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U.S. Army Toxic and Hazardous Materials Agency

TOOKLE ARMY DEPOT
PRELIMINARY ASSESSMENT/SITE INVESTIGATION
FINAL REPORT

VOLUME I
NORTH AREA AND FACILITIES AT HILL AIR FORCE BASE

DECEMBER 1988

PREPARED FOR:

U.S. ARMY TOXIC AND HAZARDOUS MATERIALS AGENCY
INSTALLATION RESTORATION DIVISION
ABERDEEN PROVING GROUND, MARYLAND 21010-5401

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UNDER:

CONTRACT NO. DAAA15-86-D-0002
TASK ORDER 0003

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REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION Unclassified			1b. RESTRICTIVE MARKINGS		
2a. SECURITY CLASSIFICATION AUTHORITY			3. DISTRIBUTION/AVAILABILITY OF REPORT		
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE					
4. PERFORMING ORGANIZATION REPORT NUMBER(S) EA Report THA51E5			5. MONITORING ORGANIZATION REPORT NUMBER(S)		
6a. NAME OF PERFORMING ORGANIZATION EA Engineering, Science, and Technology, Inc.		6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION U.S. Army Toxic and Hazardous Materials Agency		
6c. ADDRESS (City, State, and ZIP Code) 15 Loveton Circle Sparks, Maryland 21152			7b. ADDRESS (City, State, and ZIP Code) Aberdeen Proving Ground, Maryland 21010		
8a. NAME OF FUNDING/SPONSORING ORGANIZATION		8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER DAAA15-86-D-0002		
8c. ADDRESS (City, State, and ZIP Code)			10. SOURCE OF FUNDING NUMBERS		
			PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO. 003
11. TITLE (Include Security Classification) Preliminary Assessment/Site Investigation, Tooele Army Depot, Utah; Volume I-North Area					
12. PERSONAL AUTHOR(S) Andris Lapins, CPG, Linda McConnell, Thomas Porter					
13a. TYPE OF REPORT Technical		13b. TIME COVERED FROM 9/1/85 TO 11/1/87		14. DATE OF REPORT (Year, Month, Day) 12/12/88	
15. PAGE COUNT Approx: 600					
16. SUPPLEMENTARY NOTATION					
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number) Site Investigations, Hazardous Waste, Groundwater Contamination, Groundwater Monitoring, Environmental Production.		
FIELD	GROUP	SUB-GROUP			
19. ABSTRACT (Continue on reverse if necessary and identify by block number) This report documents the Preliminary Assessment/Site Investigation (PA/SI) phase of the U.S. Army Installation Restoration Program for the North Area of Tooele Army Depot (N-TEAD), Utah. The PA/SI for N-TEAD involved the performance of a records search and the development and implementation of a field sampling and analysis program. The objectives of the PA/SI were to: (1) identify sites at N-TEAD used to store, process, and/or dispose of hazardous waste; (2) determine which of these sites have a low potential for environmental contamination and/or pose no immediate apparent threat to public health and welfare; (3) determine which sites have a high potential for environmental contamination and/or pose a threat to public health and welfare; (4) perform limited sampling of soil, groundwater, and/or surface water to determine existence of contamination, if any, and to evaluate potential for offsite migration; and (5) identify off-post sites which may be impacting the environmental of N-TEAD.					
20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☐ UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT. ☐ DTIC USERS			21. ABSTRACT SECURITY CLASSIFICATION Unclassified		
22a. NAME OF RESPONSIBLE INDIVIDUAL M.E. Heppner			22b. TELEPHONE (Include Area Code) (301) 671-3530		22c. OFFICE SYMBOL AMXTH-IR-D

Following review of the available databases and performance of an onsite visit, 27 N-TEAD sites and 3 off-depot sites were identified as potential sources of environmental contamination. Of these sites, 4 N-TEAD sites were considered to present a significant potential threat to the environment and/or public health and welfare: (1) the TNT Washout Facility Area, (2) the Former Transformer Storage Area, (3) a PCB Spill Site, and (4) the Open Burn/Open Detonation (OB/OD) Grounds. A field sampling/analysis program was developed for each of these sites to provide sufficient data to evaluate the existence of contamination, if any, and to provide a preliminary assessment of the potential for contaminant migration, if appropriate. The field effort involved the installation of five monitoring wells and four lysimeters; and sampling/analysis of groundwater (from existing and previously installed wells), soil, wastewater, and sediment. All samples were analyzed for explosives, the major contaminant of concern, and selected samples were analyzed for inorganics, metals, and organic priority pollutants.

The bottom sediment within the former (Old) TNT Washout Ponds was found to be contaminated with significant levels of various explosive compounds. TNT was found at concentration levels as high as 20,700 ppm. However, bottom sediment within the existing (new) TNT Washout Basin and the surficial soils in the vicinity of the TNT Washout Ponds were not found to be contaminated with explosives. The deep regional aquifer beneath the site, which is used as a drinking water source, was found to be contaminated with explosives. A shallow perched groundwater zone, created by effluent seepage through the base was also found to contain detectable levels of explosive compounds. Seepage of effluent from the Laundry Effluent Pond was determined to provide a potential mechanism for the mobilization of explosives in subsurface soils in the TNT Washout Facility Area.

PCB was detected in soil samples obtained from the Former Transformer Storage Area and PCB Spill Site at levels (<0.214 $\mu\text{g/g}$) which do not present a threat to the environment or to public health and welfare. Evidence of groundwater contamination from past activities at the OB/OD Grounds was not indicated as a result of sampling and analysis of two water supply wells located downgradient of the site.

Fourteen sites at N-TEAD, assessed by records review, personnel interviews, and/or onsite visits, were considered to present a low potential for environmental contamination: (1) Transformer Boxing Site, (2) Radiological Storage Facility, (3) Pesticide/Herbicide Storage Facility, (4) PCB Storage Facility, (5) Domestic Wastewater Spreading Grounds, (6) Staging Area Near Surveillance Test Site, (7) AEO Furnace Site, (8) AEO Demilitarization Facility, (9) AEO Maintenance Facility, (10) Rifle Range, (11) DPDO Yard, (12) Radiological Waste Storage Area, (13) Open Storage within Igloo Storage Area, and (14) Burial Area within Industrial Area. In addition, an off-depot site (Hercules Coal Resin Facility) was determined not to present a significant threat to the groundwater quality of N-TEAD. The potential impact of two other off-depot sites investigated (Bauer Mine Trailings and Anaconda Deep Mine sites) on the quality of ground water at N-TEAD could not be determined due to the unavailability of groundwater analytical chemistry data for the sites.

