
Cadmium	6.17	5.9 E-08
Chromium	48.4	4.6 E-07
Lead	425	4.0 E-06
Nickel	43.5	4.1 E-07
Selenium	0.448	4.3 E-09
TCDD[a]	0.000035	3.3 E-13
HpCDD[a]	0.00017	1.6 E-12
OCDD[a]	0.00022	2.1 E-12
TCDF[a]	0.00032	3.0 E-12
PECDF[a]	0.000021	7.8 E-13
HxCDF[a]	0.000082	7.8 E-13
HpCDF[a]	0.00013	1.2 E-12
TNT Leaching Beds Subsite		
2,4-dinitrotoluene	4.7	4.5E-08
HMX	6.7	6.4E-08
RDX	260	2.5E-06
1,3,5-trinitrobenzene	56	5.3E-07
2,4,6-trinitrotoluene	5,200	5.0E-05

[a] TCDD (2,3,7,8-Tetrachlorodibenzo-p-dioxin)
HpCDD (2,3,4,7,8-Heptachlorodibenzo-p-dioxin)
OCDD (2,3,4,5,6,7,8,9-Octachlorodibenzo-p-dioxin)
TCDF (2,3,7,8-Tetrachlorodibenzofuran)
PeCDF (2,3,4,7,8-Pentachlorodibenzofuran)
HxCDF (2,3,4,6,7,8-Hexachlorodibenzofuran)
HpCDF (2,3,4,6,7,8,9-Heptachlorodibenzofuran)

health effects. The doses need to be modified for lifetime exposures, to be applicable to non-threshold carcinogenic health effects (Section 7.5). The doses presented in the following section represent unweighted doses used for calculation of hazard quotients and indices. The doses are converted into weighted doses for calculation of the excess cancer risk by time adjustment for exposure duration and lifetime exposure (i.e., 20/70[0.285] years for occupational exposure and 30/70[0.428] years for residential exposure). For calculation of soil ingestion dose at the Abandoned Landfill and the Chemical Burial Site/Construction Debris Landfill soil concentrations are the maximum reported values. The TNT Leaching Beds Subsite sample numbers allowed for the calculation of an average and an upper bound exposure dose. The slant boring placed adjacent to the DRMO Trench Area enabled a sample to be collected near the trench surface, about 15 feet into the boring. This would qualify the sample collected at this location as a surface sample (at the base of the trench). However, the analytical results for this sample indicated that many of the contaminants were present in concentrations exceeding the maximum calibrated concentration of the certified analytical method, and therefore the concentrations of these compounds were reported as greater than 1.0 μg/g (Qualifier E, quantified by GC method). The soil ingestion exposure and risks at this site are treated as follows: the concentration in soils were based on reported values from JMM. The values used for risk calculations were as described in Section 7.2 and approximated the values reported by Benioff, et al. (1988).

The potential for soil ingestion exposure to organics at the DRMO Trench Area is significantly greater than at the Abandoned Landfill and the Chemical Burial Site/Construction Debris Landfill. Several VOCs were detected in concentrations near or exceeding 1 μg/g. The pesticides DDD and DDT were detected in concentrations exceeding 2 μg/g. The dichlorobenzenes were present in concentrations exceeding 100 μg/g. At the other three sites, there is only one instance of a nonexplosives organic compound (chlordane at the Chemical Burial Site) being detected in a concentration exceeding 1 μg/g.

Ingestion of fugitive dust at the Abandoned Landfill, Chemical Burial Site/Construction Debris Landfill, DRMO Trench Area, and Vehicle Maintenance Subsite was considered a major contributing factor to the total absorbed dose of contaminant and thus the potential risk. Dermal absorption was not considered for these sites since there were low levels of soil

contaminants, low partitioning across the *stratum corneum* and many of these compounds are strongly sorbed to soils (T. McLaughlin, 1984, SCAQMD, 1988).

The estimate of the exposure dose from inhaling windblown dust involves three distinct steps. The first step involves estimating the quantity of dust generated. The second step involves estimating the concentration of dust (and therefore each contaminant) in the air. The third step uses the airborne contaminant concentrations to estimate an exposure dose.

Respirable dust rather than total airborne dust is critical in examining potential exposure. Respirable dust generally corresponds to particles with a mean aerodynamic diameter smaller than ten microns, and is generally referred to as PM10. The methods of Cowherd, et al., have been used to model the rate of dust generation (Cowherd, et al., 1984). The basic equation used is as follows:

Equation 2:

$$E_{10} = 0.036\ (1-V)\ (\frac{[\mu]}{U_t})^3\ F(x)$$

where:

E_{10}	=	Average PM_{10} emission rate per unit area (g/m^2-hr)
V	=	Fraction of surface covered by vegetation (dimensionless)
[U]	=	Mean annual wind speed (m/s)
u_t	=	Threshold wind speed (m/s)
F(x)	=	Wind speed distribution function

This equation assumes that there is an unlimited reservoir of dust, which implies that the surface is generally dry and exposed to the wind. The first condition is met by the fact that SIAD is located in a high desert environment. The second condition assumes that the soil consists of fairly small particles (fine sand) and that material which can interfere with erosion such as rocks and vegetation is discontinuous. The input values for this equation are given in Table 7-11. The second step of estimating dust (and contaminant) concentrations from the

TABLE 7-11

PM_{10} GENERATION RATE FROM WIND EROSION

Parameter	Value Used	Rationale
Vegetative Cover, V (dimensionless)		Estimated from direct observation.
Chemical Burial Site	0.5	
Abandoned Landfill	0.7	
TNT Leaching Beds Subsite	0.0	
Mean Annual Windspeed, [u] (m/s)	1.94	(J. Ryan, SIAD, 1990)
Threshold Windspeed, u_t (m/s)	0.40	Determined from Figure 3-4 of Cowherd (1984), on the basis that typical soil consists of fine sands with an average particle diameter between 0.30 and 0.35 mm.
F (x)	1.91	Determined from Figure 4-3 of Cowherd (1984).
PM_{10} Emission Rate, E_{10} ($g/m^{2\text{-}hr}$)		Calculated by Equation 2.
Chemical Burial Site	3.9	
Abandoned Landfill	2.4	
TNT Leaching Beds Subsite	7.8	

TABLE 7-11 (Continued)

AIRBORNE CONTAMINANT CONCENTRATIONS FROM WIND EROSION

Parameter	Value	Rationale
PM_{10} Emission Rate, E_{10} (g/m^{2-hr})		Calculated by Equation 2.
Chemical Burial Site	3.9	
Abandoned Landfill	2.4	
TNT Leaching Beds Subsite	7.8	
Contaminant Concentration in soil, C	See Table 7-7	Concentration in most contaminated area within each size.
C ($\mu g/g$)		
Area at the Source, A (M^2)		Measured from map.
Chemical Burial Site	5100	
Abandoned Landfill	187,000	
TNT Leaching Beds Subsite	446	
Box Height, H (m)	2	Conservative value large enough to permit dust to enter the breathing zone.
Crosswind Width, W (M)		Length of contaminated area perpendicular to the average wind direction of 260°.
Chemical Burial Site	27	
Abandoned Landfill	500	
TNT Leaching Beds Subsite	24.4	
Average Wind speed, I.C. U (m/s)	1.94	(J. Ryan, SIAD, 1990)

dust emission rates was performed by using a box model, the equation for which is given as follows:

Equation 3:

$$C_a = \frac{E_{10} \times C \times A}{H \times W \times \mu} \times \frac{1mg}{1{,}000\mu g} \times \frac{1hr}{3{,}600\text{sec}}$$

Where:

C_a	=	Contaminant concentration in air (mg/m^3)
E_{10}	=	Average PM_{10} emission rate per unit area ($g/m^{2\text{-}hr}$)
C	=	Contaminant concentration in soil ($\mu g/g$)
H	=	Box Height (m)
W	=	Cross-wind width of the area source (m)
μ	=	Average wind speed (m/s)

A box model assumes that there is a volume into which particles enter and exit at constant rates. Complete and instantaneous mixing of the particles within the box is assumed. The particle entrance (and exit) rate is equal to the dust emission rate. The length and width of the box filled by the dust is equal to the dimensions of the respective sources. A realistic box height is difficult to estimate in an open area. A height of two meters was used as a conservative value large enough to permit particles to enter the breathing zone of the visitor. The specific input values for Equation 3 are summarized in Table 7-12.

The exposure doses for this scenario are estimated by Equation 4:

TABLE 7-12

AIRBORNE CONTAMINANT CONCENTRATIONS FROM WIND EROSION

Parameter	Value	Rationale
PM_{10} Emission Rate, E_{10} ($g/m^{2\text{-}hr}$)		Calculated by Equation 2.
Chemical Burial Site	3.9	
Abandoned Landfill	2.4	
TNT Leaching Beds Subsite	7.8	
Contaminant Concentration in Soil, C	See Table 7-10	Concentration in most contaminanted area within sampling location.
C ($\mu g/g$)		
Area at the Source, A (M^2)		Measured from map.
Chemical Burial Site	5,100	
Abandoned Landfill	187,000	
TNT Leaching Beds Subsite	446	
Box Height, H (m)	2	Conservative value large enough to permit dust to enter the breathing zone.
Crosswing Width, W (M)		
Chemical Burial Site	27	Length of contaminated area perpendicular to the average wind direction of 260°.
Abandoned Landfill	500	
TNT Leaching Beds Subsite	24.4	
Average Wind Speed, I.C.U (m/s)	1.94	(J. Ryan, SIAD, 1990).

Equation 4:

$$Dose = \frac{IR \times D \times F \times C_a}{B_w}$$

Where:

Dose	=	Average daily intake (mg/kg/day)
IR	=	Inhalation rate (nm^3/hr)
F	=	Frequency of days of exposure to contaminants (dimensionless)
C_a	=	Contaminant concentration in air (mg/m^3)
D	=	Duration of exposure (hours/day)
B_w	=	Body weight (kg)

Equation 4 is analogous to Equation 1, with an inhalation rate substituted for a soil ingestion rate. The inputs and the resulting exposure doses for this equation are summarized in Tables 7-13 and 7-14.

7.3.7 Exposure Assumptions for Future Scenarios

If SIAD was closed at some future date, the land may be used for residential purposes. Theoretically, a resident could to use the shallow aquifer for his or her domestic water supply, thereby creating an exposure to groundwater contaminants through drinking the water and inhalation of volatile contaminants while showering. An adult has been assumed to receive all of his or her tap water from groundwater in the A zone (the shallowest and most contaminated zone of the aquifer) for a period of 30 years. In addition, a child was assumed to received all of his or her tap water from groundwater in the A zone for a period of 18 years. The DRMO Trench Area, the Abandoned Landfill, and the Chemical Burial Site were analyzed using the location of the highest groundwater concentrations to calculate the risks. As in the case of the soil exposure estimates, use of these maximum concentrations is conservative (but the available data is not sufficient to refine the analysis). Data from DRMO-05-MWA, was used to represent the DRMO Trench Area. Data from CCB-02-MWA represented the Chemical Burial Site, and data from ALF-02-MWA represented the

TABLE 7-13

DUST INHALATION DOSE PARAMETERS - CASUAL VISITOR

Parameter	Value	Rationale
Inhalation Rate, IR (m^3/hr)	1.3[a]	Representative rate for light, adult activity (USEPA, 1989b)
Exposure Duration, D (hours/day)	1	Best professional judgement.
Exposure Frequency, F (dimensionless)	0.067	Corresponds to two periods of exposure per 30 day month.
Contaminant Concentration in Air, C_a (mg/m^3)	See Table 7-12	Calculated using Equation 3.
Body Weight, B_w (kg)	70	Average adult body weight (U.S. EPA, 1989b).

a - See response to comment section for results of these changes and discussions with D. Yugal Luthra, DTSC, Cal-EPA.

TABLE 7-14

DUST INHALATION DOSE - CASUAL VISITOR

Contaminant	Soil Concentration ($\mu g/g$)	Air Concentration (mg/m^3)	Exposure Dose (mg/kg/day)
Chemical Burial Site			
Trichlorofluroromethane	0.009	4.8 E-07	2.7 E-10
Chlordane	1.03	5.5 E-05	3.1 E-08
Heptachlor	0.007	3.7 E-07	2.1 E-10
Abandoned Landfill			
Cadmium	6.17	3.9 E-04	2.2 E-07
Chromium	48.4	3.0 E-03	1.7 E-06
Lead	425	2.7 E-02	1.5 E-05
Selenium	0.442	2.8 E-05	1.6 E-08
TCDD[a]	0.000035	2.2 E-09	1.3 E-12
HpCDD[a]	0.00017	1.1 E-08	6.1 E-12
OCDD[a]	0.00022	1.4 E-08	7.9 E-12
TCDF[a]	0.00032	2.0 E-08	1.2 E-11
PeCDF[a]	0.000021	1.3 E-09	7.6 E-13
HxCDF[a]	0.000082	5.2 E-09	3.0 E-12
HpCDF[a]	0.00013	8.2 E-09	4.7 E-12
TNT Leaching Beds Subsite, Average			
2,4-Dinitrotoluene		4.9E-05	2.8E-08
HMX		6.9E-05	4.0E-08
RDX		2.7E-03	1.5E-06
1,3,5-Trinitrobenzene		5.8E-04	3.3E-07
2,4,6-Trinitrotoluene		5.4E-02	3.1E-05

TABLE 7-14 (Continued)

DUST INHALATION DOSE - CASUAL VISITOR

Contaminant	Soil Concentration ($\mu g/g$)	Air Concentration (mg/m^3)	Exposure Dose (mg/kg/day)
TNT Leaching Beds Subsite, RME			
2,4-Dinitrotoluene		9.2E-05	5.3E-08
HMX		1.2E-04	6.8E-08
RDX		5.8E-03	3.3E-06
1,3,5-Trinitrobenzene		9.0E-04	5.1E-07
2,4,6-Trinitrotoluene		8.3E-02	4.7E-05

[a] TCDD (2,3,7,8-Tetrachlorodibenzo-p-dioxin)
HpCDD (2,3,4,7,8-Heptachlorodibenzo-p-dioxin)
OCDD (2,3,4,5,6,7,8,9-Octachlorodibenzo-p-dioxin)
TCDF (2,3,7,8-Tetrachlorodibenzofuran)
PeCDF (2,3,4,7,8-Pentachlorodibenzofuran)
HxCDF (2,3,4,6,7,8-Hexachlorodibenzofuran)
HpCDF (2,3,4,6,7,8,9-Heptachlorodibenzofuran)

Abandoned Landfill. For the DRMO Trench Area, the average of the sample and duplicate concentrations is used as the contaminant concentration. At the TNT Leaching Beds Site, three scenarios were analyzed. Two of these scenarios treated the Vehicle Maintenance Area and the TNT Leaching Beds Subsites as hot spots. Data from TNT-01-MWA was used to represent the TNT Leaching Beds Subsite, while data from TNT-10-MWA was used to represent the Vehicle Maintenance Subsite. As in the case of the DRMO Trench Area, the average of the sample and duplicate concentrations is used as the contaminant concentration. In addition to these two scenarios, chemical concentrations from the entire contaminated portion of the TNT Leaching Beds Area have been averaged in order to estimate an average dose from using site-wide groundwater. Included in this calculation are data from TNT-01-MWA, TNT-02-MWA, TNT-03-MWA, TNT-08-MWA, TNT-09-MWA, TNT-10-MWA, and TNT-13-MWA. If a contaminant was detected at least once, it was presumed to be present at one half of its detection limit in detected samples.

The exposure dose a person could receive through use of the groundwater as drinking water has been estimated by Equation 5:

Equation 5:

$$Dose = \frac{IR \times C}{B_w} \times \frac{1mg}{1{,}000\mu g}$$

Where:

Dose	=	Average daily intake (mg/kg/day)
IR	=	Ingestion rate (L/day)
C	=	Contaminant concentration in groundwater (μg/L)
B_w	=	Body weight (kg)

Inputs for this equation are presented in Table 7-15. Separate inputs were necessary for adults and children. The child's exposure has been further broken down into the age ranges of 0 to 5 and 6 to 17. Individual exposure doses were calculated for these two age ranges. (The associated risks were estimated using a weighted average of the two exposure doses.

TABLE 7-15

WATER INGESTION DOSE PARAMETERS - FUTURE RESIDENTS

Parameter	Value	Rationale
Ingestion Rate, IR (l/day)		
Adult	2	Reasonable worst-case value recommend in the Exposure Factors Handbook (USEPA, 1989b).
Child, 0-5	0.8	
Child, 6-17	1.1	Calculated as 2 standard deviation aboce the weighted averages of U.S. EPA data (USEPA, 1984).
Contaminant Concentration	See Table 7-16	Data Collected by JMM in 1990.
Body Weight, BW (kg)		
Adult	70	Average adult body weight (USEPA, 1989b).
Child, 0-5	15	Averages derived from USEPA data (USEPA, 1985).
Child 6-17	45	

See Section 7.5). The resulting groundwater exposure doses at each of the sites is presented in Table 7-16. In addition to potential ingestion exposure from drinking water, a person could inhale volatile groundwater contaminants while showering. Inhalation could also occur from using hot water for other purposes, but these other exposures have not been considered. Trapping of VOCs inside a residence, inhalation from sprinkler irrigation and absorption of VOCs from foods were also deemed minor risk components and not considered.

Potential exposure from inhalation of volatile contaminants while showering has been calculated using Equation 6:

Equation 6:

$$Dose = \frac{C_a \times IR \times D}{B_w}$$

When:

Dose	=	Average daily intake (mg/kg/day)
C_a	=	Concentration of contaminant in air (mg/m^3)
IR	=	Inhalation rate (m^3/hr)
D	=	Duration of exposure (hr/day)
B_w	=	Body weight (kg)

This equation assumes that a person takes a shower every day. The airborne contaminant concentration varies as a function of groundwater concentration and time. An average airborne concentration was estimated using a model by Fos' and Chrostowski (1987). This model has been validated by a comparison with experiments performed by Andelman (1985). The model assumes that there is a steady state flux between VOCs at the border of each shower droplet and VOCs in the surrounding air. This concept can be used to calculate a VOC emission rate from water into the air. A box model is then used to determine the concentration of VOCs in the shower room. Exposure occurs both during the shower and while dressing afterwards in the shower room, as the VOC concentration does not

TABLE 7-16

GROUNDWATER CONTAMINANT INGESTION DOSE - FUTURE RESIDENTS
(Page 1 of 3)

Contaminant	Groundwater Concentration (μg/l)	Adult Dose (mg/kg/day)	Child Dose 0-5 (mg/kg/day)	Child Dose 6-17 (mg/kg/day)
Chemical Burial Site				
Trichloroethylene	6.76	1.9 E-04	3.6 E-04	1.7 E-04
Arsenic	7.25	2.1 E-04	3.9 E-04	1.8 E-04
Selenium	10.6	3.0 E-04	5.7 E-04	2.6 E-04
Abandoned Landfill				
Trichloroethylene	70.5	2.0 E-03	3.8 E-03	1.7 E-03
Cyanide	3.3	9.4 E-05	1.8 E-04	8.1 E-05
DRMO Trench				
Trichloroethylene	25.7	7.3 E-04	1.4 E-03	6.3 E-04
Selenium	11.7	3.3 E-04	6.2 E-04	2.9 E-04
Arsenic	4.8	1.4 E-04	2.6 E-04	1.2 E-04
TNT Leach Beds - Vehicle Maintenance Area Subsite				
Trichloroethylene	953	2.7 E-02	5.1 E-02	2.3 E-02
Carbon Tetrachloride	190	5.4 E-03	1.0 E-02	4.6 E-03
Chloroform	923	2.6 E-02	4.9 E-02	2.3 E-02
1,2 - Dichloroethane	101	2.9 E-03	5.4 E-03	2.5 E-03
Chromium	227	6.5 E-03	1.2 E-02	5.5 E-03
Arsenic	12	3.4 E-04	3.2 E-04	1.5 E-04
Benzene	5.94	1.7 E-04	6.4 E-04	2.9 E-04

TABLE 7-16 (Page 2 of 3)

GROUNDWATER CONTAMINANT INGESTION DOSE - FUTURE RESIDENTS

Contaminant	Groundwater Concentration (μg/l)	Adult Dose (mg/kg/day)	Child Dose 0-5 (mg/kg/day)	Child Dose 6-17 (mg/kg/day)
TNT Leaching Beds Subsite - Average				
Arsenic	13	3.7 E-04	6.9 E-04	3.2 E-04
Chromium	3.7	1.1 E-04	2.0 E-04	9.0 E-05
Mercury	0.16	4.6 E-06	8.5 E-06	3.9 E-06
Selenium	3.7	1.1 E-04	2.0 E-04	9.0 E-05
Benzene	0	0.0	0.0	0.0
Carbon Tetrachloride	2.2	6.3 E-05	1.2 E-04	5.4 E-05
Chloroform	4.4	1.3 E-04	2.3 E-04	1.1 E-04
1,2-DCA	0.3	8.6 E-06	1.6 E-05	7.3 E-06
TCE	22	6.3 E-04	1.2 E-03	5.4 E-04
2,4-DNP	11	3.1 E-04	5.9 E-04	2.7 E-04
2,4-DNT	3.6	1.0 E-04	1.9 E-04	8.8 E-05
HMX	1.8	5.1 E-05	9.6 E-05	4.4 E-05
RDX	48	1.4 E-03	2.6 E-03	1.2 E-03
Tetryl	0.68	1.9 E-05	3.6 E-05	1.7 E-05
1,3,5-TNB	26	7.4 E-04	1.4 E-03	6.4 E-04
2,4,6-TNT	1.4	4.0 E-05	7.5 E-05	3.4 E-05
TNT Leaching Beds Subsite - RME[a]				
Arsenic	17	4.9 E-04	9.1 E-04	4.2 E-04
Chromium	4.6	1.3 E-04	2.5 E-04	1.1 E-04
Mercury	0.24	6.9 E-06	1.3 E-05	5.9 E-06
Selenium	5.5	1.6 E-04	2.9 E-04	1.3 E-04
Benzene	0	0.0	0.0	0.0

TABLE 7-16 (Page 3 of 3)

GROUNDWATER CONTAMINANT INGESTION DOSE - FUTURE RESIDENTS

Contaminant	Groundwater Concentration (μg/l)	Adult Dose (mg/kg/day)	Child Dose 0-5 (mg/kg/day)	Child Dose 6-17 (mg/kg/day)
Carbon tetrachloride	5.6	1.6 E-04	3.0 E-04	1.4 E-04
Chloroform	12	3.4 E-04	6.4 E-04	2.9 E-04
1,2-DCA	0.41	1.2 E-05	2.2 E-05	1.0 E-05
TCE	56	1.6 E-03	3.0 E-03	1.4 E-03
2,4-DNP	12	3.4 E-04	6.4 E-04	2.9 E-04
2,4-DNT	6.4	1.8 E-04	3.4 E-04	1.6 E-04
HMX	3.1	8.9 E-05	1.7 E-04	7.6 E-05
RDX	110	3.1 E-03	5.9 E-03	2.7 E-03
Tetryl	1.2	3.4 E-05	6.4 E-05	2.9 E-05
1,3,5-TNB	67	1.9 E-03	3.6 E-03	1.6 E-03
2,4,6-TNT	2.9	8.3 E-05	1.5 E-04	7.1 E-05

[a] Reasonable maximally exposed individual; 95th percentile upper bound concentration.

immediately go to zero after the shower is turned off. This model provides good agreement with Andelman's experimental results.