The potential presence of environmental contamination was determined to exist at the Barrel Storage Area, Sewage Lagoon, Munition Saving Site, Chemical Range, Surveillance Test Site, X-Ray Lagoon, and Sanitary Landfill. The sampling and analysis of soil and/or groundwater would be required to determine the presence/absence of contamination in these areas. Results, conclusions, and recommendations are included in the report.

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE

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LIST OF ABBREVIATIONS AND ACRONYMS

General

AEHA	Army Environmental Health Agency
AFSC	Air Force Systems Command
ALS	Above land surface
AMCR	Army Material Command Regulation
ASTM	American Society of Testing and Materials
BLS	Below land surface
BTC	Below top of casing
CAMDS	Chemical Agent Munition Disposal System
CE	U.S. Army Corps of Engineers
CFR	Code of Federal Regulations
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CES	Civil Engineering Squadron
CGW	Chemistry Groundwater File
CRL	Certified Reporting Limit
CSO	Chemistry Soil File
DFAE	Directorate of Facilities Engineering
DMS	Data Management System
DOD	Department of Defense
DOT	Department of Transportation
DPDO	Defense Property Disposal Office
DPDS	Defense Property Disposal System
DRMO	Defense Reutilization Marketing Office
EPA	Environmental Protection Agency
ESE	Environmental Science and Engineering, Inc.
GC	Gas chromatograph method of chemical analysis
GC/MS	Gas chromatograph/mass spectrometry
GFD	Geotechnical field drilling file
GGs	Geotechnical groundwater stabilization file
GMA	Geotechnical map location file
GVC	Geotechnical well construction file
GWQA	Groundwater Quality Assessment
HAFB	Hill Air Force Base
HMTC	Hazardous Materials Technical Center
HX, HE	High Explosive
IRDMS	Installation Restoration Data Management System
ID	Inside diameter
IRP	Installation Restoration Program
IWL	Industrial Waste Lagoon
JMM	James M. Montgomery, Consulting Engineers, Inc.
LWC	Local wind circulation
MCL	Maximum contaminant level
MSL	Mean sea level
NCO	Non-commissioned officer
ND	Not detected
NPDES	National Pollutant Discharge Elimination System
N-TEAD	North Area - Tooele Army Depot
OB/OD	Open Burn/Open Detonation

LIST OF ABBREVIATIONS AND ACRONYMS (Cont.)

General

OD	Outside diameter
PA/RP	Plan of Accomplishment/Resource Plan
PA/SI	Preliminary Assessment/Site Investigation
PED	Production Engineering Division, Maintenance Directorate
POL	Petroleum, oil, and lubricant
PVC	Polyvinyl chloride
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
SOP	Standard Operating Procedure
SR	State route
SS	Split spoon
TDS	Total dissolved solids
TEAD	Tooele Army Depot
TOC	Total organic carbon
TOD	Tooele Ordnance depot
TOX	Total organic halogens
TSCA	Toxic Substance Control Act
USAEHA	U.S. Army Environmental Hygiene Agency
USAETL	U.S. Army Engineer Topographic Laboratories
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USCS	Univied Soil Classification System
USGS	U.S. Geological Survey
UXO	Unexploded ordnance
VOC	Volatile organic compounds
WCC	Woodward-Clyde Consultants
WP	White phosphorus

Units of Measure

°C	Degrees Celsius
°F	Degrees Farenheit
ft	Feet
ft/day	Feet per day
ft/sec	Feet per second
ft/year	Feet per year
gals	Gallons
gpd	Gallons per day
gpm	Gallons per minute
in.	Inches
km	Kilometers
m	Meters
MGD	Million gallons per day
mg	Milligrams
mg/L	Milligrams per liter
ng	Nanograms
ng/L	Nanograms per liter
ppb	Parts per billion
ppm	Parts per million

LIST OF ABBREVIATIONS AND ACRONYMS (Cont.)

Units of Measure (Cont.)

pCi/L	Picocuries per liter
µg/L	Micrograms per liter
umhos/cm	Microumhos per centimeter

Chemicals

Ag	Silver
As	Arsenic
Ba	Barium
Ca	Calcium
CaCO ₃	Calcium carbonate
Cd	Cadmium
Cl	Chloride
CO ₃	Carbonate
Cn	Cyanide
Cr	Chromium
CTC	Carbon tetrachloride
Cu	Copper
DNB	Dinitrobenzene
DNT	Dinitrotoluene
Fe	Iron
HCL	Hydrochloric acid
Hg	Mercury
HMX	Octahydro-tetranito-tetrazocine
HNO ₃	Nitric acid
K	Potassium
Na	Sodium
Ni	Nickel
NO ₂	Nitrite nitrogen
NO ₃	Nitrate nitrogen
Pb	Lead
PCB's	Polychlorinated byphenols
RDX	Cyclonite (high explosive primer)
Se	Selenium
TCA	1,1,1-trichloroethane
TCE	Trichloroethene (same as trichloroethylene)
TNT	Trinitrotoluene
Zn	Zinc

EXECUTIVE SUMMARY

EA Engineering, Science, and Technology, Inc. was contracted by the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) to conduct a Preliminary Assessment/Site Investigation (PA/SI) at the Tooele Army Depot (TEAD), Utah, under Contract No. DAAA15-86-D-0002. USATHAMA has the mission of conducting the U.S. Army Installation Restoration Program (IRP). The objective of this program is to identify and eliminate or control the migration of contamination resulting from past operations throughout the Army and consists of three phases: Preliminary Assessment, Remedial Investigation/Feasibility Study, and Remedial Actions. The work accomplished under this contract constitutes the Preliminary Assessment phase.

The Tooele Army Depot consists of three physically separated facilities: the North Area, the South Area, and the TEAD Rail Shops at Hill Air Force Base. Volume I of this report addresses the North Area (N-TEAD) and the TEAD facilities at Hill Air Force Base (HAFB). Volume II of this report addresses the South Area of TEAD (S-TEAD).

N-TEAD is located in Tooele County, Utah and covers approximately 25,000 acres. N-TEAD, which began operating in 1942, is one of the major ammunition storage and equipment maintenance installations in the continental United States. The primary missions include administration of the TEAD complex; repair and maintenance of tactical wheeled vehicles and power generation equipment; and storage, maintenance, issuance, and disposal of conventional munitions.