The basic equations used to estimate the VOC concentrations in air are:

Equation 7:

$$C_a(t) = (S/R)\ (1-\exp(-R_t))\ for\ t \leq D_s$$

Equation 8:

$$C_a(t) = (S/R)\ (\exp(RD_s)-1)\ \exp\ (-R_t)\ for\ t > D_s$$

Where:

$C_{a(t)}$	=	VOC concentration in air at time t (mg/m^3)
S	=	Airborne VOC generation rate (mg/m^3-min)
R	=	Air exchange (min^{-1})
L	=	Time since beginning of the shower (min)
D_s	=	Shower duration (min)

The average VOC concentration was calculated by integrating Equations 7 and 8 over time. Appendix Q1 describes the model in detail and delineates all input parameters. Inputs for Equations 6 to 8 are compiled in Table 7-17. The airborne VOC generation rates and average exposure doses for the different VOCs are shown in Table 7-18.

Construction workers could be exposed to soil contaminants if the areas of contamination are built upon in the future. This scenario applies to all of the sites except the DRMO Trench Area, where the contamination is deeper than what is normally encountered during residential construction projects, such as building houses or installing underground utilities. As in the case of the casual visitor scenario, exposure could occur through direct ingestion of soil or through inhalation of fugitive dust. Soil ingestion exposure has been estimated using

TABLE 7-17

OFF-BASE SHOWER INHALATION EXPOSURE PARAMETERS - FUTURE RESIDENTS

Variable	Value	Rationale
Inhalation Rate, IR ($m/^3hr$)	1.3[a]	Representative rate for light, adult activity (USEPA, 1989b).
Exposure Duration D (hrs)	0.33	Corresponds to 20 minutes. Best professional judgement based on a 15 minute shower.
Body Weight, BW (kg)		
Adult	70	Average adult body weight (USEPA, 1989b).
Child, 0-5	15	Average derived from USEPA data (USEPA, 1985).
Child, 6-17	45	
Airborne VOC Generation Rate, S ($\mu g/m^3$-min)	See Table 7-16	Calculated in Appendix Q8.1.
Air Exchange Rate, R (min^{-1})	0.0083	Typical value for a tight house (Foster and Chrostowski, 1987). Typical value for a loose in 0.025 min^{-1}.
Shower Duration, D_s (min)	15	95th percentile of a range from 1 to 20 minutes with an average value of 7 minutes (James and Kniuman, 1987).

a - See response to comment section.

TABLE 7-18

GROUNDWATER CONTAMINANT SHOWER INHALATION - FUTURE RESIDENTS

VOC	Concentration in Groundwater ($\mu g/l$)	VOC Generation Rate in Shower ($\mu g/m^3$-min)	Adult Dose (mg/kg/shr)	Child Dose 0-5 (mg/kg/shr)	Child Dose 6-17 (mg/kg/shr)
Chemical Burial Site					
Trichloroethylene	6.76	10.6	2.7 E-04	1.76 E-03	7.5 E-04
Abandoned Landfill					
Trichloroethylene	70.5	110.7	2.8 E-03	1.8 E-02	7.8 E-03
DRMO Trench Area					
Trichloroethylene	25.7	40.4	1.0 E-03	6.6 E-03	2.8 E-03
TNT Leaching Beds - Vehicle Maintenance Area Subsite					
Trichloroethylene	952	1,495.9	3.7 E-02	2.4 E-01	1.6 E-01
Carbon Tetrachloride	190	282	7.1 E-03	4.6 E-02	2.0 E-02
Chloroform	923	1,494.6	3.7 E-02	2.4 E-01	1.0 E-01
1,2 - Dichloroethane	101	166.36	4.2 E-03	2.7 E-02	1.1 E-02
Benzene	5.94	11.22	2.8 E-04	1.8 E-03	7.9 E-04

TABLE 7-18 (Continued)

GROUNDWATER CONTAMINANT SHOWER INHALATION - FUTURE RESIDENTS

VOC	Concentration in Groundwater (μg/l)	VOC Generation Rate in Shower ($\mu g/m^3$-min)	Adult Dose (mg/kg/shr)	Child Dose 0-5 (mg/kg/shr)	Child Dose 6-17 (mg/kg/shr)
TNT Leaching Beds Subsite - Average					
Benzene	0.0	0.0	0.0	0.0	0.0
Carbon tetrachloride	2.2	3.27	8.2 E-05	5.4 E-04	2.3 E-04
Chloroform	4.4	7.13	1.8 E-04	1.1 E-03	5.0 E-04
1,2-DCA	0.3	0.49	1.2 E-05	8.1 E-05	3.5 E-05
TCE	22	34.57	8.7 E-04	5.7 E-03	2.4 E-03
TNT Leaching Beds Subsite - RME[a]					
Benzene	0.0	0.0	0.0	0.0	0.0
Carbon tetrachloride	5.6	8.33	2.1 E-04	1.3 E-03	5.9 E-04
Chloroform	12	19.43	4.9 E-04	3.2 E-03	1.3 E-03
1,2-DCE	0.41	0.68	1.7 E-05	1.1 E-04	4.7 E-05
TCE	56	88.0	2.2 E-03	1.1 E-02	6.2 E-03

[a] RME = Reasonable maximally exposed individual; 95th percentile upper bound concentration.

Equation 1. The inputs for this equation are presented in Table 7-19. The contaminant concentrations are the same as for the casual visitor scenario. The quantity of dust ingested is assumed to be comparable to an adult engaged in outdoor physical activity. The resulting exposure doses are summarized in Table 7-20.

The quantity of dust inhaled is estimated using two different methods. The first method uses a model to estimate the quantity of dust generated while tilling a field, on the assumption that tilling would create exposure conditions similar to trenching. Since this model has not been validated for trenching, and since construction can generate very large concentrations of dust, the exposure was also estimated assuming that dust concentrations are equal to twice the OSHA nuisance dust limit of 5 mg/m^3 for respirable particles.

ACGIH and OSHA established maximum limits for airborne particulates (inorganic and organic) in the work place. The OSHA standard for total particulates, nonspeciated is 15 mg/m^3 and for respirable particles ($< 10\mu$) is 5 mg/m^3. At the 5 mg/m^3 level, significant physical parameters such as deposits in the eyes, ears, and nasal passages, throat and eye irritation, upper respiratory tract problems and other physical irritation occurs (Fed. Reg. 54(12):2332-2597, 1989). ACGIH states that at the 10 mg/m^3 level visibility is significantly reduced, unpleasant deposits in the eyes, ears, and nasal passages occur and injury to the mucous membranes can occur (ACGIH Documentation of TLVs and Biological Exposure Indices, 1991, page 445).

For estimating contaminant exposure, by modeling the dust generated by a tractor tilling a field, another equation from Cowherd (1984) is used:

Equation 9:

$$E = K(604)(S)^{0}.5$$

Where:

E	=	Emission rate (kg/hectare)
K	=	Particle size multiplier (dimensionless)
S	=	Silt content of surface soils (percent)

TABLE 7-19

SOIL INGESTION DOSE PARAMETERS - CONSTRUCTION WORKER

Parameter	Value Used	Rationale
Ingestion Rate, IR (mg/day)	480	Typical value for an adult engaged in outdoor physical activity (Hawley, 1985, USEPA, 1991).
Frequency, F (dimensionless)	0.36	Assumes workers build for five days a week for half a year.
Contaminant Concentrations, C (μg/g)	____	See Table 7-20.
Body Weight, BW (kg)	70	Average adult body weight (USEPA, 1989b).

TABLE 7-20

SOIL INGESTION DOSE - CASUAL VISITOR
(Page 1 of 3)

Contaminant	Soil Concentration µg/g	Dose mg/kg/day
Chemical Burial Site		
Trichlorofluoromethane	0.009	2.7E-10
Chlordane	1.04	3.2E-08
Heptachlor	0.007	2.1E-10
Heptachlor epoxide	0.006	1.8E-10
Abandoned Landfill		
Cadmium	6.18	5.9E-08
Chromium	48.4	4.6E-07
Lead	440	4.2E-06
Nickel	43.6	4.2E-07
Selenium	0.44	4.2E-09
TCDD[a]	0.000035	3.3E-13
HpCDD[a]	0.00017	1.6E-12
OCDD[a]	0.00022	2.1E-12
TCDF[a]	0.00032	3.0E-12
PECDF[a]	0.000021	2.0E-13
HxCDF[a]	0.000082	7.8E-13
HpCDF[a]	0.00013	1.2E-12

TABLE 7-20

SOIL INGESTION DOSE - CASUAL VISITOR
(Page 2 of 3)

Contaminant	Soil Concentration µg/g	Dose mg/kg/day
DRMO Trench		
1,2-DCB	76.6	7.3E-07
1,3-DCB	122.0	1.2E-06
1,4-DCB	23.6	2.2E-07
Aldrin	0.058	5.5E-10
DDD	2.25	2.1E-08
DDT	2.53	2.4E-08
Benzene	1.09	1.0E-08
Chlorobenzene	24.5	2.3E-07
Chloroform	0.054	5.1E-10
1,1-DCE	0.156	1.6E-09
Ethylbenzene	5.38	5.1E-08
Methylene chloride	0.562	5.4E-09
1,1,2,2-tetrachloroethane	1.5	1.4E-08
PCE	1.7	1.6E-08
Toluene	33	3.1E-07
1,1,1-TCA	1.44	1.4E-08
TCE	31.4	3.0E-07
Xylenes	29.1	2.8E-07
TNT Leaching Beds Subsite - Average		
2,4-DNT	4.7	4.5E-08
HMX	6.7	6.4E-08
RDX	260.0	2.5E-06
1,3,5-TNB	56.0	5.3E-07
2,4,6-TNT	5,200.0	5.0E-05

TABLE 7-20

SOIL INGESTION DOSE - CASUAL VISITOR
(Page 3 of 3)

Contaminant	Soil Concentration µg/g	Dose mg/kg/day
TNT Leaching Beds Subsite - RME[b]		
2,4-DNT	8.9	8.5E-08
HMX	11.5	1.1E-07
RDX	560.0	5.3E-06
1,3,5-TNB	87.0	8.3E-07
2,4,6-TNT	8,000.0	7.6E-05

[a] TCDD (2,3,7,8-Tetrachlorodibenzo-p-dioxin)
HpCDD (2,3,4,7,8-Heptachlorodibenzo-p-dioxin)
OCDD (2,3,4,5,6,7,8,9-Octachlorodibenzo-p-dioxin)
TCDF (2,3,7,8-Tetrachlorodibenzofuran)
PeCDF (2,3,4,7,8-Pentachlorodibenzofuran)
HxCDF (2,3,4,6,7,8-Hexachlorodibenzofuran)
HpCDF (2,3,4,6,7,8,9-Heptachlorodibenzofuran)

[b] RME = Reasonable maximally exposed individual; 95th percentile upper bound concentration.

For this scenario, it is assumed that 100 meters of land 1 meter wide are dug up during a day. While the area of the sites would prohibit this activity from continuing for any significant length of time, home building could continue for a longer duration. Thus, the exposure was assumed to last for six months.

A box model identical to that used for the casual visitor scenario was used in order to estimate dust concentrations from dust emission rates, with the exception that the box height is assumed to be 3 meters since the exposed person is presumed to be sitting on a backhoe. Once again, potential exposure is only assumed to occur from the PM10 fraction of the dust. The percentage of dust within the PM10 category is assumed to be 21 percent. Finally, the exposure dose has been estimated using Equation 4. All of the input parameters are listed in Table 7-21, with exposure doses listed in Table 7-22.

Equation 4 is used to estimate the exposure dose that a person could experience if dust levels were as high as the OSHA nuisance dust standard. All of the input parameters are identical to those listed in Table 7-21, with the exception that the contaminant concentration in air (Ca) is calculated in a different manner. The total airborne dust concentration is estimated to equal the OSHA limit of 10 mg/m^3 which is twice the OSHA dust limit for particles $\leq$ 10 $\mu g/l$. The airborne contaminant concentrations are then calculated by multiplying the contaminant concentration in soil by the PM10 concentration in the air. These concentrations and the resulting exposure doses are presented in Table 7-23.

The airborne contaminant concentrations are estimated to be about seven times higher when modeled by the agricultural tilling model as opposed to modeling of total dust concentration equal to the nuisance dust limit promulgated by OSHA. Since the OSHA limit encompasses conditions under which there would be distinctly visible levels of dust and deposits in eyes, ears, and nasal passages, it is thought that the tilling model is unrealistic. Therefore, exposure doses assuming a total suspended particulate concentration of 10 mg/m^3 have been used in estimating the human health risks in Section 5. For estimating exposure to fugitive dust for the future residential land use at the TNT Leaching Beds site, a gaussian dispersion model was used (Cowherd, 1984) to predict air particle levels. The model utilizes the following equation:

TABLE 7-21

DUST INHALATION DOSE PARAMETERS - CONSTRUCTION WORKER

Parameter	Value Used	Rationale
Particle size multiplier, K (dimensionless)	0.21	Appropriate value for evaluating PM_{10} (Cowherd, 1984).
Silt Content of soil, I.C.s	20	Estimate by field geologist.
Emission Rate, E (Kg/hectare)	770	Calculated be equation 9.
Area trenched per day, A	100	Assumed value based on daily activity at 100 meters of trench dug, 1 meter wide.
Daily PM_{10} Emission	7.7	Calculated by the quantity E X A, using appropriate conversion factors.
Contaminant Concentration in Soil, C. ($\mu g/g$)	——	See Table 7-22.
Box Height, H (m)	3	Conservative value large enough to permit dust to enter the breathing zone of a person riding a backhoe.
Crosswind Width, W (m)	1	Assumed width of trench.
Average Wind Speed, U. I.C.	1.94	SIAD Environmental Report 1 August 1990.
Inhalation Rate, IR	5.0*	Representative rate for heavy, adult activity (USEPA, 1989b).
Exposure Duration, D (hours/day)	8	Standard work day.

TABLE 7-21 (Continued)

DUST INHALATION DOSE PARAMETERS - CONSTRUCTION WORKER

Parameter	Value Used	Rationale
Exposure Frequency, F (dimensionless)	0.36	Corresponds to working five days per week for half a year.
Contaminant Concentration in Air, Ca. (mg/m^3)	See Table 7-22	Calculated using Equation 3.
Body Weight, Bw (kg)	70	Average adult body weight (USEPA, 1989b)

a - See response to comment section for the effect of this change as discussed with Dr. Yugal Luthra, DTSC, Cal-EPA.

TABLE 7-22

DUST INHALATION DOSE - CONSTRUCTION WORKER

Contaminant	Soil Concentration µg/g	Air Concentration (mg/m^3)	Exposure Dose (mg/kg/day)
Chemical Burial Site			
Trichlorofluoromethane	0.009	1.37 E-08	3.3 E-09
Chlordane	1.04	1.57 E-05	3.8 E-07
Heptachlor	0.007	1.07 E-07	2.6 E-09
Heptachlor epoxide	0.006	9.13 E-08	2.2 E-09
Abandoned Landfill			
Cadmium	6.18	9.4 E-05	2.3 E-06
Chromium	48.4	7.4 E-04	1.8 E-05
Lead	440	6.5 E-03	1.6 E-04
Nickel	43.6	6.6 E-04	1.6 E-05
Selenium	0.44	6.8 E-06	1.7 E-07
TCDD[a]	0.000035	5.3 E-10	1.3 E-11
HpCDD[a]	0.00017	2.6 E-09	6.3 E-11
OCDD[a]	0.00022	3.4 E-09	8.2 E-11
TCDF[a]	0.00032	4.9 E-09	1.2 E-10
PeCDF[a]	0.000021	3.2 E-10	7.3 E-12
HxCDF[a]	0.000082	1.3 E-09	3.0 E-11
HpCDF[a]	0.00013	2.0 E-09	4.8 E-11
DRMO Trench			
None			

TABLE 7-22 (Continued)

DUST INHALATION DOSE - CONSTRUCTION WORKER

Contaminant	Soil Concentration µg/g	Air Concentration (mg/m^3)	Exposure Dose (mg/kg/day)
TNT Leaching Beds Subsite - Average			
2,4-DNT	4.7	7.1 E-05	1.7 E-06
HMX	6.7	1.2 E-04	2.5 E-06
RDX	260.0	3.9 E-03	9.7 E-05
1,3,5-TNB	56.0	8.5 E-04	2.1 E-05
2,4,6-TNT	5,200.0	7.9 E-02	1.9 E-03
TNT Leaching Beds Subsite - RME[b]			
2,4-DNT	8.9	1.3 E-04	3.3 E-06
HMX	11.5	1.7 E-04	4.3 E-06
RDX	560.0	8.5 E-03	2.1 E-04
1,3,5-TNB	87.0	1.3 E-03	3.2 E-05
2,4,6-TNT	8,000.0	1.2 E-01	3.0 E-03

[a] TCDD (2,3,7,8-Tetrachlorodibenzo-p-dioxin)
HpCDD (2,3,4,7,8-Heptachlorodibenzo-p-dioxin)
OCDD (2,3,4,5,6,7,8,9-Octachlorodibenzo-p-dioxin)
TCDF (2,3,7,8-Tetrachlorodibenzofuran)
PeCDF (2,3,4,7,8-Pentachlorodibenzofuran)
HxCDF (2,3,4,6,7,8-Hexachlorodibenzofuran)
HpCDF (2,3,4,6,7,8,9-Heptachlorodibenzofuran)

[b] RME = Reasonable maximally exposed individual

TABLE 7-23

DUST INHALATION DOSE - CONSTRUCTION WORKER: MAXIMUM PERMITTED DUST LEVELS

Contaminant	Soil Concentration µg/g	Air Concentration (mg/m^3)	Exposure Dose (mg/kg/day)
Chemical Burial Site			
Trichlorofluoromethane	0.009	1.9 E-08	4.6 E-10
Chlordane	1.04	2.2 E-06	5.3 E-08
Heptachlor	0.007	1.5 E-08	3.6 E-10
Heptachlor epoxide	0.006	1.3 E-08	3.1 E-10
Abandoned Landfill			
Cadmium	6.18	1.3 E-05	3.2 E-07
Chromium	48.4	1.0 E-04	2.5 E-06
Lead	440	9.2 E-04	2.2 E-05
Nickel	43.6	9.2 E-05	2.2 E-06
Selenium	0.44	9.3 E-07	2.3 E-08
TCDD[a]	0.000035	7.4 E-11	1.8 E-12
HpCDD[a]	0.00017	3.6 E-10	8.7 E-12
OCDD[a]	0.00022	4.6 E-10	1.1 E-11
TCDF[a]	0.00032	6.7 E-10	1.6 E-11
PeCDF[a]	0.000021	4.4 E-11	1.1 E-12
HxCDF[a]	0.000082	1.7 E-10	4.2 E-12
HpCDF[a]	0.00013	2.7 E-10	6.7 E-12
DRMO Trench			
None			

TABLE 7-23 (Continued)

DUST INHALATION DOSE - CONSTRUCTION WORKER: MAXIMUM PERMITTED DUST LEVELS

Contaminant	Soil Concentration µg/g	Air Concentration (mg/m^3)	Exposure Dose (mg/kg/day)
TNT Leaching Beds Subsite - Average			
2,4-DNT	4.7	9.9 E-06	2.4 E-07
HMX	6.7	1.4 E-06	3.4 E-07
RDX	260.0	5.5 E-04	1.3 E-05
1,3,5-TNB	56.0	1.2 E-04	2.9 E-06
2,4,6-TNT	5,200.0	1.1 E-02	2.7 E-04
TNT Leaching Beds Subsite - RME[b]			
2,4-DNT	8.9	1.9 E-05	4.6 E-07
HMX	11.5	2.4 E-05	5.9 E-07
RDX	560.0	1.2 E-03	2.9 E-05
1,3,5-TNB	87.0	1.8 E-04	4.5 E-06
2,4,6-TNT	8,000.0	1.7 E-02	4.1 E-04

[a] TCDD (2,3,7,8-Tetrachlorodibenzo-p-dioxin)
HpCDD (2,3,4,7,8-Heptachlorodibenzo-p-dioxin)
OCDD (2,3,4,5,6,7,8,9-Octachlorodibenzo-p-dioxin)
TCDF (2,3,7,8-Tetrachlorodibenzofuran)
PeCDF (2,3,4,7,8-Pentachlorodibenzofuran)
HxCDF (2,3,4,6,7,8-Hexachlorodibenzofuran)
HpCDF (2,3,4,6,7,8,9-Heptachlorodibenzofuran)lo

[b] RME = Reasonable maximally exposed individual

Equation 10:

$$C = Q / 3.14 * \Sigma Y * \Sigma Z * U$$

Where:	Q	=	Contaminant emission rate (mg/s)
	Sigma Y	=	Horizontal dispersion coefficient (m)
	Sigma Z	=	Vertical dispersion coefficient (m)
	u	=	Wind Speed (m/s)
	C	=	Contaminant Concentration (mg/m^3)

The model assumes that the receptor is 100 meters from the source area. This is the closest distance for which a Gaussian dispersion model can be validated. The wind velocity is an average of 1.9 m/s (J. Ryan, 1990) and, based on wind rose data, the wind blows from the TNT Leaching Beds Area towards the receptor 40 percent of the time. The atmospheric stability conditions are assumed to be Class C which determines the dispersion coefficients. Since there is a mixture of conditions during the year, Class C is a reasonable conservative average (Cowherd, 1984). The TNT Leaching Beds Area is 450 m^2 with a crosswind width of 24m. It is further assumed that the exposed individual remains outside 338 days a year, 8 hours per day.