The TEAD PA/SI, initiated in September 1985, involved the performance of a records search, employee interviews, site inspections, and the development and implementation of a field sampling/analysis program. The objectives of the PA/SI were: (1) using the available database, identify sites at N-TEAD used to store, process, and/or dispose of hazardous waste; (2) determine which of these sites have a low potential for environmental contamination and/or pose a threat to public health and welfare; (3) determine which sites have a high potential for environmental contamination and/or pose no immediate apparent threat to public health and welfare; (4) perform limited sampling of soil, ground water, and/or surface water to determine existence of contamination, if any, and to evaluate potential for offsite migration; and (5) identify off-post sites which may be impacting the environmental quality of N-TEAD. It was not the intent of this study to determine the extent of contamination, only to preliminarily examine the potential existence of contamination at a site. Contaminated sites would then be recommended for inclusion in the remedial investigation for the purpose of determining the horizontal and vertical extent of that contamination.

Following review of the available database and performance of the onsite visit, a Field Sampling Design Plan was prepared for eighteen (18) N-TEAD sites and three (3) off-depot sites identified as potential sources of environmental contamination. Of these sites, four (4) N-TEAD sites were considered to pose a significant potential threat to the environment and/or public health and welfare: (1) the TNT Washout

Facility Area, (2) the Former Transformer Storage Area, (3) a PCB Spill Site, and (4) the Open Burn/Open Detonation (OB/OD) Grounds. A field sampling/analysis program was developed for each of these sites to evaluate the existence of contamination, if any, and to provide a preliminary assessment of the potential for contaminant migration, if appropriate. Following development of the Field Sampling Plan, nine additional sites were included in the PA/SI effort for N-TEAD, and were assessed from information obtained from available records and personnel interviews.

The field effort at the TNT Washout Facility Area involved the installation of five monitoring wells (4 shallow and 1 deep) and four lysimeters; and sampling/analysis of groundwater from existing and previously installed wells, surficial soils, wastewater and sediment from a Laundry Effluent Pond, sediment from a New TNT Washout Pond, and soils from four (4) former (Old) TNT Washout ponds. All samples were analyzed for explosives, the major contaminant of concern, and selected samples were analyzed for metals and organic priority pollutants. The major findings of the PA/SI activities performed in this area are summarized as follows:

- . The bottom sediment and the soil directly beneath (to a depth of at least 5 feet below) the former (Old) TNT Washout ponds was found to be contaminated with significant levels of various explosive compounds. Bottom sediment samples analyzed contained TNT at concentration levels as high as 20,733 µg/g.
- . The bottom sediment within the existing (New) TNT Washout Basin at the site was found not to be contaminated with any explosives. Nitrate+nitrite nitrogen levels were found to be <11.1 µg/g.
- . Surficial soils in the vicinity of the TNT Washout ponds were not found to be contaminated with explosives.
- . The deep regional aquifer beneath the site, which is used as a drinking water source, was found to be contaminated with 2,4-DNT at a concentration of >20 µg/L. Significant levels of sodium (220,000 µg/L) and nitrate+nitrite nitrogen (61,000 µg/L) were also detected.
- . Effluent within the Laundry Effluent Pond was found to contain various metals, however, none of the metal concentrations exceeded Federal and State water quality standards. Nitrate+nitrite nitrogen was detected in the effluent and sediment of the Laundry Effluent Pond at concentrations of 1,180 µg/L and <11.1 µg/g, respectively. No volatile organics, semi-volatile organics, or explosives were detected in the effluent or sediment.

- A shallow perched groundwater zone exists in the immediate vicinity of the Laundry Effluent Pond as a result of effluent seepage from the pond. This perched groundwater was found to contain detectable levels of explosive compounds. Based on the data obtained, it appears that the Laundry Effluent Pond provides a mechanism for the mobilization of explosives in subsurface soils at the site.
- Migration of explosives from the perched groundwater zone to the deeper regional aquifer has occurred, indicating the perched groundwater zone is in direct communication with the deep regional aquifer beneath the site.

To minimize contaminant migration, it was recommended that the installation either relocate or discontinue operation of the Laundry Effluent Pond, or install an impermeable liner beneath the pond. The performance of soil borings and the installation of additional monitoring wells (screened into the deep regional aquifer and the perched groundwater zone) was also recommended to further determine the presence and extent of subsurface explosives contamination at the site. Furthermore, it was recommended that a Health Risk/Endangerment Assessment be performed from the available database of information for the site.

Composite surficial soil samples were collected at two sites identified as potential sources of PCB contamination: the Former Transformer Storage Area and a PCB Spill Site. The highest PCB concentration detected in all samples collected and analyzed was 0.19 $\mu\text{g/g}$. The Federal regulations (40 CFR 761D) for PCBs require contaminated soils with PCB concentrations greater than 50 $\mu\text{g/g}$ to be removed and properly disposed of. These regulations do not apply to soils containing PCB concentrations less than 50 $\mu\text{g/g}$. Results of PCB determinations conducted on the samples obtained indicated that the Former Transformer Storage Area and PCB Spill Site do not present a threat to the environment or to public health and welfare.

The OB/OD Grounds, located in the southwest corner of N-TEAD, have been used extensively for the detonation of conventional munitions. The sampling of surficial soils within the detonation pits during a previous investigation, revealed the presence of explosives. Two Depot water supply wells are located downgradient of this area, therefore, a potential public health risk was considered to exist. Due to the great depth to groundwater (>700 ft) and the potential for unexploded ordnance in the area, groundwater monitoring wells were not installed at the site. Instead, water samples were collected from the two downgradient drinking water supply wells for priority pollutant and explosives content determination in order to evaluate if the supply wells had been adversely impacted. Results of the sampling and analysis showed that the water quality of both wells had not been impacted from activities conducted at this site.

Six sites at N-TEAD, assessed by records review, personnel interviews, and an onsite visit, were considered to have a low potential for environmental contamination. These sites were: (1) the Transformer Boxing Site, (2) Radiological Storage Facility, (3) Pesticide/Herbicide

Storage Facility, (4) PCB Storage Facility (5) Domestic Wastewater Spreading Grounds, and (6) the Staging Area Near Surveillance Test Site. An additional eight sites at N-TEAD, assessed by only records review and personnel interviews were also considered to have a low potential for environmental contamination. These sites were: (1) AEO Demilitarization Facility, (2) AEO Furnace Site, (3) AEO Maintenance Facility (4) Rifle Range, (5) DPDO Yard, (6) Radiological Waste Storage Area, (7) Open Storage With Igloo Storage Area, and (8) Buildup Area Within Industrial Area. It was recommended that, at a minimum, site inspections be performed to ground verify reported conditions at these eight sites.