Dermal exposure was calculated based on exposure to soils via dermal contact and is an estimate of the absorbed dose; not the amount of soil contacting the skin. Absorption factors are used to reflect the desorption of the chemical from soil and the absorption of the chemicals across the *stratum corneum* and into the blood stream. The following equation was used to estimate the absorbed dermal dose:

$$Dose = \frac{Cs \times Cf \times Sa \times Af \times ABS \times EF \times ED}{BW \times AT}$$

where:	Dose	=	average daily absorbed dose (mg/kg/day)
	Cs	=	concentration in soil (mg/kg)
	Cf	=	conversion factor (10^{-6} kg/mg)
	Sa	=	skin surface area available for contact (cm^2/event)
	Af	=	skin to soil adherence factor (mg/cm^2)
	ABS	=	absorption factor (unitless)
	EF	=	exposure frequency (events/year)
	ED	=	exposure duration (years)
	Bw	=	body weight (kg)
	At	=	averaging time (days)

The high concentration of explosive compounds in the surface soils of the TNT Leaching Beds Subsite indicated that dermal exposure might contribute to additional risk. Dermal contact was estimated to occur to hands, forearms and face. The exposure time was assumed to be 338 days/year (RME) and an exposure duration of 30 years (USEPA, 1989d). The dermal absorption rate for the explosive compounds was assumed to be 0.05 and the adhesion rate was considered to be 2.1 gm/cm^2. Based on these input parameters, dosages and risks were calculated for the casual visitor, the future construction workers, and the future adult resident.

7.4 TOXICITY ASSESSMENT

This section provides information on the adverse health effects associated with the chemicals of potential concern designated at the Abandoned Landfill, Chemical Burial Site/Construction Debris Landfill, DRMO Trench Area, TNT Vehicle Maintenance Subsite, and TNT Leaching Beds Subsite. This information is intended to provide a general overview and is not intended to be a comprehensive, detailed evaluation of the toxic effects of these chemicals. More

detailed information and evaluations are presented in the toxicology profiles located in Appendix Q3.

Toxicity assessment is based on the ability of a compound at an administered dose to elicit an adverse human health response. Adverse health responses can be acute or chronic, non-carcinogenic, systemic affecting specific organ sites, carcinogenic or reproductive effects. Non-carcinogenic acute and chronic effects exhibit threshold dose-response curves while carcinogenic and reproductive events generally show a non-threshold dose-response curve.

The noncancerous, or threshold, health effects of a chemical are evaluated using a Reference Dose (RfD) approach. A RfD is a conservative estimate of the daily intake of a chemical (mg chemical/kg body weight/day) that is without risk of any threshold health effects in humans, including sensitive subpopulations. RfDs are specific for a given exposure route (oral, inhalation or dermal) and for a given exposure period (acute, subchronic or chronic). The RfD is usually calculated from experimental data which identify the No Observed Adverse Effect Level (NOAEL) or the Lowest Observed Adverse Effect Level (LOAEL) in animals or humans. In order to provide a margin of safety, the RfD is taken to be the NOAEL or LOAEL divided by an appropriate uncertainty factor. The Agency for Toxic Substances and Disease Registry (ATSDR) uses a similar approach to evaluate threshold health effects of a chemical. The RfD value are utilized as a bench mark for threshold hazard index; RfDs are presented in the ARAR discussion in Section 3.0 and Table 7-24.

For carcinogenic effects, USEPA evaluates chemicals in a two-step process. In the first step, both human and animal studies are reviewed to determine the weight of evidence that the chemical is carcinogenic. A weight-of-evidence classification is then assigned, as presented in Table 7-25.

In the second part of the evaluation, a slope factor (SF) is calculated which is an estimate of the slope of the cancer dose-response curve at low doses. This may be used to calculate cancer risk from any given exposure level. The SF is calculated by extrapolation from observed data at high dose levels using a model which assumes that the dose-response curve becomes linear at low doses and has no threshold (i.e., the curve passes through the origin).

TABLE 7-24

CHRONIC REFERENCE DOSES FOR POTENTIAL NONCARCINOGENS[a]

Site Chemical	Toxicity Effect	Type of Study	Study Dose (mg/kg/day)	UF	MF	RfD (mg/kg/day)	Confidence in RfD
Carbon tetrachlide	liver lesions	chronic	0.71	100	1	0.0007	Moderate
Chloroform	liver lesions	chronic	12.9	1000	1	0.01	Low
Chlorobenzene		liver & kidney effects	chronic	27.3	1000	1	0.02Low
1,2-dichlorobenzene	NA	chronic	89	100	1	0.09	Low
1,3-dichlorobenzene	NA	NA	NA	NA	NA	0.09	--
1,4-dichlorobenzene	NA	chronic	NA	NA	1	0.09	--
1,2-dichloroethane	None	chronic	115	100	1	1	Moderate
2,4-dinitrophenol	liver	subchornic		NA		0.02[d]	--
2,4-dinitrotoluene	liver	chronic		NA		0.001[c]	--
bis(2-ethylhexyl)phthalate	increased relative liver weight	chronic	19	1000	1	0.02	Low
HMX	liver	chronic		NA		0.05[d]	--
1,1,1,-trichloroethylene						Pending	
Tetrachloroethylene	hepatoxicity	chronic	14	100	1	0.1	Low
TCFM	mortality	chronic	714.3	1000	1	0.3	Low
Phenol	reduced total body weight	chronic	60	1000	1	0.6	Moderate
RDX	liver	chronic		NA		0.003[c]	--
Tetryl	liver	chronic		NA		--[b]	--
1,3,5-trinitrobenzene	liver, kidney	chronic		NA		0.00005[c]	--
2,4,6-trinitrotoluene	liver, kidney, skin	chronic		NA		0.0005[d]	--
Toluene	CNS effects	chronic	42	100	1	0.02	Moderate
Xylenes	none observed	chronic	357	100	1	2	Moderate
Chlordane	liver necrosis	chronic	0.045	1000	1	0.00006	Low
Heptachlor	increased liver weight	chronic	0.14	300	1	0.0005	Low
DDT	liver lesions	chronic	0.05	100	1	0.0005	Low

NA = Not Analyzed
UF = Uncertainty Factor
MF = Modifying Factor

(a) All values from IRIS (USEPA 1990b) unless noted otherwise. Abbreviations used: RfD_s - Subchronic Reference Dose, mg/kg-day
RfD_c - Chronic Reference Dose, mg/kg/day
SF - Slope Factor, $(mg/kg\text{-}day)^{-1}$

(b) No value available.
(c) Value from HEAST (USEPA) 1990a).
(d) Calculated according to the procedure used by USEPA (1990b) to derive chronic RfD value, but without the subchronic uncertainty factor.
(e) Value is oral Minimal Risk Level (ATSDR 1988a).

TABLE 7-25 (Continued)

CARCINOGENIC POTENCY

Compound	Ingestion SF $(mg/kg/day)^{-1}$	Carcinogen Category/ Group	Ingestion Weight of Evidence	Source	Inhalation SF $(mg/kg/day)^{-1}$	Carcinogen Category/ Group	Inhalation Weight of Evidence	Source
Pesticides								
Aldrin	1.7E+01	B2	1,000	HEAST	1.7E+01	B2	NA	HEAST
Chlordane	1.3E+0	B2	1,000	HEAST	1.3E+0	B2	NA	HEAST
p,p'-DDD	3.4E-01	B2	100	HEAST	3.4E-01	NA	NA	HEAST
p,p'-DDT	3.4E-01	B2	100	HEAST	3.4E-01	B2	NA	HEAST
Heptachlor	4.5E+0	B2	300	HEAST	ND	B2	NA	HEAST
Hexachlorodibenzo-p-dioxin	6.2E+03	B2	NA	HEAST	ND	B2	NA	HEAST

NA = Not Available
ND = None Detected

HEAST Tables, 3rd quarter 1990

TABLE 7-25

CARCINOGENIC POTENCY

Compound	Ingestion SF $(mg/kg/day)^{-1}$	Carcinogen Category/ Group	Ingestion Weight of Evidence	Source	Inhalation SF $(mg/kg/day)^{-1}$	Carcinogen Category/ Group	Inhalation Weight of Evidence	Source
Inorganics								
Arsenic	1.8	A	1	Reg IX EPA	1.5E+1	A	ND	IRIS (9/90)
Cadmium	ND	NA	--	HEAST	6.1E+0	B1	NA	HEAST
Chromium	NA	NA	500	IRIS (2/88)	4.1E+1	A	NA	IRIS (2/88)
Lead	NA	NA	--	IRIS	ND	NA	ND	HEAST
Selenium	ND	NA	15	HEAST	ND	NA	NA	HEAST
Zinc	ND	NA	NA	HEAST	ND	NA	NA	HEAST
Organics								
Benzene	2.9E-2	A	NA	IRIS (3/90)	2.9E-2	A	NA	HEAST
Carbon tetrachloride	1.3E-01	B2	1,000	HEAST	1.3E-01	B2	B2	HEAST
Chloroform	6.1E-03	B2	1,000	IRIS (9/90)	8.1E-02	ND	B2	HEAST
Chlorobenzene	ND	ND	1,000	HEAST	ND	NA	10,000	HEAST
1,2-dichlorobenzene	ND	ND	1,000	HEAST	ND	ND	1,000	HEAST
1,3-dichlorobenzene	ND	ND	--	--	ND	--	ND	
1,4-dichlorobenzene	2.4E-02	B2	--	HEAST	ND	B2	NA	IRIS
1,2-dichloroethane	9.1E-02	B2	1,000	HEAST	9.1E-02	B2	NA	HEAST
bis(2-ethylhexyl)phthalate	1.4E-02	B2	1,000	IRIS (8/89)	ND	B2	NA	IRIS (8/89)
1,1,1-trichloroethylene	1.1E-02	B2	NA	HEAST	1.7E-02	B2	NA	HEAST
Tetrachloroethylene	5.1E-02	B2	1,000	HEAST	3.3E-03	B2	NA	HEAST
Trichlorofluoromethane	--	B2	1,000	HEAST	--	B2	1,000	HEAST
Toluene	NA	D	NA	IRIS (7/90)	NA	D	NA	IRIS (7/90)
Xylene	NA	D	100	HEAST	NA	D	NA	HEAST
Explosives								
2,4-Dinitrophenol	ND	MA	NA	IRIS	ND	NA	NA	IRIS
2,4-Dinitrotoluene	6.8E-01	B2	NA	IRIS	ND	B2	NA	IRIS
HMX	ND	D	NA	IRIS	ND	D	NA	IRIS
RDX	1.1E-01	C	NA	IRIS	ND	NA	NA	IRIS
Tetryl	ND	NA	NA	IRIS	ND	NA	NA	IRIS
1,3,5-Trinitrobenzene	ND	NA	NA	IRIS	ND	NA	NA	IRIS
2,4,6-Trinitrotoluene	3.0E-02	C	NA	IRIS	ND	C	NA	IRIS

To ensure an adequate margin of safety, the SF is taken to be the upper 95th percent confidence limit of the slope. Thus, the actual slope factors could be lower but are not likely to be higher.

Potential reproductive outcome due to exposure of soil and water borne contaminants were considered. As delineated in the toxicity profiles, compounds like lead and selenium could adversely affect the fetus and/or reproductive outcome. Several of the VOCs have reproductive/fetotoxic effects in rodents but there is limited human data on their effects. Similar conclusions for the organochlorine pesticides are noted. However, the organochlorine pesticides are known to affect avian reproductive fecundancy (e.g., birds of prey).

The sections describing the adverse health effects of each chemical and the basis for the RfDs and SFs that have been derived are presented in Appendix Q3.

7.5 RISK CHARACTERIZATION

This risk characterization section converts the calculated exposure doses into potential health risks. Chronic, non-carcinogenic risks are based on the presumption that a threshold dose is required to elicit a response while carcinogenic risks are presumed to exist regardless of the dose.

7.5.1 Carcinogenic Risks

The incremental carcinogenic risk is calculated for each exposure scenario based on the following basic equation:

$$\text{Risk} = \text{Exposure Dose} \times \text{Slope Factor}$$

where Slope Factor (SF) is a slope in units of $(mg/kg/day)^{-1}$ based on a compound specific cancer bioassay dose response curve. The exposure dose is adjusted over a 70-year lifetime. The summation of dose is in keeping with the concept that for genotoxic agents there exists no threshold dose and implies that total, lifetime exposure is of greater importance then the

actual dose during the exposure event(s). Ingestion and inhalation risks are calculated separately since compounds often have different SFs for differing routes of exposure. The different SFs relate to the pharmacokinetics inherit each chemical/organ and the specific routes of uptake. SFs are listed in Table 7-23.

The weighted exposure dose used for calculation of the excess cancer risk is calculated based on an exposure duration and the 70-year lifetime. For the casual visitor and the worker, the exposure duration was 20 years and the weighted dose calculated as 20/70 times the unweighted dose. Similarly, the residential weighted dose was calculated as 30/70 times the unweighted dose. In both cases, the estimated excess cancer risk is the product of the weighted dose times and slope factor of the compound.

Lifetime daily intakes, using an averaging time of 70 years, effectively prorates the total cumulative dose over a lifetime. This approach is based on the assumption for carcinogens that a high dose received over a short period of time at any age is equivalent to a corresponding low dose received over a lifetime (USEPA 1989b). This assumption is unlikely to be true for all carcinogens, and introduces uncertainty into the assessment of potential risk. This may lead to an overestimate or underestimate of potential risk, depending upon the actual timing of exposure and the mechanism of action of individual carcinogens.

Slope factors are derived by USEPA in an intentionally conservative way, that is, the actual risk is not expected to exceed the predicted risk, and could be considerably lower. Cancer risks calculated using these conservative slope factors and reasonable maximum exposure estimates are upper bound estimates of excess cancer risk potentially arising from exposure to the chemicals in question. A number of assumptions have been made in the derivation of these values, many of which are likely to overestimate exposure and toxicity. The actual incidence of excess cancers is likely to be lower than these estimates and may be zero.

The magnitude of cancer risk relative to Superfund site remediation goals in the National Contingency Plan ranges from 10^{-4} (one-in-ten-thousand) to 10^{-6} (one-in-one-million) depending on the site, proposed usage, and chemicals of concern (USEPA, 1989). For the

State of California, drinking water standards require cleanup to 10^{-6} (one-in-one-million) or MCL values.

7.5.2 Noncarcinogenic Effects

The potential for adverse effects on human health other than cancer is evaluated by comparing an intake over a specific time period with a reference dose derived for a similar exposure period. This comparison is performed by calculating a noncancer hazard quotient as follows:

$$HQ = DI/RfD$$

where:

HQ = Hazard Quotient (unitless) for subchronic (HI_s) or chronic (HI_c) exposure

DI = Daily Intake (mg/kg-day) for subchronic (DI_s) or chronic (DI_c) exposure

RfD = Reference Dose (mg/kg-day) for subchronic (RfD_s) or chronic (RfD_c) exposure

Also, since some individuals are exposed by more than one pathway, hazard quotients are summed for each pathway becoming a hazard index (HI) that contributes to the exposure to the same individual in a given subpopulation. If the total hazard index is equal to or less than 1E+0, it is believed that no threshold health effects will occur. If a hazard index exceeds 1E+0, there is a possibility that noncancer health effects may occur; however, a hazard index above 1E+0 does not predict that health effects will occur. In particular, summing hazard quotients across all chemicals and hazard indices across all pathways assumes that all acute and chronic effects are additive. Since this assumption is known not to be accurate, when a total population hazard index exceeds 1E+0, it is appropriate to re-examine the noncancer effects, and to segregate the individual hazard quotients on the basis of target organ or mechanism of action (USEPA 1989b).

Calculations of values representing overall reasonable maximum subchronic and chronic daily intakes are described in Section 7.3 and Appendix Q4. Derivation of chemical-specific reference doses, are described in Section 7.4, and summarized in Table 7-23. Using these values, hazard quotients have been calculated for chemicals of potential concern at each site, and summed to provide overall subpopulation hazard indices. Detailed calculations are presented in Appendix Q4, and the results are summarized in Appendix Q4. Due to the inherent uncertainty in calculating hazard indices, all values are reported to only one significant figure.

The calculation of hazard indices represents an appropriate estimate of chronic health effects and is derived from a ratio of the exposure dose to the dose required to induce an adverse health effect. The dose causing a health effect is equivalent to the reference dose (RfD). RfDs for the various contaminants are listed in Table 7-24. The hazard index is summed for each exposure route and chemical, and the total hazard index is compared to 1.0. If the hazard index is less than 1.0, then no chronic health effects are expected to occur. If the hazard index is greater than 1.0, then adverse health risks are possible. In the case of noncarcinogenic effects, chronic exposure below a threshold dose, results in a non-response or a diminished response. Table 7-24 outlines some of the potential effects of chronic exposure to the compound of concern. Further noncarcinogenic effects are listed in each chemical profile presented in Appendix Q3.

7.5.3 Current Exposure Scenarios - Carcinogenic Risks

The incremental excess cancer risks estimated from the current conditions are compiled in Appendix Q4 for each site. In the casual visitor scenario, adults were assumed to visit the site twice a month, 12 months a year, for 20 years.

7.5.3.1 Abandoned Landfill

The incremental excess cancer risks estimated for the current conditions at the Abandoned Landfill are given in Table Q4-7 (Appendix Q4). For the casual visitor scenario, cadmium, chromium, lead and phenol were determined to be the chemicals of potential concern in the

surface soils. Based on the current exposure scenario, risks at this site do not exceed 2E-05. The site-specific data for the risk calculations are based on the assumption that the total amount of chromium actually reaching the lungs via inhalation is hexavalent chromium (Cr^{+6}). Excess cancer risk is also enhanced by high levels of cadmium (Cd) in the surface soils. As with chromium, we have assumed that 100 percent of the exposed dose is absorbed, this may significantly overestimate the actual risk. If the contribution of both Cr^{+6} and Cd were eliminated from the risk determination, the risk posed by the other contaminants would not exceed 10^{-6}. Interpretation of the chromium and cadmium toxicity is based on a single datum. If the casual visitor were a pregnant female, there could be elevated risk of fetal toxicity due to lead exposure. Since there is no established threshold for lead and fetal toxicity, the actual toxicity is unknown. However, current ambient soil lead levels in major metropolitan areas exceed 500 μg/gm. U.S. Public Health Services (USPHS) has stated that soils containing between 500 and 1,000 μg/gm do not constitute a significant human health impact (ATSDR, 1989). Hence, the magnitude of the reproductive risk for a casual visitor is not well established.

7.5.3.2 Chemical Burial Site/Construction Debris Landfill

For the Chemical Burial Site/Construction Debris Landfill, the incremental cancer risk estimates are detailed in Table Q4-9 (Appendix Q4). For the casual visitor scenario, the chemicals of concern are TCFM, chlordane and heptachlor in the surface soils. Based on the current exposure pathways and estimated exposure levels, the total excess cancer risk is 2E-08. The site-specific data at this site indicate minimal risk for exposure to surface soils.

7.5.3.3 DRMO Trench Area

For the DRMO Trench Area, the incremental estimated excess cancer risks are listed in Table Q4-11 (Appendix Q4). For the casual visitor scenario, it was determined that the sum of the ingested dose plus the modeled fugitive dust rate yielded an excess cancer risk of 7E-08. The risk calculations were based on maximum reported values for 1,2-, 1,3-, and 1,4-dichlorobenzene, 1,1-DCE, TCE, and DDD and DDT.

The level of contamination at the site does not present a current chronic hazard to the casual visitor. The site of contamination is located approximately 10 to 12 feet below the surrounding area and it is highly unlikely that a construction worker would trench directly through the DRMO Trench at the 12-foot depth. The limited size of the trench and the depth precludes the construction worker scenario at this site. Hence, the only future scenario for the DRMO Trench Area carried quantitatively will be the future resident installing a potable well into the TCE contaminated aquifer at the site.

7.5.3.4 TNT Vehicle Maintenance Site

For the TNT Vehicle Maintenance Area subsite, it was determined that surface soil contaminants were not in sufficient quantity to pose an adverse health risk. A soil gas survey detected low levels of VOCs in soils. Lack of surface soil contaminant makes the pathway incomplete and hence only a qualitative examination of the vehicle maintenance site surface soil was necessary.

7.5.3.5 TNT Leaching Beds Subsite

For the TNT Leaching Beds Subsite, it was determined that the casual visitor scenarios presented a risk associated with the surface soil contaminants. The risks are quantified in Tables Q4-12 and Q4-13 (Appendix Q4).

For the casual visitor at the TNT Leaching Beds Site, exposure to surface soils containing average levels ot 2,4-DNT, RDX, and 2,4,6-TNT resulted in an excess cancer risk of 8E-07. The calculated excess cancer risk for the RME individual increases to 8E-06 based primarily on the contribution of 2,4,6-TNT in the surface soil. The excess cancer risk is within the range targeted for concern by USEPA.

7.5.4 Future Exposure Scenarios - Carcinogenic Risks

Future exposure scenarios are based on the construction/remedial worker operating a trenching backhoe at a contaminated site and future resident (if the base is inactivated and

converted into a residential area) installing a potable supply well into the contaminated aquifer. Groundwater would be used for drinking, cooking, and bathing.

Adult male or female remedial/construction workers were assumed to be at the site for 8 hours, 5 days-a-week for a total of 6 months. Combined ingestion of soil particles and fugitive dust is assumed to be in excess of 480 mg/day [air particle loading was modeled (BOX and Cowherd) or OSHA limits were utilized].

Future residents consisted of adult male/female residents with children. Total exposure to soil and groundwater was estimated for a period of 30 years for adults and the child was represented by default values of 0 to 5 years and 6 to 17 years for a total of 18 years (USEPA, 1989). Although exposure doses were calculated for children, carcinogenic risk was not calculated for children.

7.5.4.1 Abandoned Landfill

Based on the exposure scenario for a construction worker digging a trench through the most contaminated portion of the Abandoned Landfill, he or she would be exposed to a total excess cancer risk of 7E-05, Table Q4-8. Under this scenario it is assumed that a worker digs a trench through the most contaminated area at ALF-3 where the major contaminants of concern are chromium (48.4 μg/gm) and tetrachlorodibenzofurans (1.4 ppb). The chromium is based on a single datum and the carcinogenic potential is difficult to assess. The human health risks of the dibenzofurans in soils are also difficult to assess since chronic human health data is lacking and the chlorinated dibenzofurans are sorbed to soil particles.

Another future exposure scenario addressed at this site is the resident who will be exposed to chloroform and TCE from contaminated groundwater. When the groundwater ingestion and inhalation (shower) pathways are summed for the future resident, a total excess cancer risk of 3E-05 exists with the major input derived from TCE (Table Q4-1). The calculation of potential shower exposure, by the method of Foster & Chrostowski (1987), is given in Appendix Q1.

7.5.4.2 Chemical Burial Site/Construction Debris Landfill

The future exposure scenarios for the Chemical Burial Site/Construction Debris Landfill include the same remedial/construction worker and a future resident (Table Q4-10). For the construction workers, inhalation exposure to soil-borne pesticides yields an excess cancer risk of 1E-09 and a combined total inhalation plus ingestion risk of 5E-08. For this exposure scenario, the excess cancer risk is less than 10^{-6}.

The proposed future resident would be exposed to arsenic and TCE contaminated groundwater (Table Q4-2). Assuming a family and a child would live at the site, drink, eat, and bathe using the existing contaminated groundwater, the excess cancer risk would not be expected to exceed 2E-04 for the adult.

7.5.4.3 DRMO Trench Area

The future scenarios associated with the DRMO Trench Area are limited to the potential future resident who is exposed to contaminated groundwater (Table Q4-3). Construction worker/remedial workers were not considered since the trench surface lies approximately 12 feet below grade.

For groundwater contamination, the total estimated excess cancer risk is 1E-04 for adults due to ingestion, inhalation, and bathing. The excess cancer risk is based predominantly on the presence of TCE. Selenium levels exceed the MCLs for drinking water and these could enhance potential birth/reproduction risks associated with groundwater consumption. The actual potential for reproductive risks are unknown since selenium has not been demonstrated to induce malformation in mammals. However, the excess cancer risks for groundwater consumption at this site exceed the 10^{-6} bench mark established by the state for drinking water.

7.5.4.4 Vehicle Maintenance Area Subsite

Future exposure at the Vehicle Maintenance Area Subsite is limited to future residents utilizing the contaminated groundwater for drinking and bathing. The future exposure scenarios include an average exposure level and reasonably maximally exposed individual (RME). There is no detected soil contamination in this subsite that would constitute an excess cancer risk at this time.

For the average VOC ingestion and inhalation exposure to the future resident at the Vehicle Maintenance Area Subsite, the excess cancer risk is 3E-03 for the adult. The major contaminants contributing to this risk are arsenic, 1,2-DCA, TCE, carbon tetrachloride and chloroform. Arsenic is based on single sample just outside the range. The total summed pathway/compound excess cancer risk for the site is 3E-03 (Table Q4-4 in Appendix Q4).

For the RME individual family, the contaminants are the same but the estimated exposure level is increased. With the increased exposure levels, the excess cancer risk rises to a sum of 5E-03 for a child and 5E-03 for the adult. Hence, significant risk for potential increased tumor rates exist at the site for the RME.

7.5.4.5 TNT Leaching Beds Subsite

Future exposure at the TNT Leaching Beds Subsite for the construction/remedial worker and future potential residents includes exposure to contaminated surface soils and contaminated groundwater for drinking and bathing. The future exposure scenarios include both an average and a RME exposure level.

For the average munitions ingestion and fugitive dust inhalation at the TNT Leaching Beds Subsite, the excess cancer risk is 7E-06. The RME individual would be exposed at a level that would lead to a calculated excess cancer risk of 1E-05. The major contributing factors are 2,4,6,-TNT and RDX, and the excess risks for both exposure scenarios exceed the 1E-06 benchmark (Tables Q4-14 and Q4-15).

For the future resident, total exposure is estimated from potential soil ingestion, fugitive dust, groundwater ingestion, and bathing. In the average exposure scenario, soil ingestion and fugitive dust yield calculated excess cancer risks for the adult of 4E-04 for the average exposure level, and 6E-04 for the RME individual. The major contributing contaminants are 2,4,6-TNT, RDX, and 2,4,-DNT, and the 1E-06 benchmark is exceeded for all exposure scenarios (Tables Q4-16 and Q4-17).

The cancer risks associated with dermal exposure to the casual visitor were 9E-09 for average exposure and 7E-07 for the RME. The cancer risks for dermal exposure to the construction workers were 1E-06 for average exposure and 5E-06 for the RME. The cancer risks for dermal exposure to the future adult residents were 1E-06 for the average exposure and 2E-04 for the RME.

Potential consumption of contaminated groundwater would result in excess cancer risk estimates for adults would be 4E-04 for the average exposure level and 6E-04 for the RME individual. The major risk contributing contaminants are 2,4,-DNT, RDX and 2,4,6,-TNT. For the adult, the calculated excess cancer risk is 4E-04 for the consumption of groundwater and 5E-05 for the inhalation component. (Tables Q4-5 and Q4-6, Appendix Q4.)

7.5.5 Current Exposure Scenarios - Chronic Health Effects

Since there were chronic risks indicated in the risk calculations, the following is a discussion of potential adverse human health effects associated with specific chemicals. The hazard index is a benchmark and acts as a trigger for potential risk. However, the compounds need to be considered on an individual basis due to organ specificity. The hazard indices for chronic health effects at the various sites are detailed in Tables 7-26 through 7-29. As stated in 7.5.2, hazard indices greater than one indicate the potential for adverse chronic health effects. For sites where the hazard index exceeds one, the contaminants contributing to that risk are briefly discussed as to possible health risk implications.

7.5.5.1 Abandoned Landfill

For the Abandoned Landfill site, exposure to soil-borne lead could enhance fetotoxic effects. For birth defects, no threshold lead exposure dose exists so prediction of risk is not possible. The presence of dibenzofurans and dibenzodioxins in soils could indicate the potential risk of chloracne and potential chemical effects based on extrapolation from specific rodent data (ASTDR, 1989). The dioxins are known to induce cytochrome P450 and related enzyme levels and to enhance thymic involution in rodents (Safe, 1986). However, the total hazard index is 5E-04 which is below the benchmark of 1.0 (Table 7-26).

7.5.5.2 Chemical Burial Site/Construction Debris Landfill

At the Chemical Burial Site/Construction Debris Landfill, the major chronic and/or acute effects are attributable to chlordane in the soil. These compounds are enzyme inducers and cause liver injury and central nervous system (CNS) stimulation. They are acutely toxic both orally and dermally. The total hazard index is 7E-04 which is below the benchmark of 1.0 (Table 7-27).

7.5.5.3 DRMO Trench Area

High levels of chlorobenzenes and petroleum compounds at the DRMO Trench Area contribute to the potential of chronic and acute human health effects from surface soil exposure. Ingestion of chlorobenzenes and VOCs results in CNS depression, renal damage, and liver injury. Some of these compounds (e.g., 1,4-dichlorobenzene, 1,2-DCA, PCE, TCE) are rodent carcinogens (ASTDR, 1989; Klassen, 1987). Compounds like benzene have strong immuno-suppressive effects with loss of B and T cell competence. The pesticides chlordane and DDT are hepatotoxic and cause CNS stimulation and suppression. At the concentrations detected in the DRMO soils they are probably not toxic to humans. The surface soils at the DRMO Trench Area could present an acute hazard to site remediation workers. A total hazard index exceeding 1E-01 indicates low potential for chronic human health effects (Table 7-28).

7.5.5.4 Vehicle Maintenance Area Subsite

For the Vehicle Maintenance Area Subsite, there are no surface soil contaminants, therefore, the hazard index is below 1 for the present scenario. However, VOC contaminated groundwater at this subsite could lead to liver and renal damage in the future scenario based on short-term exposure via ingestion. It is difficult to predict what the combination of the carbon tetrachloride, chloroform, 1,2-DCA and TCE would be to an exposed individual. Based on rodent data (ASTDR, 1989) it is predictable that short-term exposure could lead to liver damage and CNS depression. Only direct contact with neat solvents or occupational inhalation has produced dizziness, nausea, vomiting and ataxia as short-term effects (Table 7-29).

7.5.5.5 TNT Leaching Beds Subsite

The surface soil contaminants at the TNT Leaching Beds Subsite contain high levels of munitions related compounds. The nitroaromatic compounds related to nitrotoluenes (2,4,-DNT, 1,3,5,-TNB and 2,4,6-TNT) and the triazine related compounds (HMX and RDX) are hepatotoxic to rodents and might be expected to have similar toxicity towards humans. For the current casual visitor scenario, the average exposure results in a hazard index of 2E-01 while the RME exposure level results in a index of 4E-01. Both values are below benchmark of 1.0 (Table 7-30). For dermal exposure the hazard index was 4E-03 for the average and 1E-01 for the RME.

7.5.6 Future Exposure Scenarios - Chronic Health Effects

Hazard indices for the future exposure scenarios are detailed in Tables 7-26 through 7-30. As stated, a hazard index greater than 1.0 is a benchmark indicative of potential adverse chronic health effects. The potential effects for site-specific contaminants have been detailed in the current exposure scenario section.

TABLE 7-26

SUMMARY OF HAZARD INDEX
ABANDONED LANDFILL

Population	Exposure Point	Exposure Matrix	Exposure Route	Hazard Index
Casual Visitor	On-Site	Soil	Ingestion	2E-04
			Inhalation	3E-04
			Total	**5E-04**
Construction Worker	Future On-Site	Soil	Ingestion	2E-02
			Inhalation	4E-04
			Total	**2E-02**
Adult Resident	Future On-Site	Soil	Ingestion	--
			Inhalation	--
			Total	**N/C**
		Water	Ingestion	5E-03
			Inhalation	--
			Total	**5E-03**
Child Resident	Future On-Site	Soil	Ingestion	--
			Inhalation	--
			Total	**N/C**
		Water	Ingestion	--
			Inhalation	--
			Total	**N/C**

N/C - Not calculated

TABLE 7-27

SUMMARY OF HAZARD INDEX
CHEMICAL BURIAL SITE/CONSTRUCTION DEBRIS LANDFILL

Population	Exposure Point	Exposure Matrix	Exposure Route	Hazard Index
Casual Visitor	On-Site	Soil	Ingestion	2E-04
			Inhalation	5E-04
			Total	**7E-04**
Construction Worker	Future On-Site	Soil	Ingestion	4E-02
			Inhalation	9E-04
			Total	**4E-02**
Adult Resident	Future On-Site	Soil	Ingestion	--
			Inhalation	--
			Total	**N/C**
		Water	Ingestion	4E-01
			Inhalation	--
			Total	**4E-01**
Child Resident	Future On-Site	Soil	Ingestion	--
			Inhalation	--
			Total	N/C
		Water	Ingestion	--
			Inhalation	--
			Total	N/C

N/C - Not calculated

TABLE 7-28

SUMMARY OF HAZARD INDEX
DRMO TRENCH AREA

Population	Exposure Point	Exposure Matrix	Exposure Route	Hazard Index
Casual Visitor	On-Site	Soil	Ingestion	3E-04
			Inhalation	1E-01
			Total	**1E-01**
Construction Worker	Future On-Site	Soil	Ingestion	--
			Inhalation	--
			Total	**N/C**
Adult Resident	Future On-Site	Soil	Ingestion	--
			Inhalation	--
			Total	**N/C**
		Water	Ingestion	2E-01
			Inhalation	--
			Total	**2E-01**
Child Resident	Future On-Site	Soil	Ingestion	--
			Inhalation	--
			Total	**N/C**
		Water	Ingestion	--
			Inhalation	--
			Total	**N/C**

N/C - Not calculated

TABLE 7-29

SUMMARY OF HAZARD INDEX
VEHICLE MAINTENANCE AREA SUBSITE

Population	Exposure Point	Exposure Matrix	Exposure Route	Hazard Index
Casual Visitor	On-site	Soil	Ingestion	--
			Inhalation	--
			Total	**N/C**
Construction Worker	Future On-Site	Soil	Ingestion	--
			Inhalation	--
			Total	**N/C**
Adult Resident	Future On-Site	Soil	Ingestion	--
			Inhalation	--
			Total	**N/C**
		Water	Ingestion	1E+01
			Inhalation	1E+01
			Total	**2E+01**
Child Resident	Future On-Site	Soil	Ingestion	--
			Inhalation	--
			Total	**N/C**
		Water	Ingestion	--
			Inhalation	--
			Total	**N/C**

N/C - Not calculated

TABLE 7-30

SUMMARY OF HAZARD INDEX
TNT LEACHING BEDS SUBSITE

Population	Exposure Point	Exposure Matrix	Exposure Route	Hazard Index Average	Hazard Index RME
Casual Visitor	On-Site	Soil	Ingestion	1E-01	2E-01
			Inhalation	7E-02	1E-01
			Dermal	4E-03	1E-01
			Total	**2E-01**	**4E-01**
Construction Worker	Future On-Site	Soil	Ingestion	3E+00	5E+00
			Inhalation	6E-02	1E-01
			Dermal	5E+00	1E+01
			Total	**8E+00**	**15E+00**
Adult Resident	Future On-Site	Soil	Ingestion	2E+01	3E+01
			Inhalation	5E-01	8E-01
			Dermal	8E-01	3E+01
			Total	**2E+01**	**6E+01**
		Water	Ingestion	2E+01	4E+01
			Inhalation	1E-01	4E-01
			Total	**2E+01**	**4E+01**
Child Resident	Future On-Site	Soil	Ingestion	--	--
			Inhalation	--	--
			Total	**N/C**	**N/C**
		Water	Ingestion	--	--
			Inhalation	--	--
			Total	**N/C**	**N/C**

N/C - Not calculated

7.5.6.1 Abandoned Landfill

For the Abandoned Landfill site the future construction worker would be exposed to soil-borne lead and potentially dioxins/dibenzofurans. The total hazard index associated with soil was calculated to be 2E-02. For adult future resident exposed to TCE and carbon tetrachloride in the groundwater, a hazard index of 5E-03 was calculated for each individual. These indices are below the benchmark of 1.0 (Table 7-26).

7.5.6.2 Chemical Burial Site/Construction Debris Landfill

For the future construction worker at the Chemical Burial Site/Construction Debris Landfill, exposure to soil-borne pesticides and freon derivations result in a calculated hazard index of 4E-02. For the future resident adult consuming TCE contaminated groundwater, the hazard index was determined to be 4E-01. Both future exposure scenarios result in hazard indices below the benchmark for chronic health risks (Table 7-27).

7.5.6.3 DRMO Trench Area

Future exposure scenarios at the DRMO Trench Area include only the potential future resident child and adult. The construction worker scenario was not analyzed due to the physical nature of the trench (approximately 10 to 12 feet below surrounding soil surface) and the low likelihood of a trench being dug through the actual trench area. Consequently, the consumption of groundwater containing TCE and selenium was considered for the adult. The calculated hazard indices for exposed individuals was 2E-01 which was below the level of concern for chronic human health effects (Table 7-28).

7.5.6.4 Vehicle Maintenance Area Subsite

Future exposure scenarios for the Vehicle Maintenance Area Subsite are limited to future resident adult consuming groundwater contaminated with arsenic, chromium, TCE, carbon tetrachloride, chloroform, and 1,2,-DCA at an RME exposure rate. For the average adult consuming groundwater at the site, a hazard index of 2.0 was calculated. Clearly,

consumption and utilization of contaminated groundwater at this site exceed the benchmark value of 1.0 and an excess chronic human health risk could exist for this site (Table 7-29).

7.5.6.5 TNT Leaching Beds Subsite

Future exposure scenarios at the TNT Leaching Beds Subsite include an average and RME exposure level for the construction worker for soil ingestion and fugitive dust, and soil ingestion, fugitive dust, and groundwater ingestion and utilization for the future resident adult (Table 7-30). For the construction worker, the average exposure resulted in a calculated hazard index of 8.0 and the RME exposure resulted in an index of 15.0. Dermal exposure resulted in an index of 5E+00 for average and 1E+1 for the RME exposure. For the future residential soil exposure pathway, the average and RME adult hazard index was calculated to be 20 and 60. The future average and RME adult hazard index calculated were 20 and 40 for ingestion and 1E-01 to 4E-01 for showering. All hazard indices for the potential future summed exposure scenarios/pathways exceed the benchmark of 1.0. As noted earlier, chronic liver and potential renal effects could result from the consumption of soils and groundwater at the TNT Leaching Beds Subsite.

7.5.7 Risk Characterization Uncertainties

7.5.7.1 Site Characterization

Abandoned Landfill

The magnitude and distribution of contaminants at the Abandoned Landfill was characterized by soil trenching and boring of three soil boring profiles. The first depth sampled was at 5 feet; this data was chosen to represent the surface soil. Groundwater sampling was accomplished by installing three monitoring wells. Water samples indicated the presence of several organic and inorganic constituents. The history of the Abandoned Landfill, its large area and the fact that groundwater sampling was conducted at only three points indicates that the data may not be representative of site contamination. Consequently, the maximum

detected level was chosen for risk determination. This approach provides for a conservative estimation of potential human health exposure/risk.

Chemical Burial Site/Construction Debris Landfill

Two monitoring wells and six soil borings were placed at this site as part of the Phase I RI. Contamination detected in the six surface soil samples (5 foot) may not be representative of the site. Groundwater monitoring data collected from only two points are insufficient to perform fate and transport modeling of water contaminants. Hence, maximum detected levels of contaminants were used for risk determination. This approach provides a conservative estimate of potential human health risk associated with site contaminants.

DRMO Trench Area

Eight soil borings and three monitoring wells were installed during the Phase I RI. The 5-foot soil sample was chosen as representative of the surface soil. Of these soil borings, only one intersected the base of the trench with sufficient proximity to detect significant contamination. Hence, data for soil contamination in the trench are based on only one detect. The level of several of the detected organic constituents exceeded the maximum IRDMS certified limits and were reported at greater than 1 μg/gm. However, actual ESE data indicated quantification of the compounds at levels that were near those previously reported (Benioff et al., 1988). Hence, a conservative approach to risk quantification used the ESE data which was more representative of actual levels of contamination. Using these data may tend to overestimate risks. Groundwater sampling was of insufficient size to perform fate and transport modeling of the organics in the groundwater plume.

TNT Leaching Beds Area

The nature and extent of contamination at the TNT Leaching Beds Area was assessed by installation of 13 monitoring wells and eight soil borings. The sampling at this site provided sufficient data to assess both soil and groundwater contamination. Soil and groundwater plume concentrations were determined utilizing fate and transport modeling; plume definition

indicates groundwater flow towards the northwest and northeast. Use of average and upper bound VOC levels in groundwater provides a conservative approach to risk estimation.

7.5.7.2 Selection of Contaminants of Concern

Contaminants of potential concern at the Abandoned Landfill, Chemical Burial Site/Construction Debris Landfill, DRMO Trench Area, and the Vehicle Maintenance Area Subsite have been selected on their potential to adversely affect human health. The selection procedure evaluated compounds by their concentration above background level, prevalence, potential toxicity to humans, and potential bio-availability. It is assumed that essential nutrients do not affect risk. All chromium was assumed to be hexavalent. This may overestimate the risk.

In the case of the Vehicle Maintenance Area Subsite where high levels of TCE were detected (952 μg/L) in the groundwater, vinyl chloride was not detected. Since both 1,2-DCA and TCE potentially can give rise to vinyl chloride as a metabolite degradation product in soil/groundwater matrices (Smith and Dragon, 1984), its lack of detection indicates that it is unlikely to be present at the site. This uncertainty is further diminished by the fact that no potential new sources of TCE have been present for almost 40 years. Hence, the likelihood for the presence of TCE breakdown products is decreased at this site. The assumption that the average and upperbound concentrations of TCE at this site represent the level of contamination, allows for a conservative estimation of risk to potential human receptors.