It was recommended that soils and/or sediment in the Barrel Storage Area, Sewage Lagoon, Chemical Range, and Surveillance Test Site be sampled and analyzed to determine whether environmental contamination has occurred in these areas. If soils are found to be contaminated, it was further recommended that monitoring wells be installed at these sites to determine if groundwater contamination has also occurred.

It was recommended that a visual inspection of the condition of the bottom liner within the X-ray Lagoon be performed, and its contents sampled and analyzed, in order to determine whether the waste it contains is hazardous and whether contaminants may have been released to the environment. The installation of groundwater monitoring wells was recommended to determine if groundwater contamination has occurred.

The installation of a minimum of three groundwater monitoring wells, around the perimeter of the Sanitary Landfill, was recommended to evaluate the potential existence of groundwater contamination at this site.

An off-depot site (Hercules Coal Resin Facility) was determined not to present a significant threat to the groundwater quality of N-TEAD. The potential impact of two other off-depot sites investigated (Bauer Mine Tailings and Anaconda Deep Mine sites) on the quality of groundwater at N-TEAD could not be determined due to the unavailability of groundwater analytical chemistry data for the sites.

A potential for soil contamination exists at the TEAD Rail Shops located at Hill Air Force Base (HAFB). The U.S. Air Force has included, and is currently investigating, this site as part of its IRP, Phase II Field Investigation of sites at HAFB. It was recommended that further activities for this site be based on the results and findings of the Air Force's Phase II Sampling and Analytical Program.

PART A

TOOELE ARMY DEPOT - NORTH AREA

1. INTRODUCTION

1.1 BACKGROUND

1.1.1 Location

The Tooele Army Depot (TEAD) is located in North Central Utah. The TEAD Complex is under one command, but consists of three physically separated areas: North Area, South Area, and Hill Air Force Base (HAFB) Rail Shops. Figure 1-1 is a map showing the general location of the TEAD complex. Figure 1-2 is an area map of the North Area (N-TEAD).

N-TEAD, originally the Tooele Ordnance Depot, is located approximately 35 miles southwest of Salt Lake City, in Tooele County, Utah. N-TEAD covers an area of about 24,732 acres. The City of Grantsville (1980 population: 4,419) is situated just beyond the northern N-TEAD boundary, and the City of Tooele (1980 population: 14,335) is located immediately east of N-TEAD. N-TEAD is bounded on the west by the Stansbury Mountains, on the east by the Oquirrh Mountains, on the south by the Stockton Bar (South Mountain), and to the north is the Great Salt Lake.

1.1.2 Installation History

The Tooele Ordnance Depot (TOD) was established 7 April 1942 by the Army Ordnance Department. Construction of the facilities, including igloos, magazines, administration buildings, military and civilian housing, roads, hardstands for vehicle storage, and other allied appurtenances, was completed in January 1943.

More than 1,625,000 tons of material were shipped and received by TOD during World War II. In addition, the Depot overhauled 997 major automotive vehicles, 1,347 major artillery pieces, and salvaged 896 tanks. Within a period of less than 3 years, the proceeds from the brass salvage of the Depot totaled almost \$10 million.

The installation was designated a subdepot of the Ogden Arsenal (in Ogden, Utah) in March 1947. In November 1949, the Tooele subdepot was again redesignated Tooele Ordnance Depot and the Ogden Arsenal was designated as a subdepot under Tooele. In 1955, Ogden Arsenal, having once again been declared an arsenal in 1950, was discontinued and its mission transferred to Tooele.

On 30 March 1961, two major West Coast Ordnance Installations were scheduled to be deactivated and their missions transferred to TOD. The installations were Benicia Arsenal located near Oakland, California, and Mt. Ranier Ordnance Depot located near Tacoma, Washington. The transferred missions were Guided Missile Rebuild, Tires and Tubes Rebuild, Calibration of Test Equipment, and other similar maintenance missions.

The Tooele Ordnance Depot was redesignated Tooele Army Depot in August 1962. Since that time, TEAD's mission has been gradually altered and expanded to include support of other Army installations throughout the