One additional source of uncertainty is the fact that not all known potential explosives compound degradation products were analyzed in surface soils or groundwater. Although most products are unstable, the major stable photochemical degradation product of 2,4,6-TNT (1,3,5-TNB) was detected in both surface soil and groundwater.

7.5.7.3 Exposure Pathways

For all sites except the TNT Leaching Beds Subsite, the 5-foot interval was assumed to represent the actual surface soil conditions. As a result, the calculated risk associated with

surface soils from these sites must be interpreted cautiously. However, the absence of true surface soil data was mitigated in part by utilizing maximum detected concentrations to predict a conservative potential human health risk. If contaminants are mobile and the landfill areas overburdened with clean fill, the 5-foot sample may not overestimate hot spot concentration. Lack of surface soils represents a data gap.

Groundwater contamination at the Abandoned Landfill, Chemical Burial Site/ Construction Debris Landfill, and DRMO Trench Area could not be adequately assessed due to lack of physical and chemical data. The lack of complete contamination assessment is compensated by a conservative estimation of potential human health risks utilizing maximum detected values.

No surface soil samples were collected outside the TNT Leaching Beds Area. No air samples were taken and thus exposure to potential populations off-site were not quantified. The acral size of the TNT Leaching beds suggests that the contribution of these contaminants would be small compared to the total base. Inhalation pathways for showering and VOC exposure were modeled by Foster and Chrostowski (1987). Particulate emissions were calculated based on the box model and Cowherd, et al (1984).

7.5.7.4 Background Soil and Groundwater Data

Background soils and groundwater data collected during the Phase I RI appear sufficient to define the sites with regard to background soil and groundwater contamination (Table 7-2). Elevated levels of arsenic in soil and groundwater at the Abandoned Landfill and TNT Leaching Beds Area indicate that site-related contamination may be a factor. However, the levels are only slightly above background range. The use of maximum arsenic concentrations at these sites increases the conservative nature of the risk assessment.

Surface soil definition at the Abandoned Landfill, Chemical Burial Site/Construction Debris Landfill, and DRMO Trench Area indicates a low frequency of contaminant detection. Maximum detected concentrations were utilized to compensate for under estimation of

contamination. The actual risks may be lower at these sites due to the conservative exposure assumptions.

7.5.7.5 Estimation of Exposure Point Concentrations

The exposure point concentrations used for arsenic risk quantification at the Abandoned Landfill, Chemical Burial Site/Construction Debris Landfill, and DRMO Trench Area were the maximum detected levels in soil and groundwater which are equivalent to an maximally exposed individual (MEI). The TNT Vehicle Maintenance Area Subsite exposure point concentrations were an average and an RME.

The exposure point concentrations used for assessing risk at the TNT Leaching Beds Subsite were the arithmetic mean and the 95th percentile upper-bound values of measured concentrations. For surface soils, these values are based on data from eight composite samples, and therefore, provide a realistic measure of actual average contamination at the site. The effect of this uncertainty (increase or decrease conservatism) is not known.

An additional uncertainty is introduced by the use of surface soil concentrations for calculating daily intake resulting from incidental ingestion of soil/dust by future adult residents. It is likely that some portion of the total soil ingested each day comes from soils uncontaminated by site-specific sources, and that concentrations of contaminants in indoor dust would be lower than the concentrations in surrounding surface soil. The assumption that all ingested soil is as contaminated as the surface soil increases the conservatism of the risk assessment, by an amount that is dependent upon the actual fraction of ingested soil that is not contaminated by site-related chemicals.

7.5.7.6 Exposure Levels

Exposure levels are highly dependent upon the activities in which the potential receptors participate. As discussed in Section 7.3, there are essentially no data concerning human exposure to the TNT Leaching Beds Subsite. Where possible, standardized assumptions concerning human exposure from sources such as USEPA (1989b, 1989d, 1988d) are used.

However, even standardized assumptions are uncertain. For example, there is considerable debate concerning actual soil ingestion rates of children and adults, and extrapolation to casual visitors and construction workers is even more uncertain. Standardized assumptions are more likely to increase than decrease conservatism, although this cannot be stated with certainty.

7.5.7.7 Concentration of Volatiles from Household Uses of Water

Airborne TCE concentrations associated with showering were evaluated by the method of Foster and Chrostowski (1987). Default parameters utilized in the model and actual TCE concentrations could exceed or underestimate the predicted TCE exposure levels. The MEI scenario exposure as the maximum point-source concentration was based on three samples per site for the Abandoned Landfill, Chemical Burial Site/Construction Debris Landfill, and DRMO Trench Area. Maximum and average values were assumed to more precisely estimate risk at the Vehicle Maintenance Area Site. Overall, based on the data, the risk estimate to human health via VOC inhalation represents a conservative approach.

7.5.7.8 Reproductive Effects

The presence of metals in surface soils and groundwater that are known to adversely affect reproductive outcome increases the potential risk at a site. Dose-response relationships in laboratory animals and human epidemiological data for lead exposure indicate that without appropriate modeling, adverse reproductive effects are likely to be underestimated by point-source exposure calculations. Moreover, no threshold has been identified for developmental toxicity of lead. However, since no residential exposure pathway exists for the resident woman of childbearing-age (fetal exposure), an accurate assessment for reproductive risk cannot be determined with certainty.

The presence of selenium in groundwater at the Abandoned Landfill and DRMO Trench Area suggests a potential for reproductive human health hazard to future female, child-bearing-age residents. Dose-response relationships in avian species demonstrate a clear causal relationship between selenium uptake and malformities and death. Elevated oral exposure

to sodium selenite reduces female fertility in rodents and adversely effects fetal growth rates. However, there appears to be significant differences in the spectrum of developmental malformations induced between avian and rodent species. Dose-extrapolation from the rodent to the human with regard to potential reproductive toxicity of selenium is confounded since selenium plays a role as an essential trace nutrient in the human diet. Excess selenium intake in humans results in chronic selenosis as exemplified by brittle nails, alopecia, skin lesions and nervous disorders (Yang, et al., 1988). However, there are no reported dose-response or epidemiological investigations in primates or humans to provide a scientific basis for estimating actual risks of adverse reproductive outcome due to excess selenium ingestion. Consequently, a large degree of uncertainty exists in predicting potential human health risk to oral ingestion of excess selenium.

Reproductive effects caused by VOCs are limited to primarily to embryolethality and fetotoxicity with marginal teratogenic effects. Carbon tetrachloride, chloroform, 1,2-dichloroethane, xylene, toluene and TCE are embryo-lethal only at maternally toxic doses. No terata have been observed in rodents at these confounding doses, suggesting that there are limited reproductive effects of VOCs. Human epidemiological investigations are limited and provide neither positive or negative information as to possible human reproductive outcome.

7.5.7.9 Mixture of Contaminants

Large numbers of contaminants, particularly at the DRMO Trench Area, add considerably to the risk uncertainty for a human health evaluation. Several of the pesticides are known rodent carcinogens with no human epidemiology to support carcinogenicity in man. These compounds are cytotoxic, elicit neurological symptoms, and are potent inducers of hepatic drug metabolizing enzymes. Their effects on drug metabolism can either enhance or inhibit activation of carcinogens *in vivo* and can enhance the detoxification of compounds like chlorobenzenes and TCE.

The wide variety of potent enzyme inducers, potential carcinogens, potential fetal toxicants and cytotoxic agents at the same site increases uncertainty in estimating risk. The potential toxicity of these compounds is further confounded by the fact that they are soil borne,

thereby having differing capacity to be absorbed and/or bio-availability. The combination of TCE, carbon tetrachloride, 1,2-DCA and chloroform in the groundwater at the TNT site also adds to uncertainty in risk estimation. All of the compounds are cytotoxic to the liver and act as weak carcinogens. The compounds could enhance metabolism of the nitro toluene compounds and either increase or decrease the toxicity of nitro aromatics. Many nitro aromatics are renal and bladder carcinogens and the interaction of these compounds is difficult to predict.

The risk assessment process developed by USEPA assumes that risks from multiple chemicals are additive, both for cancer and for organ-specific noncancer effects. There are examples in the scientific literature of exposure to two chemicals resulting in risks that are more than additive (synergism) or less than additive (antagonism). Levine, et al (1990) examined the toxic interactions between 2,4,6-TNT and RDX in rats, and found antagonistic interactions for most toxic effects. However, insufficient dose-response information was available to provide quantitative adjustment for nonadditive interactions among 2,4,6-TNT and RDX or other chemicals of potential concern. The assumption of additivity of effects could increase or decrease the conservatism of the risk assessment, depending on the actual modes of interaction among all the chemicals of potential concern.

7.5.7.10 Potential Land Use

Projected future land use is speculative, and the possibility of residential use of SIAD land is currently unknown. It is highly unlikely that the base will be converted to residential use and that the shallow aquifer will be used as a potable water source. If the base is decommissioned, the most likely use of the area would be as an addition to the game refuge that lies to the south of Herlong.

7.5.7.11 Risks Not Quantified

Toxicity values were available for most of the compounds that were designated potential chemicals of concern. However, cancer potency factors (slope factors) were not available for all compounds examined. Slope factors were unavailable for 1,3,5-TNB, a contaminant

present at the highest concentration in groundwater at the TNT Leaching Beds Area. Chronic toxicity and reproductive toxicity data was generally available for most of the compounds. The munitions compound tetryl was the only compound included in the BRA where key toxicity data was not fully available.

7.5.8 Risk Characterization Summary

Cancer risk for the current casual visitor scenario are below the benchmark of 1E-06 for the Chemical Burial Site/Construction Debris Landfill, DRMO Trench Area, Vehicle Maintenance Area Subsite and the average exposure level for the TNT Leaching Beds Subsite. The excess cancer risk for the Abandoned Landfill (2.E-05) exceeds the 1E-06 level. The excess cancer risk is due to the presence of chromium and cadmium in surface soils. The RME excess cancer risk at the TNT Leaching Beds Area Subsite was 8E-06 and was due to RDX and 2,4,6-TNT (Tables 7-31 through 7-36).

Cancer Risk - Future Scenario

For the future construction worker scenario, the excess cancer risk benchmark is exceeded at the Abandoned Landfill (7E-05, due to the chromium cadmium and dioxins), and at the TNT Leaching Beds Area (1E-05, due to the RDX and 2,4,6-TNT). The excess cancer risk was not exceeded for the construction worker at the Chemical Burial Site/Construction Debris Landfill or the TNT Vehicle Maintenance Area Subsite. The excess cancer risk for the average construction worker at the TNT Leaching Beds Subsite was 8E-06 (average) and 1E-05 (RME) for soil and fugitive dust pathways.

For the future residential scenario which includes ingestion of soil and water and inhalation of fugitive dust and VOCs from groundwater, the excess cancer risk benchmark of 1E-06 was exceeded at the Abandoned Landfill, Chemical Burial Site/ Construction Debris Landfill, DRMO Trench Area, TNT Vehicle Maintenance Area Subsite, and TNT Leaching Beds Subsite. At the Abandoned Landfill, consumption of groundwater and bathing with water contaminated with TCE yielded a future potential risk of 3E-05 for adults. At the Chemical Burial Site/Construction Debris Landfill, consumption of groundwater and bathing with water

TABLE 7-31

SUMMARY OF POTENTIAL CARCINOGENIC RISKS
ABANDONED LANDFILL

Group			Route of Exposure	Carcinogen Group			
Population	Point	Matrix		A	B	C	Total
Casual Visitor	On Site	Soil	Ingestion	--	4E-08	--	4E-08
			Inhalation	2E-05	5E-07	--	2E-05
			Total	**2E-05**	**5E-07**	N/C	**2E-05**
Construction Worker	Future On Site	Soil	Ingestion	7E-05	2E-06	--	7E-05
			Inhalation	1E-06	4E-08	--	1E-06
			Total	**7E-05**	**2E-06**	N/C	**7E-05**
Adult Resident	Future On Site	Soil	Ingestion	--	--	--	--
			Inhalation	--	--	--	--
			Total	N/C	N/C	N/C	N/C
Adult Resident	Future On Site	Water	Ingestion	--	9E-06	--	9E-06
			Inhalation	--	2E-05	--	2E-05
			Total	N/C	**3E-05**	N/C	**3E-05**
Child Resident	Future On Site	Soil	Ingestion	--	--	--	--
			Inhalation	--	--	--	--
			Total	N/C	N/C	N/C	N/C
Child Resident	Future On Site	Water	Ingestion	--	--	--	--
			Inhalation	--	--	--	--
			Total	N/C	N/C	N/C	N/C

N/C = Not calculated

TABLE 7-32

SUMMARY OF POTENTIAL CARCINOGENIC RISKS
CHEMICAL BURIAL SITE/CONSTRUCTION DEBRIS LANDFILL

Group			Route of Exposure	Carcinogen Group			
Population	Point	Matrix		A	B	C	Total
Casual Visitor	On Site	Soil	Ingestion	--	4E-09	--	4E-09
			Inhalation	--	1E-08	--	1E-08
			Total	**N/C**	**2E-08**	**N/C**	**2E-08**
Construction Worker	Future On Site	Soil	Ingestion	--	5E-08	--	5E-08
			Inhalation	--	1E-09	--	1E-09
			Total	**N/C**	**5E-08**	**N/C**	**5E-08**
Adult Resident	Future On Site	Soil	Ingestion	--	2E-08	--	2E-08
			Inhalation	--	1E-08	--	1E-08
			Total	**N/C**	**3E-08**	**N/C**	**3E-08**
Adult Resident	Future On Site	Water	Ingestion	2E-04	9E-07	--	2E-04
			Inhalation	--	2E-06	--	2E-06
			Total	**2E-04**	**3E 06**	**N/C**	**2E-04**
Child Resident	Future On Site	Soil	Ingestion	--	--	--	--
			Inhalation	--	--	--	--
			Total	**N/C**	**N/C**	**N/C**	**N/C**
Child Resident	Future On Site	Water	Ingestion	--	--	--	--
			Inhalation	--	--	--	--
			Total	**N/C**	**N/C**	**N/C**	**N/C**

N/C = Not calculated

TABLE 7-33

SUMMARY OF POTENTIAL CARCINOGENIC RISKS
DRMO TRENCH AREA

Group			Route of Exposure	Carcinogen Group			
Population	Point	Matrix		A	B	C	Total
Casual Visitor	On Site	Soil	Ingestion	9E-11	8E-09	2E-09	1E-08
			Inhalation	3E-10	3E-08	3E-08	6E-08
			Total	**4E-10**	**4E-08**	**3E-08**	**7E-08**
Construction Worker	Future On Site	Soil	Ingestion	--	--	--	--
			Inhalation	--	--	--	--
			Total	N/C	N/C	N/C	N/C
Adult Resident	Future On Site	Soil	Ingestion	--	--	--	--
			Inhalation	--	--	--	--
			Total	N/C	N/C	N/C	N/C
Adult Resident	Future On Site	Water	Ingestion	1E-04	3E-06	--	1E-04
			Inhalation	--	7E-06	--	7E-06
			Total	**1E-04**	**1E-05**	N/C	**1E-04**
Child Resident	Future On Site	Soil	Ingestion	--	--	--	--
			Inhalation	--	--	--	--
			Total	N/C	N/C	N/C	N/C
Child Resident	Future On Site	Water	Ingestion	--	--	--	--
			Inhalation	--	--	--	--
			Total	N/C	N/C	N/C	N/C

N/C = Not calculated

TABLE 7-34

SUMMARY OF POTENTIAL CARCINOGENIC RISKS, RME
VEHICLE MAINTENANCE AREA SUBSITE

Group			Route of Exposure	Carcinogen Group			
Population	Point	Matrix		A	B	C	Total
Casual Visitor	On Site	Soil	Ingestion	--	--	--	--
			Inhalation	--	--	--	--
			Total	**N/C**	**N/C**	**N/C**	**N/C**
Construction Worker	Future On Site	Soil	Ingestion	--	--	--	--
			Inhalation	--	--	--	--
			Total	**N/C**	**N/C**	**N/C**	**N/C**
Adult Resident	Future On Site	Soil	Ingestion	--	--	--	--
			Inhalation	--	--	--	--
			Total	**N/C**	**N/C**	**N/C**	**N/C**
Adult Resident	Future On Site	Water	Ingestion	3E-04	6E-04	--	9E-04
			Inhalation	4E-06	2E-03	--	2E-03
			Total	**3E-04**	**3E-03**	**--**	**3E-03**
Child Resident	Future On Site	Soil	Ingestion	--	--	--	--
			Inhalation	--	--	--	--
			Total	**N/C**	**N/C**	**N/C**	**N/C**
Child Resident	Future On Site	Water	Ingestion	--	--	--	--
			Inhalation	--	--	--	--
			Total	**N/C**	**N/C**	**N/C**	**N/C**

N/C = Not calculated

TABLE 7-35

SUMMARY OF POTENTIAL CARCINOGENIC RISKS, AVERAGE
TNT LEACHING BEDS SUBSITE

Group			Route of Exposure	Carcinogen Group			Total
Population	Point	Matrix		A	B	C	
Casual Visitor	On Site	Soil	Ingestion	--	9E-09	5E-07	5E-07
			Inhalation	--	5E-09	3E-07	3E-07
			Dermal		1E-10	9E-09	9E-09
			Total	**N/C**	**1E-08**	**8E-07**	**8E-07**
Construction Worker	Future On Site	Soil	Ingestion	--	1E-07	6E-06	7E-06
			Inhalation	--	2E-09	1E-07	1E-07
			Dermal		2E-08	1E-06	1E-06
			Total	**N/C**	**1E-07**	**7E-06**	**7E-06**
Adult Resident	Future On Site	Soil	Ingestion	--	2E-06	1E-04	1E-04
			Inhalation	--	6E-08	3E-06	3E-06
			Dermal		2E-08	1E-06	1E-06
			Total	**N/C**	**2E-06**	**1E-04**	**1E-04**
Adult Resident	Future On Site	Water	Ingestion	3E-04	4E-05	6E-05	4E-04
			Inhalation	--	2E-05	--	2E-05
			Total	**3E-04**	**6E-05**	**6E-05**	**4E-04**
Child Resident	Future On Site	Soil	Ingestion	--	--	--	--
			Inhalation	--	--	--	--
			Total	**N/C**	**N/C**	**N/C**	**N/C**
Child Resident	Future On Site	Water	Ingestion	--	--	--	--
			Inhalation	--	--	--	--
			Total	**N/C**	**N/C**	**N/C**	**N/C**

N/C = Not calculated

TABLE 7-36

SUMMARY OF POTENTIAL CARCINOGENIC RISKS, RME
TNT LEACHING BEDS SUBSITE

Group			Route of Exposure	Carcinogen Group			
Population	Point	Matrix		A	B	C	Total
Casual Visitor	On Site	Soil	Ingestion	--	2E-08	8E-07	8E-07
			Inhalation	--	1E-08	5E-07	5E-07
			Dermal		9E-08	7E-06	7E-06
			Total	**N/C**	**1E-07**	**8E-06**	**8E-06**
Construction Worker	Future On Site	Soil	Ingestion	--	2E-07	1E-05	1E-05
			Inhalation	--	4E-09	2E-07	2E-07
			Dermal		7E-08	5E-06	5E-06
			Total	**N/C**	**3E-07**	**1E-05**	**1E-05**
Adult Resident	Future On Site	Soil	Ingestion	--	4E-06	2E-04	2E-04
			Inhalation	--	1E-07	5E-06	6E-06
			Dermal		3E-06	2E-04	2E-04
			Total	**N/C**	**7E-06**	**4E-04**	**4E-04**
Adult Resident	Future On Site	Water	Ingestion	4E-04	7E-05	1E-04	7E-04
			Inhalation	--	5E-05	--	5E-05
			Total	**4E-04**	**1E-04**	**1E-04**	**7E-04**
Child Resident	Future On Site	Soil	Ingestion	--	--	--	--
			Inhalation	--	--	--	--
			Total	**N/C**	**N/C**	**N/C**	**N/C**
Child Resident	Future On Site	Water	Ingestion	--	--	--	--
			Inhalation	--	--	--	--
			Total	**N/C**	**N/C**	**N/C**	**N/C**

N[redacted] No[redacted]ulate[redacted]

contaminated with arsenic and TCE yielded a potential risk of 2E-04 for adults. Results were similar for the DRMO Trench Area and contaminated groundwater. At this site, the calculated risk was 1E-04 for adults. For the TNT Leaching Beds Area Subsite, future residential soil ingestion and fugitive dust yields an excess cancer risk of 1E-04 for adult (average). The RME for adults was 4E-04. Finally, the future residential groundwater was calculated to be 4E-04 for adults and 7E-04 for adults (RME exposure). The risk was attributed to the high concentrations of TCE, chloroform, carbon tetrachloride, and 1,2-DCA in the groundwater. Additional site-related risk was due to the presence of 2,4,-DNT, RDX, and 2,4,6-TNT in the surface soil and the groundwater.

7.5.9 Noncancer Risk - Current and Future Scenarios

Subchronic and chronic hazard indices are less than the 1.0 benchmark for all sites by the present casual visitor scenario. Subchronic and chronic hazard indices exceed the 1.0 benchmark value for future use scenarios at the Vehicle Maintenance site and the TNT Leaching Bed site. Calculated hazard indices (up to 20) for the TNT Vehicle Maintenance Area Subsite are based on high levels of TCE, carbon tetrachloride, chloroform and 1,2-DCA in the groundwater. For the TNT Leaching Beds site, the major noncancer risk contaminants were 2-4-dinitrophenol (2,4-DNP), 2,4,6-TNT, 1,3,5-TNB, and RDX yielding a total hazard index of 20 (for the average) and 40 (for the RME). Clearly, the combination of soil and groundwater contamination at this site for the future residents could result in substantial noncancer health effects.

7.6 BASELINE RISK ASSESSMENT SUMMARY

The BRA is an analysis of the potential adverse health effects (both current and future) resulting from exposures to contaminants at the five SIAD Phase I RI sites. By definition, a BRA considers conditions under the no-action alternative, that is, in the absence of any remedial actions to control or mitigate releases. The BRA will be used to:

- Document both the magnitude and contributing causes to potential human health risks at the five SIAD Phase I RI sites.

- Assist in determining whether remedial actions may be necessary to mitigate unacceptable human health risks.

The basic methodology used in this risk assessment was developed by USEPA specifically for evaluations of risk at hazardous waste sites (USEPA, 1989b). Overall, this methodology is conservative, which means that the true risks from the site are unlikely to be higher than the derived estimates, and are most likely to be lower.

Major steps in this risk assessment are summarized in the remainder of this section.

7.6.1 Data Evaluation

Analytical data on chemical concentrations in the soils and groundwater were evaluated to identify key site-related contaminants to be included in risk quantification. Data was analyzed from samples collected from soil borings at four of the sites, surface soils from the TNT Leaching Beds Subsite, and from monitoring wells drilled into the A zone aquifer at the five locations.

Only data generated from sampling performed during the 1990 Phase I RI was of known analytical quality. Data from sampling performed in 1984 through 1986 was generally consistent with more recent results; therefore, certain earlier data has been utilized in risk characterization (Benioff, et al, 1988).

Chemicals were eliminated from consideration in the risk assessment process if they were not detected above detection limits in any sample, were present at levels less than background, or were essential nutrients (and therefore relatively nontoxic). A listing of the considered contaminants by site are presented in Table 7-37.

The chemicals of concern consisted of metals, VOCs, semi-volatile organics, base neutral extractable organics, pesticides, and explosives compounds. The contaminants were detected

TABLE 7-37

SUMMARY OF SITE-SPECIFIC CHEMICALS OF POTENTIAL CONCERN

Abandoned Landfill

- Arsenic
- Cadmium
- Chromium
- Lead
- Selenium
- Chloroform
- Trichloroethylene
- Trichlorofluoromethane
- 1,1,2,2-Tetrachloroethene
- Polychlorinated dibenzo-p-dioxins/dibenzofurans

Chemical Burial Site/Construction Debris Landfill

- Trichloroethylene
- Trichlorofluoromethane
- Chlordane
- Heptachlor
- Heptachlor epoxide

DRMO Trench Area

- Arsenic
- Selenium
- Chlorobenzene
- 1,2-dichlorobenzene
- 1,3-dichlorobenzene
- 1,4-dichlorobenzene
- 1,2-dichloroethane
- 1,1-dichloroethene
- ethylbenzenes
- 1,1,2,2-tetrachloroethane
- 1,1,1-trichloroethane
- Trichloroethylene
- Tetrachloroethylene
- Toluene
- Xylene
- Aldrin
- DDD
- DDE
- DDT

TABLE 7-37 (Continued)

SUMMARY OF SITE-SPECIFIC CHEMICALS OF POTENTIAL CONCERN

TNT Leaching Beds Area

TNT Vehicle Maintenance Area Subsite

- Arsenic
- Chromium
- Carbon tetrachloride
- Chloroform
- Benzene
- 1,2-dichloroethane
- 1,1,1-trichloroethylene

TNT Leaching Beds Subsite

- Arsenic
- Chromium
- Mercury
- Selenium
- Carbon tetrachloride
- Chloroform
- 1,2-dichloroethane
- Trichloroethylene
- 2,4-dinitrophenol
- 2,4-dinitrotoluene
- Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
- Hexahydro-1,3,5,7-trinitro-1,3,5-triazine (RDX)
- 2,4,6-trinitro phenylmethylnitramine (Tetryl)
- 1,3,5-trinitrobenzene (1,3,5,-TNB)
- 2,4,6-trinitrotoluene (2,4,6-TNT)

in surface soils (5-foot) and groundwater. The major groundwater contaminants were VOCs -mainly TCE and the most significant groundwater contamination occurred at the TNT Vehicle Maintenance Area Subsite. There was significant groundwater contamination explosives compound at the TNT Leaching Beds Area. The TNT Leaching Beds Area was the only site where fate and transport modeling could identify the soil and groundwater plumes. Inclusion of certain Class A carcinogens (As, Cr), and Pb and dioxins in the risk assessment for both soil and groundwater results in elevated risk at the Abandoned Landfill and TNT Vehicle Maintenance Area Subsites. These elevated risks must be interpreted cautiously as these compounds were present at concentrations only slightly above background levels. Maximum detected values were utilized for risk calculation at the Abandoned Landfill, Chemical Burial Site/Construction Debris Landfill, and DRMO Trench Area. Their inclusion may also overestimate the actual site-specific risk.

7.6.2 Exposure Scenarios Evaluation

Based on an analysis of current activity patterns at SIAD, the only likely exposed populations to contaminants at the five sites are casual visitors who may occasionally walk over or through the sites. As a worst-case scenario, it was assumed that in the future a house would be built on each of the sites and that a well would be installed in the aquifer below the specific site. Exposed subpopulations would then consist of construction workers who build housing and adult residents. The following pathways of exposure were judged to be most significant to human health:

- Current on-site casual visitor: incidental ingestion of soil and fugitive dust.
- Future on-site construction worker: incidental ingestion of soil and fugitive dust.
- Future adult resident: incidental ingestion of soil and fugitive dust, ingestion of water and inhalation of volatiles released from water.

Estimates of pathway-specific reasonable maximum and average exposures were made for the TNT Leaching Beds Area, and a reasonable maximum exposure estimate was evaluated for the Abandoned Landfill, Chemical Burial Site/Construction Debris Landfill, and the DRMO

Trench Area. When possible, standard assumptions were used to provide consistency with risk assessments performed at other sites (e.g., soil and water ingestion rates of residents). Site-specific exposure information required using professional judgment and USEPA guidelines to derive many key parameters. The attempt to estimate both reasonable maximum and average exposures adds some degree of confidence that actual exposures would fall within the calculated range.

7.6.3 Toxicity Information

Toxicity data on chemicals of potential concern at the sites includes information on effects on exposed animals and humans. Adverse health effects are known to occur in humans from exposure to arsenic, cadmium, chromium, lead, dioxins, chlorobenzenes, pesticides, 2,4-DNP, 2,4-DNT, RDX, tetryl, TCE and 2,4,6-TNT (see Section 7.4). In most cases, however, the data on human exposures were not sufficient to derive quantitative toxicity values. Exceptions are the oral carcinogenic slope factor for arsenic, inhalation values for cadmium, chromium, and lead, and the chronic oral reference dose for 2,4-DNP. These values were derived from human studies. Other toxicity information used in the risk assessment was derived from information based on responses of experimental animals administered known doses of the chemicals. Levels of confidence in the toxicity information range from relatively high for the human carcinogenicity of arsenic, chromium, and cadmium and the chronic oral reference dose for RDX, to low for the human carcinogenicity of RDX and 2,4,6-TNT and the reference doses for 2,4-DNP, HMX and 1,3,5-TNB.

7.6.4 Estimated Human Health Risks

7.6.4.1 Cancer Risks

Calculated excess human cancer risk for the current casual visitor scenario were below the 1E-06 benchmark at the Chemical Burial Site/Construction Debris Landfill, DRMO Trench Area, and the Vehicle Maintenance Area Subsite. Cancer risk estimates exceeded the 1E-06 benchmark at the Abandoned Landfill and the TNT Leaching Beds Subsite.

Calculated excess human cancer risk for future exposure scenarios demonstrate risk above the 1-E-06 benchmark for the construction worker at the Abandoned Landfill and the TNT Leaching Beds Subsite and for the future residents exposed to contaminated soil and groundwater at the Abandoned Landfill, Chemical Burial Site/Construction Debris Landfill, DRMO Trench Area, Vehicle Maintenance Area Subsite, TNT Leaching Beds Subsite. The excess calculated human cancer risk approached the level of 4E-04 for RME resident adult at the TNT Leaching Beds Subsite (munitions compounds) and 3E-03 for the RME resident adult at the Vehicle Maintenance Area Subsite (TCE, carbon tetrachloride, and chloroform).

7.6.4.2 Noncancer Risk

Calculated hazard indices indicated that the benchmark of 1.0 was not exceeded at any of the five sites for the current, casual visitor scenario. Hazard indices calculated for the future exposure scenarios indicated that the 1.0 benchmark was exceeded and possibly acute and chronic toxicity could occur at the TNT Leaching Bed Area. The construction worker at the TNT Leaching Beds subsite could be exposed to enough munition compounds to yield an excess hazard value of 6.0. Future residents at both the TNT Vehicle Maintenance Area Subsite and the TNT Leaching Beds Subsite could be exposed to munitions-contaminated soil and/or munitions, metal and VOC-contaminated groundwater to yield hazard indices approaching 40. The combination of contaminated soil and groundwater at these sites may pose an acute or chronic risk to future residents at these sites.

7.6.5 Risk Characterization Uncertainties

The risk assessment process provides an estimate of risk for a given site. Inherit in the process of risk analysis are uncertainties that include errors in modeling fate and transport of contaminants, estimation of levels of contaminants in surface soils and groundwater, evaluation of actual human exposure and quantifying exposure levels and predicting the likelihood of a dose of contaminants resulting in an adverse human health effect.

The contributing factor to conservative risk estimates at SIAD is the use of maximum detected values for risk calculation at the Abandoned Landfill, Chemical Burial

Site/Construction Debris Landfill, and DRMO Trench Area. The data for the Vehicle Maintenance Area Subsite and the TNT Leaching Beds Subsite allowed for the calculation of both average and RME exposure. Another uncertainty is the inclusion of the potent Class A and B carcinogens in the risk analysis when they were present at only slightly above the background levels (As, Cd, Cr). Their inclusion may unnecessarily force an overestimate of risk at a given site. Additional uncertainty is associated with the prediction of human health effects given a chemical exposure event. Included in this uncertainty are exposure quantification, absorbed dose considerations, and predicted dose-response relationships. Exposure scenarios were intentionally conservative such that estimated exposure concentrations were presumed greater than an expected average exposure for each site. A final uncertainty is that actual human health risks associated with chemical exposure are not well characterized and it is likely that actual risk at each site would be lower than the risk calculated for each site.

Section 8

Environmental Assessment

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8.0 ENVIRONMENTAL ASSESSMENT

8.1 INTRODUCTION

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), requires USEPA to protect human health and the environment with respect to releases or potential releases of contaminants from hazardous waste sites. The recently revised National Contingency Plan (NCP) defines the role of the environmental assessment in identification and characterization of actual or potential risk to the environment from contamination in the absence of any remedial action.

This environmental assessment section addresses the potential risks that the SIAD Phase I site-specific contaminants of concern may have on the flora and fauna of the area. It provides a qualitative evaluation of the current and future risks represented by the present site conditions, assuming no remedial action is taken.

The assessment addresses potential adverse impacts resulting from exposures of environmental populations to hazardous substances from wastes at the five Phase I RI sites. This assessment was performed using the Risk Assessment Guidance for Superfund (RAGS) Volume II, Environmental Evaluation Manual (USEPA, 1989a), and Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Manual (USEPA, 1989c).

8.1.1 Purpose and Objectives

The purpose of the environmental assessment is to qualitatively evaluate potential adverse ecological impacts attributable to specific sources at each of the five SIAD sites, and to identify uncertainties in this assessment process.

The objectives of this effort are to:

- Determine what hazardous contaminants have been or could be released from the contaminant sources to soils and air where flora and fauna may be exposed.
- Identify the flora and fauna likely to be present in the study area.
- Evaluate the likelihood of exposure for any flora and fauna under current conditions or potential future conditions.
- Qualitatively estimate the potential risk to ecological communities exposed to site releases.

8.1.2 Scope

This assessment is based upon data obtained during the Phase I RI field investigation and the results of the Public Health Evaluation conducted for this RI (see Section 7). As discussed in Section 1.2 of this report, previous environmental investigations conducted at SIAD identified 22 potential hazardous waste sites. Five of these hazardous waste sites were investigated during the Phase I RI.

Section 8.2 of this environmental assessment describes the site and study area. Section 8.3 discusses contaminants of concern at each of the sites. Section 8.4 assesses exposure and Section 8.5 assesses toxicity. Section 8.6 summarizes potential risks to ecological populations. Section 8.7 identifies limitations associated with the environmental assessment, and Section 8.8 summarizes conclusions.

Assumptions that were made in this evaluation are as follows:

- The analytical results from soils sampled at 5 feet are assumed to represent surface soils.
- Since groundwater is at a depth that does not appear to be accessible to plant roots and does not surface at any of the sites, contaminants in groundwater carried in the Public Health Evaluation have not been included in this Environmental Assessment.

8.2 STUDY AREA DESCRIPTION

A general description of the environmental setting of SIAD is provided in Section 2.1.

8.2.1 Vegetation

SIAD is located in a high-desert intermountain biome (Smith, 1974). As a result, plants are widely spaced with bare areas in between. Appendix A lists the plant species commonly found within the Cal-Neva Bureau of Land Management Planning Unit, which includes part of the SIAD land area.

No in-depth survey of flora has been conducted at SIAD; however, such a survey is planned for 1991. No threatened or endangered plant species are known to occur at SIAD.

Vegetation at the Construction Debris Landfill, DRMO Trench Area, and TNT Leaching Beds Area, in particular, is extremely sparse. Brush species include members of the sagebrush and juniper families. Dominant grasses are represented by members of the wheatgrass family. Visual characterization indicates that these plants grow around the periphery of these sites.

The Chemical Burial Site is completely enclosed by the Construction Debris Landfill and supports typical desert vegetation. Mounds of debris are scattered over a portion of the Construction Debris Landfill, limiting the amount of vegetation. The remaining portion of the Construction Debris Landfill supports some vegetation that is typical of the desert environment. Few plants grow in the DRMO trench itself, partly because of the debris in the trench. The vegetation surrounding the actual trench is also minimal, due to mounds of debris and heavy disturbance to the area. Vegetation grows around the TNT Leaching Beds Area, but not in the TNT Leaching Beds, which suggests that the contaminated surface soils may be phytotoxic. Vegetation at the Abandoned Landfill and Vehicle Maintenance Area Subsite is much less disturbed and more typical of the surrounding desert environment.

8.2.2 Wildlife

A variety of wildlife species is found in the general area of SIAD. A description is found in Section 2.1 and Appendix A. Included among the species inventoried for this area are four species of rabbits, 29 species of rodents, mountain lions, fox, mule deer, various reptiles and amphibians, and over 100 species of birds. Of this diverse group, the Aleutian goose, mule deer, peregrine falcon, bald eagle, and game bird species are the most significant from an ecological assessment viewpoint (Table 8-1). Mule deer and game birds are recreationally important species in the Honey Lake Basin surrounding SIAD, while peregrine falcons, bald eagles, and Aleutian geese are rare, threatened or endangered species. A complete list of wildlife occurring in the vicinity of SIAD is presented in Appendix A.

The animals expected to inhabit the Phase I RI sites fall into two classes: (1) those animals which may utilize the sites year-round, and (2) animals which may only seasonally may visit the sites. The most likely animal species to be permanent residents include small rodents, other small mammals, lizards, and snakes. These animals generally restrict their activities to early morning/evening and night. Desert rodents are primarily burrowers (Smith, 1974).

Temporary residents of the sites would mostly include insect and bird species. The appearance of these animals would be associated with major influxes of water either in the form of rainfall or snowmelt. The presence of significant moisture (rainfall and snowmelt) in desert biomes results in germination of ephemeral plants. Desert insect species lifecycles are geared to the appearance of these plants. Subsequently, birds which utilize the ephemeral plants and/or insects as a food source may become temporarily established at the sites for breeding (Smith, 1974).

8.3 CONTAMINANTS OF CONCERN

Contaminants of concern are those chemicals present in elevated concentrations at the sites under investigation that may be hazardous to flora or fauna (USEPA, 1989a).

TABLE 8-1

SIERRA ARMY DEPOT - SPECIES OF CONCERN IN THE HONEY LAKE BASIN

WILDLIFE

	Status
MAMMALS	
Order Lagomorpha	
Pigmy rabbit - Sylvilagus idahoensis	CSC[c]
White-tailed jackrabbit - Lepus townsendii	CSC[c]
Order Chiroptera	
Spotted bat - Myotis lucifugus	2[e]
BIRDS	
Order Gaviiformes	
Common Loon - Gavia immer	CSC[c]
Order Pelecaniformes	
White Pelican - Pelecans erythrorynchos	CSC[c]
Double-crested Cormorant - Phalacrocorax auritus	CSC[c]
Order Ciconiiformes	
Least Bittern - Isobrychus exilis	CSC[c]
White-faced Ibis - Plegadis chihi	CSC[c], 2[e]
Order Anseriformes	
Canada Goose (Aleutian Goose) - Branta canadensis	FE[d]
Barro's Goldeneye - Bucephala islandica	CSC[c]
Order Falconiformes	
Sharp-shinned Hawk - Accipiter striatus	CSC[c]
Cooper's Hawk - Accipiter cooperii	CSC[c]
Swainson's Hawk - Buteo swainsoni	ST[b]
Ferruginous Hawk - Buteo regalis	2[e]
Golden Eagle - Aquila chrysaetos	CSC[c]
Bald Eagle - Haliaeetus leucocephalus	SE[a], FE[d]
Osprey - Pandion Haliaetus	CSC[c]
Peregrine Falcon - Falco peregrinus	SE[a], FE[d]

TABLE 8-1 (Continued)

SIERRA ARMY DEPOT - SPECIES OF CONCERN IN THE HONEY LAKE BASIN

WILDLIFE

	Status
Order Galliformes	
Sage Grouse - Centrocercus urophasianus	CSC[(c)]
Order Gruiformes	
Sandhill Crane - Grus canadensis	CSC[(c)]
Order Charadriiformes	
Snowy Plover - Charadrius alexandrinus	CSC[(c)]
Long-billed Curlew - Numenius americanus	2[(e)]
California Gull - Larus Californicus	CSC[(c)]
Order Caprimulgiformes	
Burrowing Owl - Speotyto cunicularia	CSC[(c)]
Long-eared Owl - Asio otus	CSC[(c)]
Short-eared Owl - Asio flammeus	CSC[(c)]
Order Apodiformes	
Black Swift - Cypseloides niger	CSC[(c)]
Order Passeriformes	
Bank Swallow - Riparia riparia	ST[(b)]
Yellow Warbler - Dendroica petechia	CSC[(c)]
Yellow-breasted Chat - Icteria virens	CSC[(c)]

Codes

(a) SE Listed as Endangered by the State of California.
(b) ST Listed as Threatened by the State of California.
(c) CSC California Department of Fish and Game "Species of Special Concern".
(d) FE Listed as Endangered by the Federal Government.
(e) 2 Category 2 Candidate for Federal Listing (Taxa which existing information indicates may warrant listing, but for which substantial biological informatin to support a proposed rule is lacking).

Because groundwater is not a complete exposure pathway for plants and wildlife at SIAD, only those contaminants found in surface soils are considered contaminants of potential concern. Surface soil samples were not taken at the Abandoned Landfill, Chemical Burial Site/Construction Debris Landfill, DRMO Trench Area, or Vehicle Maintenance Area Subsite during this Phase I RI. Consequently, samples taken at the 5-foot depth for each of these sites are considered to be representative of surface samples. This assumption may not be accurate and could yield uncertainties as to the level and extent of contamination at these sites.

In addition to limiting the contaminants of concern to those found in the soil, concentration was also used to select contaminants of concern. For metals, those found at levels above background were included in the environmental assessment. Background levels are those metal concentrations found in typical U.S. deserts or typical U.S. soils as shown in Table 7-4. Any xenobiotic organic compounds at concentrations greater than detection limits were included. Site-specific contaminants of concern are discussed in the following paragraphs.

8.3.1 Abandoned Landfill

Contaminants of potential concern for this site are soil-based arsenic, cadmium, lead, zinc, and the dioxin/dibenzofurans.

8.3.1.1 Arsenic

The maximum level of arsenic found in soils at the Abandoned Landfill was 23 μg/g. The level of arsenic in uncontaminanted soils can range from 0 to 30 μg/g in typical U.S. soils and 1.2 to 18 μg/g in desert soils. The Ontario Ministry of the Environment has designated 25 μg/g as an acceptable arsenic concentration for soils that will be used as residential or parkland sites (Rinne, 1986).

8.3.1.2 Cadmium

The maximum cadmium level found in soil at the Abandoned Landfill was 6.7 μg/g. The Ontario Ministry of the Environment has designated 8 μg/g as an acceptable level for cadmium in commercial or industrial soils.

Cadmium is a concern in agricultural soils due to the ability of crops to take up cadmium at greater concentrations than other heavy metals with no resulting phytotoxic effect to the plants. The cadmium-contaminated crops are eaten by livestock; elevated levels of cadmium thus enter the food chain. For this reason, cadmium is strictly monitored in sewage sludge applications to crop and grazelands (Chaney, 1980).

8.3.1.3 Lead

The highest concentration of lead detected in a sample from this site was a surface value of 425 μg/g. Typical U.S. soils can contain from 10 to 700 μg/g lead, whereas typical desert soils contain from 10 to 70 μg/g lead.

8.3.1.4 Zinc

The maximum concentration of zinc detected in a sample from this site was 1,090 μg/g. Elevated levels of metals in surface soils can have an inhibitory effect on plants. Typical uncontaminated soils have concentrations which range from 0 to 250 μg/g.