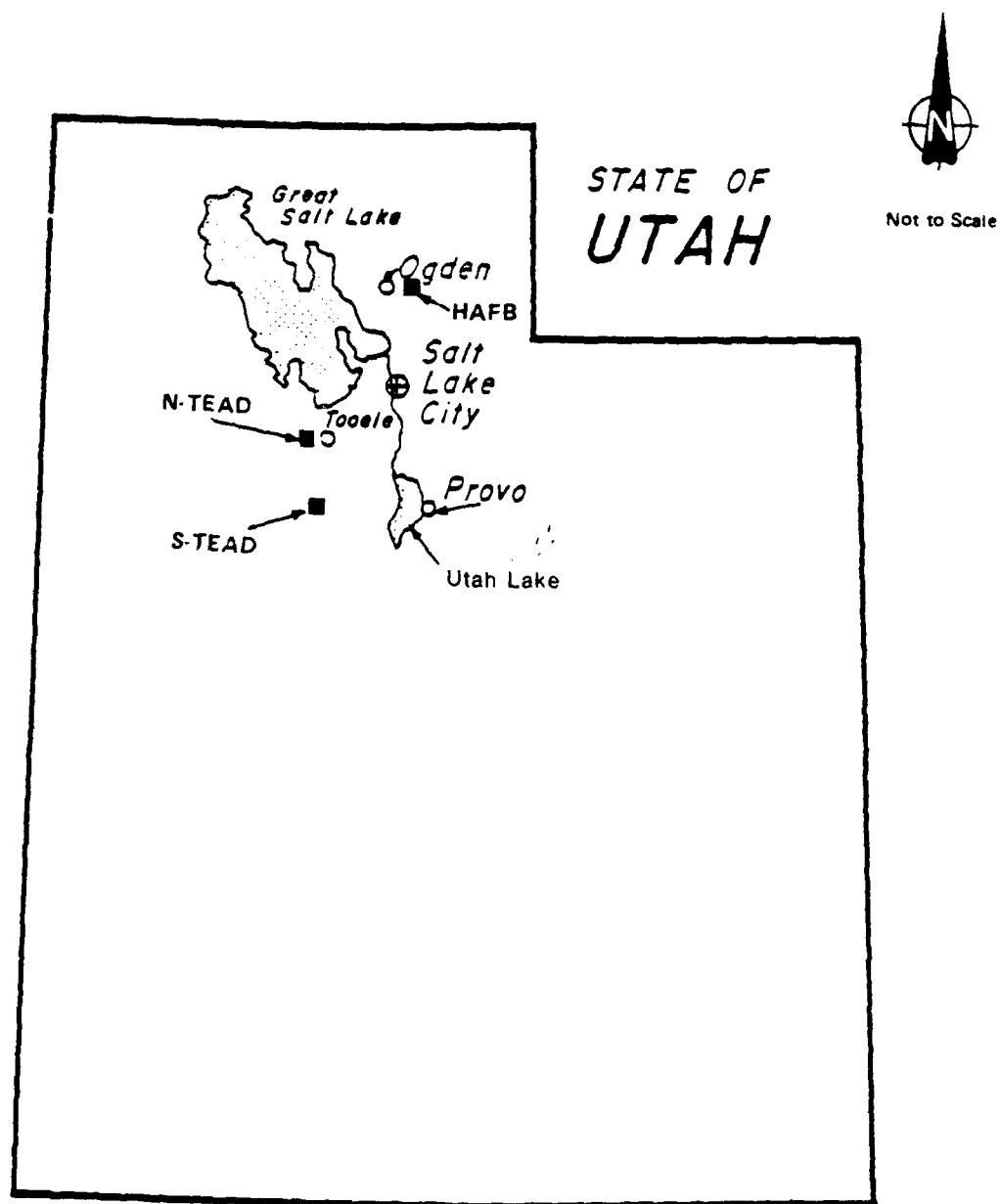


Figure 1-1. General Location Map of the Tooele Army Depot Complex.

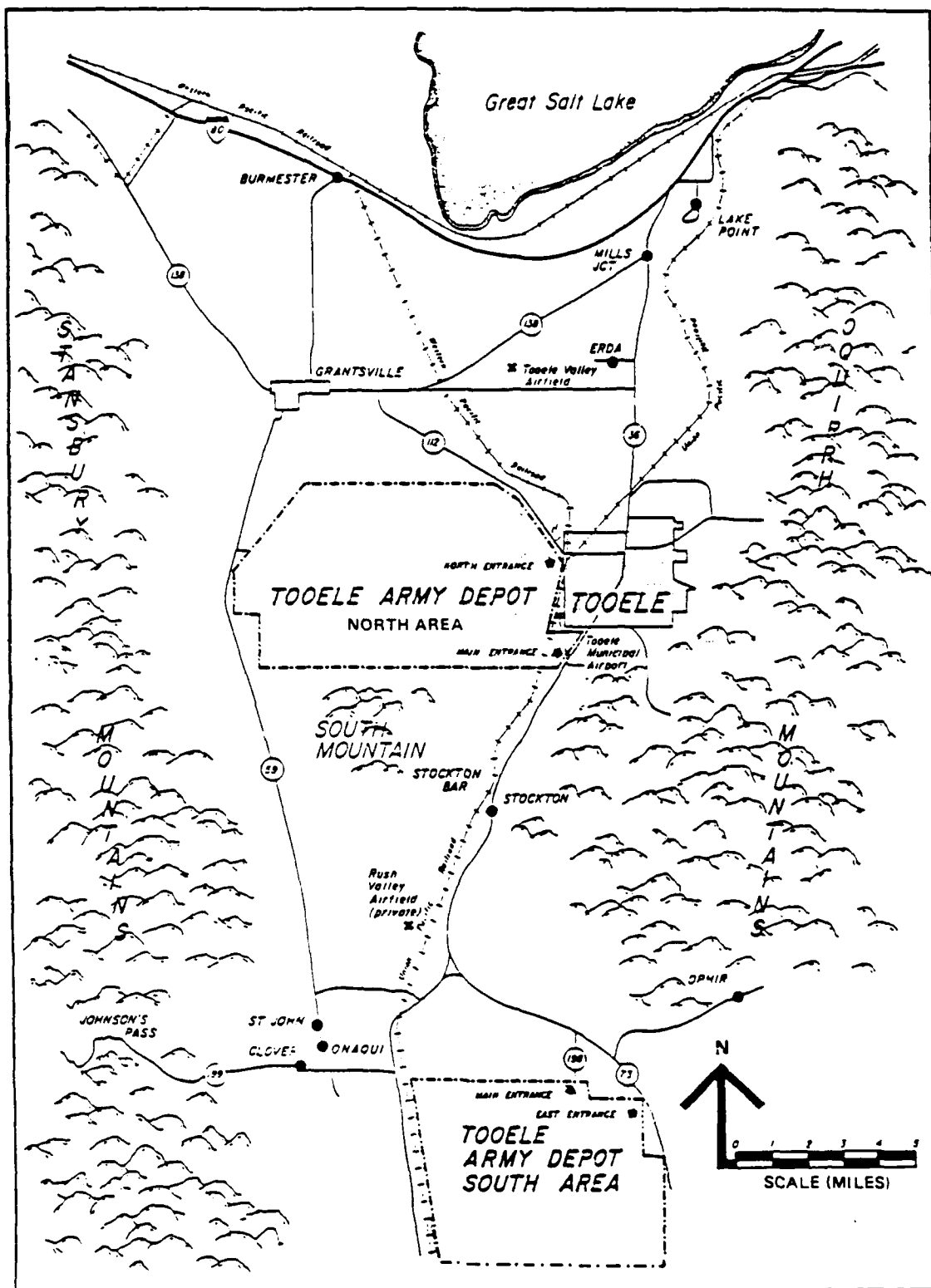


Figure 1-2. Area Map of N-TEAD.

western United States. Today, the Tooele Army Depot is one of the major ammunition storage and equipment maintenance installations in the continental United States. Between June and September of 1970, maintenance mission responsibilities for topographic equipment, troop support items, construction equipment, power generators, and serviceable assets (requiring inside/outside storage) were transferred from Granite City Army Depot located near Granite City, Illinois.

In August 1973, Umatilla Depot Activity in Hermiston, Oregon was the first satellite depot assigned to TEAD. In September 1975, the Navajo Depot Activity in Flagstaff, Arizona, and the Fort Wingate Depot Activity in Gallup, New Mexico, were reassigned from Pueblo Army Depot to TEAD.

The latest organizational change, effective on 1 July 1976, reduced the status of the Pueblo Army Depot to that of a depot activity and assigned the administration of this facility to Tooele Army Depot. Therefore, TEAD is presently responsible for four separate depot activities, i.e., Umatilla, Pueblo, Navajo, and Fort Wingate, plus the incorporated TEAD South Area.