8.3.1.5 Dioxin/Dibenzofurans

Several dioxin/dibenzofuran compounds were detected at one sampling location at concentrations ranging from <0.000091 μg/g to 0.00032 μg/g.

8.3.2 Chemical Burial Site/Construction Debris Landfill

Chlordane was detected in surface and subsurface samples at this site in concentrations ranging from 0.06 μg/g at 10 feet to 1.03 μg/g at 5 feet. Chlordane is a pesticide that is very stable in the environment. In soil, chlordane will adsorb to organic matter and volatilize slowly over time. Chlordane will not leach significantly, although this is somewhat dependent upon the composition of the soil. Sandy soils generally retain chlordane less than soils with high clay content or organic matter.

8.3.3 DRMO Trench Area

Arsenic, benzene, chlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, PCE, dichloroethene, DDT, DDD, DDE, and heptachlor were found in surface and subsurface soils in and near the DRMO Trench Area.

8.3.3.1 Arsenic

The maximum concentration of arsenic detected at the DRMO Trench Area was 22.5 μg/g. Arsenic is addressed in Section 8.3.1.1.

8.3.3.2 VOCs

Benzene, chlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, PCE, and dichloroethene have been reported at moderate to low levels in soils at this site as summarized in Table 6-9. These VOCs have a low bioaccumulation potential as evidenced by their comparatively low octanol-water partition coefficients.

8.3.3.3 Organochlorine Insecticides

p,p'-DDD, p,p'-DDE, and p,p'-DDT were detected at concentrations of 2.25 μg/g, 0.025 μ/g, and 2.56 μg/g, respectively, from a sample taken at a depth 5 feet beneath the DRMO Trench Area. DDT and its contaminant components DDD and DDE are persistent in the

environment. Estimates of the half-life for DDT biodegraded in soil range from 2 to greater than 15 years (Lichtenstein, et al, 1959; Stewart and Chisholm, 1971).

8.3.4 Vehicle Maintenance Area Subsite

No contamination at levels of concern were found in the surface or near-surface soils at this site.

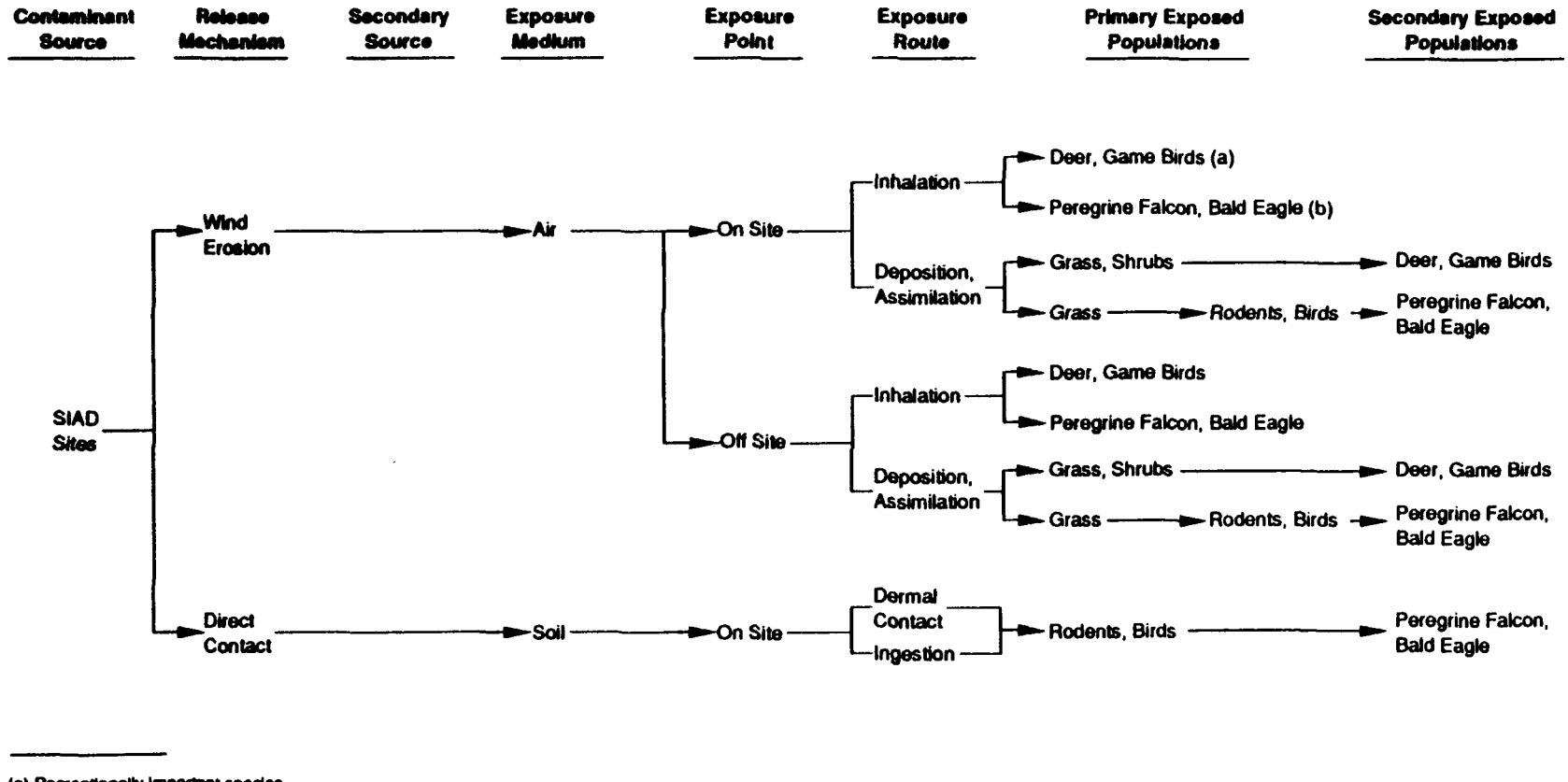
8.3.5 TNT Leaching Beds Subsite

The following explosive contaminants are considered to be of potential concern based on concentrations reported in surface or near-surface soils: 2,4-DNT, HMX, RDX, 1,3,5-TNB and 2,4,6-TNT.

Little is known about the response of terrestrial plants to 2,4,6-TNT. However, a study conducted to assess the effects of 2,4,6-TNT on yellow nutsedge found that the deleterious effects of TNT were rapid and occurred at solution concentrations of 5 mg/L and higher. Root growth was most affected. TNT and its metabolites were found throughout the plants.

8.4 EXPOSURE ASSESSMENT

The exposure assessment identifies or suggests actual or potential exposure pathways. The exposure pathways likely to be of concern to terrestrial populations are presented in Table 8-2 and in a conceptual site model as shown in Figure 8-1. Aquatic environments do not exist at these sites and consequently are not addressed in this environmental assessment. The elements which comprise a complete pathway are described in more detail in the following sections.



(a) Recreationally important species
(b) Rare, threatened, or endangered species

SIERRA ARMY DEPOT

CONCEPTUAL SITE MODEL OF POTENTIAL ENVIRONMENTAL EXPOSURE PATHWAYS AT SIAD

FIGURE 8-1

TABLE 8-2

POTENTIAL ECOLOGICAL EXPOSURE PATHWAYS
FOR CONTAMINANTS OF CONCERN

Environmental Medium	Potential Receptors	Potential Exposure Routes	Potential Pathway
Soils			
Surface Soils	Desert flora	Uptake through root system.	Yes, but minimal due to low precipitation.
	Desert fauna	Ingestion, inhalation, and dermal contact with contaminated soil; ingestion of contaminated plants.	Yes, but limited due to small areal extent of the Phase I RI sites, and relatively low concentrations of contaminants.
Groundwater			
Shallow Aquifer	Desert fauna	Ingestion, inhalation, and dermal contact with potable water supply.	No. Pathway incomplete.
Surface Water			
Standing or runoff surface water	Desert flora	Uptake through root system.	Rarely. Porous soil and infrequent preciptiation combine to limit surface runoff or standing water.
	Desert fauna	Ingestion, inhalation, and dermal contact with contaminated runoff water.	Rarely.

8.4.1 Fate and Transport of Contaminants

Fate and transport of contaminants at SIAD are depicted in Figure 8-1 as being via wind erosion and contact with soils. The arid nature of SIAD and the desert basin climate tend to limit the movement and infiltration of contaminants to the soil and possible wind erosion. Wind dispersion may be the most important release mechanism affecting the eclolgical receptors at SIAD (USATHAMA, 1979).

The ability of a compound to move within an environmental media is a function of munerous evnironmental factors (rainfall, surface water runoff, vegetative cover, wind, temperature and evapotranspiration rates) and physical-chemical factors (K_{oc}, $K_{d,}$ K_{ow}, vapor pressure, Henry's constant, half-life and bioconcentration factor. As pointed out in Section 2.0, there is limited rainfall at SIAD and elevated evaportranspiration. The influence of physical-chemical parameters on fate and transport are presented in Table 8-3. The potential for contaminants to move in the soil depends on a number of parameters. A list of water solubility, Henry's Law constants, log octanol/water partition coefficient, organic partition coefficient and bioconcentration factors are illustrated in Table 8-4. The properties include the molecular weight, solubility, volatility, and the partitioning of the compound between soil and water and between water and lipid.

Of the compounds detected at SIAD, the chlorinated organic compounds such as DDT and the dioxins probably present the greatest threat to potential environmental receptors due to their long biological half-life and their propensity for bioaccumulation. These compounds are found in limited areas and are subsurface such that they are not readily bioavailable. Of the surface soil contaminants detected, the nitroaromatic explosives are the most significant chemicals since they are present at the surface. The nitrophenols, triazines (RDX and HMX) and nitrotoluenes are potential accumulators due to their relatively high octanol/water partition coefficients.

TABLE 8-3

PHYSICAL/CHEMICAL AND ENVIRONMENTAL FATE PARAMETERS FOR CHEMICALS OF CONCERN

K_{oc} provides a measure of the extent of chemical partitioning between organic carbon and water at equilibrium. The higher the K_{oc}, the more likely a chemical is to bind to soil or sediment than to remain in water.

K_d provides a soil or sediment-specific measure of the extent of chemical partitioning between soil or sediment and water, unadjusted for dependence upon organic carbon. To adjust for the fraction of organic carbon present in soil or sediment (f_{oc}), use $K_d = K_{oc} x f_{oc}$. The higher the K_d, the more likely a chemical is to bind to soil or sediment than to remain in water.

K_{ow} provides a measure of the extent of chemical partitioning between water and octanol at equilibrium. The greater the K_{ow}, the more likely a chemical is to partition to octanol than to remain in water. Octanol is used as a surrogate for lipids (fat), and K_{ow} can be used to predict bioconcentration in aquatic organisms.

Solubility is an upper limit on a chemical's dissolved concentration in water at a specified temperature. Aqueous concentrations in excess of solubility may indicate sorption onto sediments, the presence of solubilizing chemicals such as solvents, or the presence of a non-aqueous phase liquid.

Henry's Law Constant provides a measure of the extent of chemical partitioning between air and water at equilibrium. The higher the Henry's Law constant, the more likely a chemical is to volatilize than to remain in the water.

Vapor Pressure is the pressure exerted by a chemical vapor in equilibrium with its solid or liquid form at any given temperature. It is used to calculate the rate of volatilization of a pure substance from a surface or in estimating a Henry's Law constant for chemicals with low water solubility. The higher the vapor pressure, the more likely a chemical is to exist in a gaseous state.

Diffusivity describes the movement of a molecule in a liquid or gas medium as a result of differences in concentration. It is used to calculate the dispersive component of chemical transport. The higher the diffusivity, the more likely a chemical is to move in response to concentration gradients.

Bioconcentration Factor (BCF) provides a measure of the extent of chemical partitioning at equilibrium between a biological medium such as fish tissue or plant tissue and an external medium such as water. The higher the BCF, the greater the accumulation in living tissue is likely to be.

Media-specific Half-life provides a relative measure of the persistence of a chemical in a given medium, although actual values can vary greatly depending on site-specific conditions. The greater the half-life, the more persistent a chemical is likely to be.

TABLE 8-4

CHEMICAL AND ENVIRONMENTAL FATE PARAMETERS OF CHEMICALS OF CONCERN

Compound	Molecular Weight (g/mil)	Solubility in Water (mg/L)	Henry's Law Constant (H) (atm m³/mol)	Log Octanol Water Partition Coefficient [a]	Organic Partition Coefficient (K_{oc})	Bioconcentration Factor
Inorganic						
Arsenic	75	--	--	--	--	≤4
Chromium	52	--	--	--	--	3.4
Lead	207	--	--	--	--	5.1-300
Mercury	200	--	--	--	--	5,000
Selenium	79	--	--	--	--	--
Zinc	65	--	--	--	--	--
Organic						
Benzene	78	1.7 E+03	3.9 E-03	2.13	83	--
Carbon tetrachloride	154	1.1 E+03	--	--	--	--
Chloroform	119	8.2 E+03	2.8 E-03	1.97	31	--
Chlorobenzene	113	4.7 E+03	6.2 E-01	2.84	330	--
1,2-dichlorobenzene	147	1.5 E+02[b]	1.1 E-01[b]	3.38[b]	1,700[b]	--
1,3-dichlorobenzene	147	1.5 E+02[b]	1.1 E-01[b]	3.38[b]	1,700[b]	--
1,4-dichlorobenzene	147	1.5 E+02[b]	1.1 E-01[b]	3.38[b]	1,700[b]	--
1,2-dichloroethane	99	8.5 E+03	9.8 E-04	1.48	14	--
bis(2-ethylhexyl)phthalate	390	--	--	--	--	--
1,1,2,2-tetrachloroethane	167	1.1 E+03	2.8 E-04	--	--	--
1,1,1-trichloroethene	131	1.1 E+-3	9.1 E-03	2.38	126	--
Tetrachloroethene	166	1.5 E+02	2.6 E-02	2.6	364	--
Trichlorofluoromethane	137	1.1 E+03	9.1 E-03	--	--	--
Phenol	94	9.3 E+04	4.5 E-07	1.46	14.2	--
Toluene	92	--	6.8 E-02	--	--	--
Xylene	106.2	--	7.0 E-02	--	--	--

TABLE 8-4 (Continued)

CHEMICAL AND ENVIRONMENTAL FATE PARAMETERS OF CHEMICALS OF CONCERN

Compound	Molecular Weight (g/mil)	Solubility in Water (mg/L)	Henry's Law Constant (H) (atm m³/mol)	Log Octanol Water Partition Coefficient [a]	Organic Partition Coefficient (K_{oc})	Bioconcentration Factor
Pesticides						
Aldrin	358	--	1.4 E-06	--	410	--
Chlordane	410	--	--	--	--	--
DDD	318	--	--	--	--	--
DDE	310	--	--	--	--	--
DDT	354	--	3.9 E-06	--	129	--
Heptachlor	373	--	--	--	80,000	--
Heptachlorepoxide	387	--	--	--	--	--
Dioxin/dibenzofurans	321	--	8.6 E-05	--	6.6	9,270
Explosives						
2,4-dinitrophenol	--	--	--	--	--	--
2,4-dinitrotoluene	182.6	270	1.3 E-04	1.98	260	15
HMX	296	2.6	9 E-66	0.13	130	0.5
RDX	229	42.2	1.0 E-09	0.87	63	2
Tetryl	287	75	4 E-10	2.0	270	15
1,3,5-trinitrobenzene	213	330	1.0 E-04	1.18	77	3
2,4,6-trinitrotoluene	227	124	1.1 E-06	1.6	470	7

a) From USEPA 1986

8.4.2 Exposure Routes

Three ecological exposure routes for contaminants of concern were identified. Digging and burrowing animals are indigenous to SIAD. Consequently, direct contact with contaminated soil and subsequent dermal absorption of contaminants may be a significant exposure route for wildlife. Dermal absorption of organic contaminants is of particular concern. Ingestion of contaminated soils by wildlife is also a likely exposure route.

At the Abandoned Landfill, DRMO Trench Area, and TNT Leaching Beds Area, inhalation of suspended contaminants by terrestrial wildlife may be a significant exposure route. Bioaccumulation of organic explosives, particularly 2,4,6-TNT, in the food web is not likely to be a significant exposure pathway since explosive chemicals are rapidly metabolized. The pesticides DDT, DDD, DDE, chlordane, and heptachlor and the dioxin/dibenzofurans are the only bioaccumulative contaminants of concern at the sites under investigation.

Ingestion of or direct contact with either groundwater or surface water is not an exposure pathway at any of the sites because no flowing seeps or surface water were found within or in immediate proximity to the sites. Plant uptake of contaminants in groundwater is not a likely route since the root systems do not appear to extend to the depth of the groundwater.

8.4.3 Potentially Exposed Populations

Sections 8.2.1 and 8.2.2 describe the vegetation and wildlife that may inhabit SIAD. No quantitative information is available describing plant and animal populations at each of the Phase I RI sites. A list of species identified for the Honey Lake Basin are presented in Appendix A. Table 8-1 illustrates species of concern in the Honey Lake Basin. However, it is known that the fauna of the area is diverse. Recreationally important species (mule deer, game birds) and endangered or threatened species (peregrine falcon, bald eagle, Aleutian goose) are potentially exposed populations at the Phase I RI sites. Due to the lack of vegetation in and around the TNT Leaching Beds Area and the DRMO Trench Area (as well as very sparse vegetation at the Abandoned Landfill and the Construction Debris Landfill), it is expected that mule deer would infrequently visit these areas. Similarly, the Aleutian

goose is an aquatic species and would likely confine its activities to the immediate vicinity of Honey Lake.

The two remaining species, peregrine falcons and bald eagles, may include the SIAD locale within their feeding range. They could be expected to rarely utilize any of the sites, however. Studies of feeding habits have shown that these species prefer aquatic or mountainous habitats for hunting (Gandy, 1989). Peregrine falcons sometimes prey on game bird species (e.g., quail, chukar, pigeons). However, rare and endangered species are unlikely to be exposed to chemicals of potential concern at any of the sites.

Potentially exposed populations at each of the sites would most likely be small burrowing rodents with a limited feeding range (Smith, 1974). Rodents are omnivorous and would be expected to be exposed to contaminants through inhalation and dermal contact as a result of their soil burrowing habits. Ingestion of contaminated food sources and/or soil would also be an exposure pathway for these populations. Bird populations could be exposed to contaminants through inhalation, direct contact and through ingestion of contaminated food sources. Most bird species utilizing the sites would be expected to be transient.

8.4.4 Bioaccumulation Potential

The only bioaccumulative contaminants of concern at any of the sites are the pesticides DDT,DDD, DDE, chlordane, and heptachlor and the dioxin/dibenzofurans. These compounds are highly lipophilic, environmentally stable, and are reported to accumulate in adipose tissue. Additionally, the arid climate and scarcity of organic soil will limit any microbial degradation that could naturally occur. Plants are known to take up these compounds through their roots systems.

There may be some potential for small animals to ingest soil contaminated with pesticides. These animals in turn may be eaten by raptors frequenting the area. However, the low concentrations of pesticides, small areal extent of the contaminated sites, and typical range of raptors combine to minimize the possibility of significant wildlife bioaccumulation of pesticides. Metal contaminants including arsenic, cadmium, lead, and selenium, which could

be stored by plants and animals, are not present in sufficient concentrations to cause concern (SCAQMD, 1988).

8.5 TOXICITY ASSESSMENT

Toxicity assessments of the contaminants of potential concern discussed in this environmental assessment are presented in Section 7.4 of this report. The toxicological profiles of these chemicals are found in Appendix Q3.

8.5.1 Metals

No studies revealed occurrences of adverse effects on wild animals due to cadmium. Because cadmium is similar to zinc, it can replace zinc in some enzyme pathways, thereby altering catalytic ability. Cadmium can also have adverse effects upon kidneys and the skeletal system, particularly in calcium-deprived organisms.

Lead toxicosis has been observed in plants from lead concentrations ranging from .005 to 33,000 mg/L (GRI, 1988). The effects of lead on plants include growth stimulation (at low levels), growth inhibition, leaf yellowing, abscission, inhibition of mitosis and chlorophyll synthesis, loss of turgor pressure and death.

Zinc has been reported to cause decreases in the chlorophyll content of lichens at concentrations as low as 100 mg/kg. The small areal extent of this site and the sparse distribution of vegetation in the SIAD desert area minimize the significance of zinc as an ecological threat to plants.

Zinc has been reported as depressing embryonic development in sea urchins; however, in higher animals it is an essential component of numerous systems and has exerted protective effects in many disease states. Zinc is also essential in many enzyme systems as a cofactor. Levels of zinc in soils at this site should produce little or no effect on potential environmental receptors. Zinc, like chromium, is a necessary trace element which is detrimental in large

doses. The presence of zinc at the site could in part be considered beneficial in that sufficient zinc in the diet will protect some species from the toxic effect of excess cadmium.

8.5.2 Organic Compounds

Researchers have found that the organochlorine pesticides cause induction of hepatic enzymes which in turn affects calcium metabolism so that calcium is not available for shell building (Stalmaster, 1987). DDT is particularly toxic because its metabolites cannot be excreted.

Studies have shown that the chlorinated aliphatics (e.g., PCE and dichloroethene) cause liver induction in mammals, but this adverse effect is different from that produced by DDT and its metabolites. Because of their low bioconcentration potential, they are easily excreted, and the potential for cumulative effects is much less. Theoretically, the chlorinated aliphatics could affect the operation of the hepatic tissues of these bird species, but they certainly would not be expected to have an effect to the degree that reproductive capacity would be affected.

In a study of the pharmacokinetics of TCE distribution, Pfaffenburger, et al (1980) show that TCE levels in adipose tissues decline to less than 0.4 percent of original levels within three days of discontinuing TCE exposure.