1.1.3 Installation Mission and Activities

The mission of the Tooele Army Depot is to provide for the receipt, storage, issue, maintenance, and disposal of assigned commodities; to provide installation support to attached organizations; and to operate other facilities as may be assigned. The administrative headquarters for the TEAD complex are situated in the North Area.

The first mission for Tooele Ordnance Depot assigned on 8 December 1942, was to store vehicles, small arms, and fire control equipment for export. Other mission functions included overhauling and modifying tanks and track vehicles and their armaments. In general, the order designated Tooele as a backup depot for the Stockton Ordnance Depot and Benicia Arsenal, both in California.

In 1970, N-TEAD assumed maintenance mission responsibilities for topographic equipment, troop support items, construction equipment, power generators, and serviceable assets from the Granite City Army Depot (Illinois) which was subsequently closed.

Currently, the maintenance missions at Tooele include the repair of tactical wheeled vehicles and power generation equipment. Along with these missions, all the secondary items of the components are rebuilt; including engine and power trains. Approximately 4,500 engines and 12,000 power train components are overhauled each year. In addition, Tooele has been named as the support depot for most of the Army's new Tactical Wheeled Vehicles purchased as part of the Army's Force Modernization program.

Activities at TEAD are the responsibility of nine Directorates-- Administration and Services; Ammunition Equipment; Chemical Agent Munitions Disposal System (CAMDS); Maintenance; Management Information Systems; Quality Assurance; Resources Management; Supply; and Ammunition

Operations. In addition to these Directorates, TEAD provides space for eight tenants--the Agency for International Development; Atmospheric Sciences Laboratory Meteorological Team; Defense Property Disposal Office; U.S. Army Communication Command; U.S. Army Health Clinic; U.S. Army TSARCOM Mobil Rail Shop No. 3; U.S. Army Reserves; and U.S. Army Toxic and Hazardous Materials Agency.

The major functions of TEAD are listed below.

- . Stock distribution and storage of general supplies and ammunition in the FSC groups assigned by AMCR 780-5, as directed by responsible NICPs.
- . Storage of General Services Administration strategic and critical materials.
- . Depot maintenance of general supplies and ammunition in the commodity categories assigned by AMCR 780-5.
- . Clipping and linking of small arms ammunition.
- . Demilitarization of ammunition.
- . Surveillance of ammunition.
- . Processing of general supply and ammunition returned material in the same commodity categories specified in AMCR 780-5 for depot maintenance.
- . Training supervision of assigned TOE units and provision of logistical support and training assistance to U.S. Army Reserve Units.
- . Design, manufacture, procurement, storage, and testing of ammunition equipment for demilitarization, renovation, modification, modernization, and normal maintenance of conventional ammunition.
- . Assembly of basic issue item sets and fabrication of radio harnesses, and assembly of sets from component parts or repair parts as requested by the commodity manager.

1.2 PRELIMINARY ASSESSMENT/SITE INVESTIGATION OBJECTIVES

The objectives for this Preliminary Assessment/Site Investigation (PA/SI) were: (1) using the existing available database, identify sites at N-TEAD used to store, process, and/or dispose of hazardous waste; (2) determine which of these sites have a low potential for environmental contamination and/or pose no immediate apparent threat to public health and welfare; (3) determine which sites have a high potential for environmental contamination and/or pose a threat to public health and welfare; (4) perform limited sampling of soil, groundwater, and/or surface water to determine existence of contamination, if any, and to evaluate potential for offsite migration; and (5) identify off-post

sites which may be impacting the environmental quality of N-TEAD. PA/SI tasks were separated into pre-onsite and onsite work and are described below. Table 1-1 provides a summary of the tasks, deliverables, and schedule for the N-TEAD PA/SI program.

1.2.1 Pre-Onsite Work

The first task to be performed under this phase of the PA/SI was to prepare a Plan of Accomplishment/Resource Plan (PA/RP) detailing the objectives, work schedule, and budget for the project. The PA/RP was submitted to USATHAMA on 7 October 1985 (EA 1985). EA received written comments from USATHAMA on the PA/RP and based on these comments EA submitted a revised PA/RP on 11 November 1985.

The second task was to retrieve and review available documents containing information on installation operations, waste treatment and disposal practices, known or suspected sites of contamination, previous and ongoing contamination assessment investigations, and environmental settings. Documents reviewed during this phase of the project were provided by USATHAMA.

A pre-onsite briefing with EA and USATHAMA personnel was conducted at the Aberdeen Proving Ground, Edgewood Area, 20 November 1985. The purpose of this briefing was to discuss the onsite work objectives.

1.2.2 Onsite Work

An onsite visit was conducted at N-TEAD by EA during the week of 9-13 December 1985. The purpose of this visit was to interview installation personnel, review pertinent installation documents, and visit areas of interest identified during pre-onsite work. Several key installation personnel familiar with specific areas of the installation were not available during EA's visit. TEAD personnel not available during the onsite visit were interviewed over the telephone or contacted during the predrilling visit. All areas of interest on N-TEAD were visited by an EA team member. An aerial flyover of N-TEAD was also conducted during the onsite visit which provided an opportunity to see some areas which were inaccessible from the ground. Site inspections were performed for the following N-TEAD sites:

- . TNT washout ponds/laundry effluent ponds
- . Old industrial/maintenance waste spreading area
- . Industrial wastewater lagoon
- . Sanitary landfill
- . Open burn/open detonation (OB/OD) grounds
- . PCB storage facility (Building 659)
- . Transformer open storage site
- . Transformer boxing site
- . PCB spill site
- . X-ray lagoon
- . Sewage lagoon

TABLE 1-1 SUMMARY OF PROJECT TASKS AND DELIVERABLES FOR THE N-TEAD
PA/SI PROGRAM

Task/Deliverable	Date(s)
. Project Initiation	September 1985
. Plan of Accomplishment/Resource Plan	
--Draft	7 October 1985
--Final	11 November 1985
. Pre-Onsite Briefing	20 November 1985
. Onsite Visit	9-13 December 1985
. Field Sampling Design Plan/Health and Safety Plan	
--Draft	20 January 1986
--Final Draft	6 March 1986
--Final	6 June 1986
. Sampling Design Plan Briefing	14 February 1986
. Predrilling Site Visit	19-23 May 1986
. Well Installation Field Program	30 June - 31 July 1986
. Sampling/Analysis Field Program	17 February - 5 March 1987
. Installation Reassessment Report	
--Draft	15 June 1987
--Final Draft	February 1988
--Final	December 1988

- . Pesticides/herbicides storage and handling
- . Radiological storage and handling
- . Waste water spreading area
- . Chemical range
- . Barrel storage area
- . Surveillance test site
- . Staging area near surveillance test site

The scope of work for the field program was developed using information and data obtained from the records search, Depot employee interviews, and site visits. A draft Field Sampling Design Plan was submitted to USATHAMA on 20 January 1986. EA conducted a formal briefing on the Sampling Design Plan to USATHAMA on 14 February 1986. During this briefing, USATHAMA approved EA's proposed scope of work for some of the sites and made changes to proposed scope of work at other sites. The Final Field Sampling Design Plan/Health And Safety Plan was submitted to USATHAMA on 6 June 1986.