The possible impacts of VOCs on plants and animals at these sites should be considered negligble due to: (1) the moderate to low levels present in site soils; (2) the high volatility and short half-lives of these compounds; (3) the depth at which contamination was found (15 feet); and (4) the small areal extent of the DRMO Trench Area.

8.6 POTENTIAL RISKS TO ECOLOGICAL POPULATIONS

8.6.1 Abandoned Landfill

Heavy metal contamination detected at the Abandoned Landfill is not expected to cause sigificant adverse impacts on plants and wildlife due to the low concentrations (SCAQMD, 1988) and small areal extent of this site. The capacity for certain animal species to generate

metallothioneins which sequester metals in the kidney at varying levels will control what concentration of contaminants constitute a toxic effect. The ability of certain plant species to tolerate and/or sequester metals will also determine which plant species are adversely affected by high metals concentrations.

8.6.2 Chemical Burial Site

The low concentration of chlordane detected at the Chemical Burial Site combined with the small area of extent of this site would not be expected to pose sigificant adverse effects to the environment.

8.6.3 Construction Debris Landfill

No contamination at levels of concern were found in the surface or near-surface soils at this site.

8.6.4 DRMO Trench Area

Populations of burrowing rodents and birds which may inhabit or visit the DRMO Trench Area may be at somewhat greater risk than at the less contaminated sites. However, since these communities would be expected to use this site for a short time period and/or rely on other areas for suitable habitat, exposure to contaminants of concern at this site is not expected to present a significant threat to environmental receptors.

8.6.5 TNT Leaching Beds Area

There was no direct evidence of adverse impacts of explosive chemicals and their degradation products on wildlife in the vicinity of the TNT Leaching Beds Area during preparation of the environmental assessment. Although it is expected that on occasion the site may be utilized as a secondary hunting site by some species of special concern, the contaminated area is relatively small compared to expanded home ranges typical of desert species. Moreover, the quality of hunting is likely to be less suitable than that of surrounding regions. A relatively

small percentage of any single organism's diet will be obtained from the TNT Leaching Beds Area.

Rapid metabolism and excretion of ingested 2,4,6-TNT greatly reduces bioconcentration/ bioaccumulation and is an additional mitigating factor to threats to ecological resources at this site.

Populations of burrowing rodents and migratory birds which may inhabit or visit the TNT Leaching Beds Area may be at a somewhat greater risk. However, since these populations are expected to use these sites for a short time period and/or rely on more suitable areas for habitat, their exposure to explosive chemicals and their degradation products is probably not significant.

8.6.6 Summary

Although the concentrations of pesticides found at the Chemical Burial Site and the DRMO Trench Area are relatively low, these compounds pose a potential threat to wildlife populations that may inhabit these sites. However, it is unlikely that species of special concern - bald eagles, peregrine falcons, Aleutian geese, game birds and mule deer - depend on any of the Phase I RI sites for food and shelter to any significant degree. The habitat of these sites relative to nearby areas is unsuitable or marginal for each of the noted species. Furthermore, the quality of hunting/foraging available for these species at the TNT Leaching Beds Area is poor. For example, bald eagles and peregrine falcons would only utilize common mammals found at these sites (rodents) as a secondary food source (Gandy, 1989). These factors, combined with the expanded home ranges for these species in unproductive environments (Smith, 1974), suggest minimal utilization of any of these sites and minimal or no utilization of the TNT Leaching Beds Area. Although acute exposure to these populations may occur, the probability is also quite low based on the small surface area of each of the sites. It is unlikely that any community level or ecosystem impacts are due to contamination detected at the Phase I RI sites.

Burrowing rodents are vertebrates most likely to be exposed to site contaminants. Based on multiple potential exposure routes (inhalation, ingestion of contaminated food, and contact with contaminated soil), their potential exposure is greater than other species. Birds using the TNT Leaching Beds Area for breeding purposes may be expected to be acutely exposed to munition chemicals and their degradation products primarily through ingestion of contaminated food sources and through dermal contact with contaminated soil during feeding and during dust baths/preening. No toxicity data describing the effects of munition chemicals on bird species was located in the available literature. This is a significant constraint in evaluating exposure of munition chemicals to bird populations at this site.

8.7 LIMITATIONS

The most significant limitations associated with this environmental assessment include:

(1) Knowledge of the degree to which wildlife utilize the site.

(2) Lack of surface sample data at all sites except the TNT Leaching Beds Area.

(3) Lack of specific data on concentrations of contaminants in plant tissue.

(4) Limited information on ecological toxicity to site-specific compounds.

8.8 CONCLUSIONS

Arsenic, lead, and chromium are metals which are present at the Phase I RI sites in low concentrations; they are comparable to acceptable values for soils used for parkland or industrial uses. Zinc is present at the Abandoned Landfill at a concentration high enough to warrant attention. However, the relative isolation of this sampling point indicates that this source does not present an undue hazard to the environmental receptors that could have contact with this contaminant.

The organochlorine pesticides and dioxin/dibenzofurans present at the DRMO Trench Area and the Abandoned Landfill may be a cause for concern because of their persistence in the environment, ability to bioaccumulate, and potential to adversely affect endangered bird

species, as well as burrowing animals. More suitable feeding grounds exist within the flight range of these species. Consequently, although exposure potential exists at these sites, they are not predicted to be of major importance, due to the limited areal extent of the Phase I RI sites, particularly in comparison to the overall area of the Honey Lake Basin.

Volatile organics present at the sites are in moderate to low concentrations and are not persistent in surface soils. The low bioaccumulation potential indicates that there is less opportunity for these compounds to have a cumulative effect on wildlife, including threatened raptors, which have been found near the sites. The dominant route by which these birds could be exposed to contaminants is through ingestion of small mammals. The VOCs are not considered to be a significant risk to environmental receptors.

Explosive compounds at the TNT Leaching Beds Area are a cause for concern since complete exposure pathways exist and there is limited wildlife information on toxicity. Because these contaminants are found in a highly localized area which does not support plant growth and is not attractive to animal species, this exposure route probably does not pose a significant threat to the environment.

Section 9

Remedial Investigation Conclusions and Recommendations

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9.0 REMEDIAL INVESTIGATION SUMMARY AND RECOMMENDATIONS

This section of the RI Report briefly summarizes the data gathered during the SIAD Phase I RI and presents recommendations for collection of additional data necessary to complete contaminant characterization at specific sites.

9.1 OVERVIEW

A field program was conducted at five sites at SIAD: the Abandoned Landfill, Construction Debris Landfill, Chemical Burial Site, DRMO Trench Area, and the TNT Leaching Beds Site. Major field program elements are listed below:

- Soil gas, geophysical, EOD screening, and land surveys;
- Drill and sample 30 soil borings to the water table and six soil borings to 250 feet;
- Collect surface soil samples from the TNT Leaching Beds;
- Install 18 monitoring wells and four piezometers;
- Perform two rounds of sampling at 32 monitoring wells;
- Soils and groundwater background sampling;
- Conduct aquifer tests at each newly installed monitoring well;
- Herlong potable supply well sampling.

Data gathered during this program was used to assess the geology, hydrogeology, and contaminant distribution at each of the sites.

Analytical data was screened to select contaminants for fate and transport modeling in the vadose and saturated zones.

A public health evaluation was conducted to assess the health risk at each site.

A general recommendation is to collect additional background soil samples to adequately characterize chemical contaminants in the background soils and to allow statistical evaluation.

9.2 ABANDONED LANDFILL

9.2.1 Summary of Contamination Assessment

TCE and carbon tetrachloride were detected in soil gas at the northern portion of the site. The northwestern portion of the Abandoned Landfill registered the highest VOC soil gas levels.

The aerial extent of landfill material was delineated utilizing data gathered during a geophysical survey. Test pits excavated in areas registering geophysical anomalies revealed that this landfill is comprised of surface metal debris, 2- to 4-inch thick ash and burn debris layers, and several 4- to 9-foot-thick trenches. Trench material is primarily comprised of household garbage, and burn debris.

Soil borings placed in the center of four of the test pits were sampled at 5- to 10-foot intervals to the water table. Analytical results indicate that no pervasive soil contamination is associated with these anomalies. Lead was detected above background in only one sample. Heptachlor, acetone, toluene, and TCFM were sporadically distributed in the soil at low concentrations. Dioxin/furan compounds were detected in one surface sample.

Carbon tetrachloride, chloroform, and TCE were detected in groundwater. TCE (41.000 μg/L, Round 1; 70.500 μg/L, Round 2) was detected above the MCL (5.0 μg/L) in the northwestern portion of this site. The location of TCE in groundwater corresponded to the presence of TCE in soil gas. No soil samples were collected in this area and a TCE source was not identified.

The groundwater gradient at this site is about 0.0002 to the north. Groundwater data collected from ALF-02-MWA and the downgradient monitoring well CCB-02-MWA suggest that TCE is moving northward in this area. It should be noted that this conclusion is based on only two data points and a TCE groundwater plume cannot be fully delineated until additional data is collected.

9.2.2 Abandoned Landfill Risk Assessment Summary

Chemicals of potential concern included arsenic, cadmium, chromium, lead, selenium, 1,2-DCA, TCE, TCFM, phenol, and dioxin.

Calculated cancer risks exceeded the 1E-06 benchmark for the casual visitor, construction worker, and future residents exposed to contaminated soil and groundwater at the Abandoned Landfill. Calculated noncancer risks indicated that the benchmark of 1.0 was not exceeded. Heavy metal contamination detected at the Abandoned Landfill is not expected to cause significant adverse impacts on plants and wildlife.

9.2.3 Recommendations

TCE was detected in groundwater from the northwest portion of this site. The extent of the TCE groundwater contamination, as well as the contaminant source, is not presently known. To more fully define the distribution and extent of contamination at this site, the following investigations are proposed:

- Install and sample monitoring wells in the vicinity of ALF-02-MWA to delineate the TCE plume in groundwater. Monitoring well placement would be based on existing soil gas and groundwater data.
- Perform GPR survey in the vicinity of ALF-02-MWA to identify the TCE source.
- Install and sample soil borings to the groundwater to delineate the TCE source. Soil boring placement would be based on groundwater, soil gas, and GRP data.

- Collect additional surface soil samples to more accurately determine human health risks associated with potential dermal exposure.

9.3 CHEMICAL BURIAL SITE/CONSTRUCTION DEBRIS LANDFILL

9.3.1 Contamination Assessment Summary

A soil gas survey revealed very low levels of TCE in the southwestern and northeastern portions of the Chemical Burial Site. The soil gas present in the southwestern portion is considered to be the northernmost extension of the TCE detected in the northwestern portion of the Abandoned Landfill Site. It is unknown if the source of TCE is from soil or groundwater contamination.

A disturbed area in the southeast portion of Construction Debris Landfill was identified from the geophysical survey. Test pit excavation in this area showed that the source of this anomaly was an approximately 6-inch-thick ash and burn debris zone similar to what was uncovered at the Abandoned Landfill.

No drums or other containers that may have been buried at this site were discovered from either geophysical investigations or test pit excavations. Fill material at the Chemical Burial Site was found to be 3 to 4 feet thick and is comprised of the same soil as the native soil in the area.

Low levels of organic contaminants were detected in few of the subsurface soil samples. For this reason soil contamination is not considered a likely source of groundwater contamination. Groundwater from CCB-02-MWA detected TCE (6.760 μg/L) above its MCL during Round 1. The T[illegible] found in this well may be associated with the TCE found in ALF-02-MWA.

9.3.2 Chemical Burial Site/Construction Debris Landfill Risk Assessment Summary

Chemicals of potential concern at this site included TCE, TCFM, phenol, chlordane, and heptachlor. Calculated excess human cancer risk for the current casual visitor did not exceed the 1E-06 benchmark at this site. Human cancer risk associated with future exposure scenarios demonstrated the 1E-06 benchmark was exceeded for future residents exposed to contaminated soil and groundwater. Calculated noncancer risks indicated that the benchmark of 1.0 was not exceeded. The low concentration of chlordane is not expected to pose significant adverse effects to the environment.

9.3.3 Recommendations

Recommendations for future work are associated with the delineation of the TCE detected in CCB-02-MWA and ALF-02-MWA. These recommendations are identical to those described in Section 9.2.2.

9.4 DRMO TRENCH AREA

9.4.1 Contamination Assessment Summary

A limited soil gas survey consisting of five samples was conducted at this site. Samples collected adjacent to the open trench revealed high levels of TCE. However, too few samples were collected to define the aerial extent of TCE in soil gas.

A buried trench reported to exist approximately 50 feet west of the open trench was not located. Techniques employed in the attempt to locate this trench included a geophysical survey, the excavation of three test pits in the reported location of the trench, and a review of aerial photographs.

Approximately 120 feet southwest of the open trench a burn and debris zone was discovered. Four test pits were excavated in this area and the ash layer was found to be

2- to 4-inches thick, overlying native soil. No analytical samples were collected from this area.

High levels of VOCs and pesticides were found in the 15-foot interval of DMO-11-SB which was located next to the open trench. Because this boring was drilled at an angle, the 15-foot sample corresponds to approximately 5 feet beneath the bottom of the open trench. Very few compounds were detected in any other boring, suggesting that the soil contamination at this site is restricted to the immediate area of the open trench.

Low levels of TCE were detected in soil from DMO-10-SB, also located adjacent to the open trench, near the water table. Although the TCE concentrations at these depths were low, the presence of this compound near the water table suggests that TCE has migrated through the vadose zone and has reached the groundwater. This conclusion is supported by the fact that TCE was detected in all three monitoring wells installed and sampled during this phase of the investigation.

The highest TCE concentration in groundwater (25.700 μg/L, Round 1; 18.100 μg/L, Round 2) was detected in the southernmost well. This monitoring well is located in a downgradient direction from the open trench. It should be noted that the groundwater gradient (southwest) at the site is nearly opposite the regional groundwater gradient (northeast). This suggests that TCE may be traveling downgradient from the trench towards the Herlong potable supply wells. TCE in the groundwater at this site could not be modeled due to a lack of data.

9.4.2 DRMO Trench Area Risk Assessment Summary

Chemicals of potential concern at this site included arsenic, selenium, chlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, 1,2-dichloroethane, 1,1-dichloroethene, ethylbenzene, 1,1,1-TCA, TCE, toluene, xylene, DDD, DDT, and heptachlor. Calculated excess human cancer risk for the current casual visitor scenario was below the 1E-06 bench mark at this site. Calculated excess human cancer risk were above the 1E-06 benchmark for future residents exposed to contaminated soil and

groundwater at the DRMO Trench Area. Calculated noncancer risks did not exceed the 1.0 benchmark. Exposure to contaminants of concern at this site is not expected to present a significant threat to environmental receptors.

9.4.3 Recommendations

To fully characterize the DRMO Trench Area, the following investigations are recommended:

- A soil gas survey conducted over the entire DRMO Trench Area to locate additional VOC sources in the soil and possibly track VOCs in the groundwater.
- The installation and sampling of additional monitoring wells to define the distribution of TCE in groundwater.
- Collect surface soil samples in the 0- to 5-foot interval along the length of the ash and burn debris area located about 120 feet southwest of the open trench.
- Collect additional surface soil samples to more accurately determine the risk to human health associated with potential determal exposures.

9.5 TNT LEACHING BEDS SITE

9.5.1 Contamination Assessment Summary

A soil gas survey revealed a TCE plume centered around the Vehicle Maintenance Area Subsite suggesting that this may be the source of the VOCs found in the groundwater in the western portion of this subsite. Five soil borings were located to coincide with areas of high soil gas concentrations. Toluene was the only compound detected in any of these borings.

VOCs were distributed in the groundwater from the "A"zone wells. The most frequently observed compound was TCE. Groundwater VOC plume maps show this plume is bilobate. The western lobe has the highest VOC concentrations (up to 952.000 μg/L

TCE, Round 1) and is centered around the Vehicle Maintenance Area Subsite. The Vehicle Maintenance Area is considered the TCE source at this subsite. The eastern lobe, located at the TNT Leaching Beds Subsite, is smaller and has relatively lower TCE concentrations (up to 30.500 μg/L TCE, Round 2) than the western lobe. The TNT Leaching Beds are considered to be the source of TCE contamination at this subsite. This conclusion is supported by the detection of low levels of TCE in soils beneath the leaching beds.

Explosives compounds were detected in 100 percent of the surface soils and 98 percent of the subsurface soils collected from the TNT Leaching Beds Subsite. 1,3,5-TNB, detected in 93 percent of the samples, was the most widely distributed explosive compound at this subsite. A groundwater plume comprised of explosives compounds was delineated at this site. This plume is centered around the TNT leaching beds.

Contaminant transport models were conducted in the vadose and saturated zone utilizing 1,3,5-TNB data. Saturated zone modeling was conducted on the western lobe of the TCE. The vadose zone model predicts that the concentration of 1,3,5-TNB at the bottom of the vadose zone will increase from 3 μg/g to 6 μg/g from 1990 to 2000. TCE and 1,3,5-TNB saturated zone modeling indicates that both of these plumes have moved very slowly in a northern direction since the introduction of these contaminants into the groundwater. Model predictions show that under current hydrogeologic conditions, the downgradient (northward) migration of these plumes will be negligible.

9.5.2 TNT Leaching Beds Area Risk Assessment Summary

Chemicals of potential concern included arsenic, chromium, carbon tetrachloride, chloroform, 1,2-DCA, TCE, 2,4-dinitrophenol, 2,4-dinitrotoluene, HMX, RDX, tetryl, 1,3,5-TNB, and 2,4,6-TNT. Cancer risk estimates exceeded the 1E-06 benchmark at the TNT Leaching Beds Area for the current casual visitor, construction worker, and future residents exposed to contaminated soil and groundwater. Calculated noncancer hazard indices indicated that the benchmark of 1.0 was not exceeded at this site. The exposure of explosive chemicals and their degradation products is probably not significant.

9.5.3 Recommendations

To fully characterize the extent of soil contamination at the TNT Leaching Beds, the following additional work is recommended:

- Install and sample an angled soil boring underneath the Vehicle Maintenance Area Subsite concrete pad and sample for VOCs.
- Conduct a detailed inspection of the concrete pad and attempt to identify conduits into which waste products may have been introduced to the soil.

Glossary of Acronyms and Abbreviations

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LIST OF ACRONYMS AND ABBREVIATIONS

AAL	Applied Action Level
ARAR	Applicable or relevant and appropriate requirement
ASTM	American Society for Testing and Materials
ATSDR	Agency for Toxic Substances and Disease Registry
ATV	All-terrain vehicle
AWQC	Ambient Water Quality Criteria
BETX	Benzene, ethylbenzene, toluene, and xylene
BLM	Bureau of Land Management
BNA	Base-neutral and acid extractable organic
BRA	Baseline Risk Assessment
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CPF	Cancer potency factor
CRL	Certified Reporting Limits
DCA	Dichloroethane
DDT	Dichlorodiphenyltrichloroethane
DHS	Department of Health Services
DNB	Dinitrobenzene
DNT	Dinitrotoluene
DOD	Department of Defense
DPDO	Defense Property Disposal Office
DQOs	Data Quality Objectives
DRMO	Defense Reutilization and Marketing Office
ECD	Electron capture detector
EHS	Environmental Hazards Specialists International, Inc.
EM	Electromagnetic terrain conductivity
EP	Extraction Procedure
EPIC	Environmental Photographic Interpretation Center
ESE	Environmental Science and Engineering, Inc.
FID	Flame ionization detector
FS	Feasibility Study
GC	Gas chromatograph
GPR	Ground penetrating radar
HA	Health Advisory
HMX	Cyclotetramethylene tetranitramine
HSA	Hollow stem auger
HSP	Health and Safety Plan
ID	Inside Diameter
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
JMM	James M. Montgomery, Consulting Engineers, Inc.
LOAEL	Lowest Observed Adverse Effect Level
LOD	Level of Detection
MAG	Vertical magnetic gradient
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
mg/kg	Milligrams per kilogram

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

mg/L	Milligrams per liter
MHz	Megahertz
msl	Mean sea level
NCP	National Contingency Plan
NGVD	National Geodetic Vertical Datum
NOAEL	No Observed Adverse Effect Level
NSF	National Sanitation Foundation
OD	Outer diameter
OSHA	Occupational Safety and Health Administration
OSO	Onsite Safety Officer
PCE	Perchloroethylene
PID	Photoionization Detector
PVC	Polyvinylchloride
RAGS	Risk Assessment Guidance for Superfund
RDX	Hexahydro-1,3,5-trinitro-1,3,4-triazine
RfD	Reference Dose
RI	Remeidal Investigation
RI/FS	Remedial Investigation/Feasibility Study
RME	Reasonably Maximally Exposed
RPD	Relative Percent Difference
RWQCB	Regional Water Quality Control Board
SAL	State Action Level
SARA	Superfund Amendment and Reauthorization Act
SDWS	Secondary Drinking Water Standard
SF	Slope Factor
SIAD	Sierra Army Depot
SMCL	Secondary Maximum Contaminant Level
SP	Spontaneous potential
STLC	Soluble Threshold Limit Concentration
TBCs	To be considered materials
TCA	Tetrachloroethane
TCE	Trichloroethylene
TDS	Total dissolved solids
THC	Total Hydrocarbons
TNB	Trinitrobenzene
TNT	Trinitrotoluene
TTLC	Total Treshold Limit Concentration
TRC	Tracer Research, Inc.
µg/g	Micrograms per gram
µg/L	Micrograms per liter
USAEHA	U. S. Army Environmental Health Agency
USATHAMA	U. S. Army Toxic and Hazardous Materials Agency
USCS	United Soil Classification System
USEPA	U. S. Environmental Protection Agency

LIST OF ACRONYMS AND ABBREVIATIONS
(Continued)

UXO	Unexploded ordnance
VOC	Volatile organic compound

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