Following development and implementation of the Field Sampling Program, nine additional sites (identified in EPIC photographs) were included in the PA/SI effort for N-TEAD and assessed from information gathered from available records and personnel interviews. These sites included:

- . AEO demilitarization facility
- . AEO furnace site
- . Munition sawing site
- . Rifle range
- . Ammunition maintenance facility
- . DPDO storage yard
- . Radiological waste storage area
- . Open storage within igloo area
- . Burial Area within industrial area

A Predrilling Site Visit was conducted by EA from 19 to 23 May 1986 to obtain water level measurements at existing monitoring wells, clear and stake well boring locations, and to discuss and coordinate the well drilling program with TEAD personnel. The Well Installation and Development Program was conducted during the period of 30 June - 31 July 1986, and the Field Sampling Program was conducted from 17 February to 5 March 1987.

1.3 OVERVIEW OF REPORT

The remaining chapters of this report (Volume I, Part A) address the following topics: site features, local and regional physiography, waste sources and disposal/treatment methods, findings of other environmental investigations, development and implementation of the PA/SI field program, and description of contaminant problems at specific sites.

Chapter 2, Site Features, provides a summary of the cultural resources (demography, land use, historical and archaeological sites), natural resources (flora and fauna), and climate of the area in and around N-TEAD.

Chapter 3, Physiography, is a discussion of the local and regional geology, hydrogeology, soils, and surface waters. Information presented in Chapters 2 and 3 was obtained through review of the existing available database.

Chapter 4, Hazardous Substances Characterization, briefly describes N-TEAD waste sources and waste disposal/treatment methods used at the Depot.

Chapter 5, Summary of Previous Environmental Investigations, provides a summary of the findings, conclusions, and recommendations of other environmental studies conducted at N-TEAD. This chapter addresses only those investigations which have involved extensive record searches and/or sampling and analysis.

The objective of Chapter 6, Preliminary Site Assessments, is to present background information on sites identified during the pre-onsite project investigations as potential sources of contamination. Information obtained from available records and the onsite visits is also presented in this chapter.

In Chapter 7, Field Program, the development and implementation of the PA/SI field program (well installation and sampling/ analysis programs) are described. Also addressed in this chapter are changes in the scope of the PA/SI field program that occurred following development of the Field Sampling Design Plan.

Chapter 8, Environmental Contamination Investigations, provides a detailed discussion of data obtained during the field investigations. At N-TEAD, the investigation focused on four specific sites: (1) TNT Washout Area, (2) the Former Transformer Storage Site, (3) the PCB Spill Site, and (4) the OB/OD Area. Chapter 8 also presents background information on site characteristics (soil, groundwater, surface water, topography) important to understanding contaminant transport and potential environmental and public health impacts.

Conclusions and Recommendations, based on the findings of this investigation are presented in Chapters 9 and 10, respectively. A list of references follows Chapter 10. The appendixes for the N-TEAD report (Volume I) are provided as a separate document. TEAD facilities at HAFB are addressed in Part B of this report.

1.4 ACKNOWLEDGEMENTS

The authors wish to express their appreciation to Ms. Mary Ellen Heppner and Mr. John Sanda of USATHAMA for assistance with the organizational and technical portions of this report, and to Mr. Andrew W. Anderson of USATHAMA for his aid in communications and interaction between Depot personnel and consultants.

The authors also acknowledge the cooperation and assistance provided throughout the project by Mr. Robert O'Conner and Mr. Larry Fisher of the Tooele Army Depot, whose knowledge of the Depot greatly aided our study.

2. SITE FEATURES

2.1 CULTURAL RESOURCES

2.1.1 Demography

Tooele County, where N-TEAD is located, is one of five counties comprising the Wasatch Front Multi-County Planning District (Figure 2-1). The other counties are Davis, Morgan, Salt Lake, and Weber. The Wasatch Front District, the most populous and urbanized district in the State, contained 67 percent of the State's population in 1970 and 64.7 percent in 1980. Between 1970 and 1980, the district grew by 32.7 percent, while the rest of the State grew by 48.6 percent. The district's growth was negatively impacted by population declines in the cities of Salt Lake and Ogden. At the same time, smaller cities and unincorporated areas to the south and east of Salt Lake City, outside the Wasatch Front District, grew at rates of 50 percent or more in many cases.

Tooele County, west of Salt Lake City, has exhibited a slower growth rate than most other Wasatch Front counties. Population growth in Tooele County has been subject to major fluctuations, reflecting mining and military activities. From 1950 to 1970, the total county population increased 47.2 percent, from 14,636 to 21,545.

The greatest portion of population increases occurred in three distinct time periods: 1950-1952, 1961-1963, and 1965-1968. These were related directly to government military employment connected with war activity in Korea and Vietnam. The lack of significant employment generators and the arid nature of this county have prevented large population concentrations. In addition, the heavy federal ownership of land in this part of the State reduces the acreage available for private development. There are signs, however, that given the right conditions, bedroom-type communities could develop in Tooele County servicing Salt Lake City.

Within Tooele County, growth is concentrated in areas along highway Interstate 80 and in proximity to N-TEAD. Cities in these areas, such as Tooele and Grantsville, have had positive growth, while the more southern areas of Stockton, Rush Valley, and Ophir have experienced a definite population loss. A profile of growth within Tooele County is provided in Table 2-1.

The population of the area surrounding N-TEAD, primarily Tooele County, has increased approximately 20.8 percent during the period 1970-1980, while Tooele City has experienced an 14.3 percent increase, according to preliminary 1980 census figures. Since 1980, population growth in Tooele County has practically ceased, primarily as a result of drastic cutbacks in the local mining industry. During this period, Anaconda dropped from a workforce of more than 700 to a caretaker force of less than 20. Kennecott Copper has reduced from a 7,000-plus workforce to an approximately workforce of 2,100 and the Mercur gold mine operation has changed hands several times and is reducing its scope of operations.

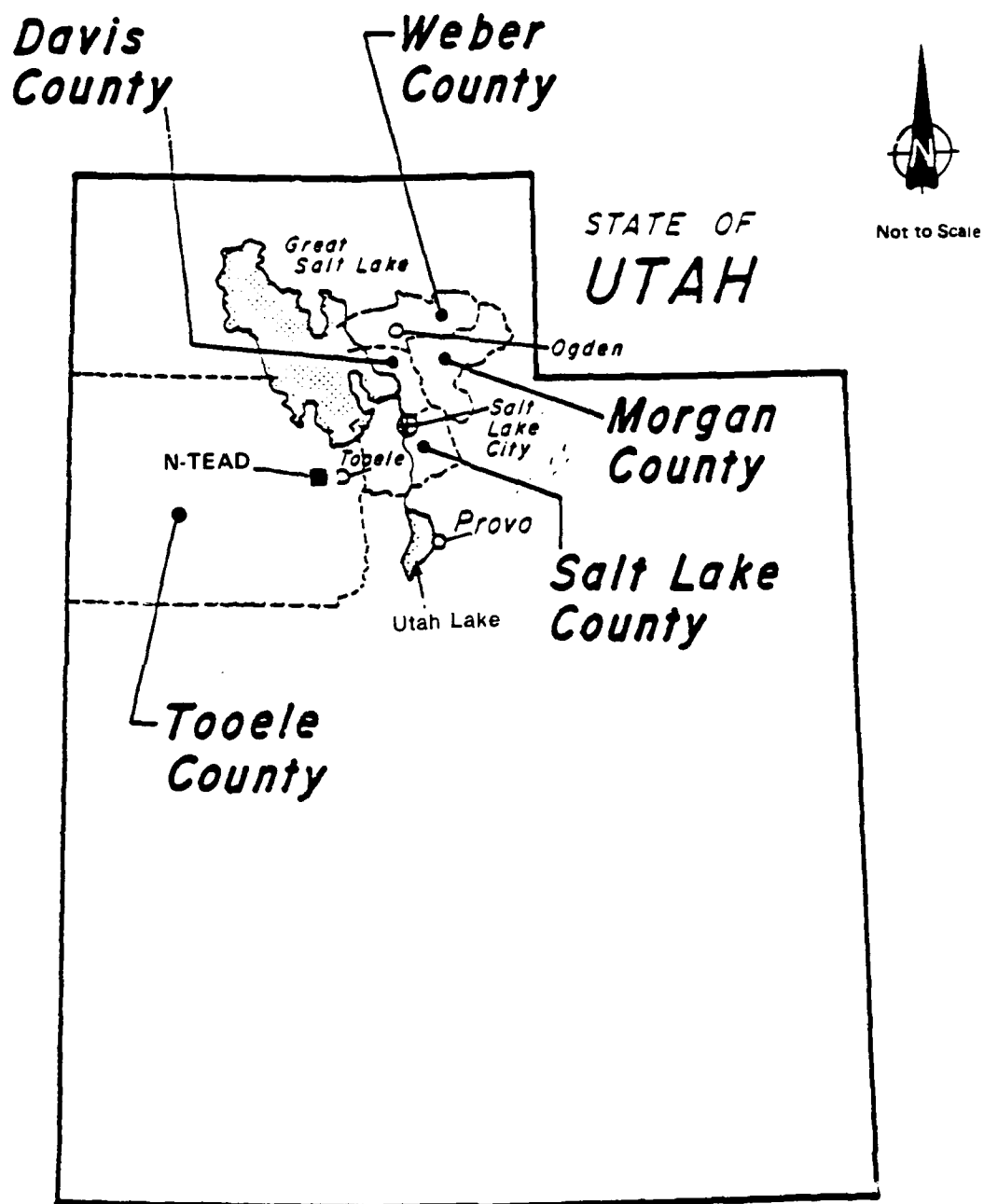


Figure 2-1. Wasatch Front Multi-County Planning District.

TABLE 2-1 POPULATION IN TOOELE COUNTY, 1970-1980

	<u>1970</u>	<u>1980</u>	<u>% Change</u>
Tooele County	21,545	26,033	20.8
Unincorporated areas	4,208	5,164	22.7
Incorporated areas	17,337	20,869	20.4
Tooele City	12,539	14,335	14.3
Grantsville City	2,931	4,419	50.8
Stockton Town	469	437	-6.8
Rush Valley Town	541	356	-34.2
Vernon Town	NA	181	--
Ophir Town	76	42	-44.7

Source: U.S. Department of Commerce, Bureau of Census,
1980 Census of Population and Housing; March
1981.

The Tooele County Master Plan predicts a 60 percent increase in County population between 1980 and 1990 (U.S. Army 1982 and Tooele Army Depot 1985a).

2.1.2 Land Use

N-TEAD is located in Tooele Valley, which is bounded on the north by the Great Salt Lake, on the east by the Oquirrh Mountains, on the south by South Mountain, and on the west by the Stansbury Mountains. With the exception of Grantsville, City of Tooele, Stockton, and occasional residential development north of City of Tooele, Tooele Valley is predominantly undeveloped. Grazing and limited cultivation predominate. Grantsville is located approximately 2 miles north of the northwest corner of N-TEAD; City of Tooele lies adjacent to the northeast corner; and Stockton is located approximately 3 miles to the south along State Route (SR) 36.

With the exception of the City of Tooele, properties immediately adjacent to the N-TEAD boundaries are undeveloped. The properties to the north are used as pasture or cultivated, and the properties to the west and south are used for rangeland grazing. The properties to the east of N-TEAD consist of the City of Tooele and undeveloped rangeland along the lower western slopes of the Oquirrh Mountains. Scattered gravel pits are also located southeast of N-TEAD along SR 36. With the exception of the southeastern portion (bounded by SR 36), N-TEAD is bounded on the east by Union Pacific Railroad right-of-way. Residential development within the City of Tooele boundaries abuts the northern boundary of this portion of N-TEAD. The Tooele Municipal Airport and some scattered residential uses are located along the eastern boundary north to SR 112. SR 112 forms the northeastern boundary of N-TEAD. The area northeast of SR 112 is presently undeveloped.

Land use guidelines for Tooele County are provided in "A Master Plan For Tooele County" (1972), and the "Tooele County Zoning Ordinance and Map" (October 1981). The master plan map designates the area surrounding N-TEAD as MU-40 (with the exception of the area included within the corporate limits of Tooele City). The county zoning map designates the area south and west of N-TEAD as MU-40; the area to the north as A-20, RR-10, and M-D; and the unincorporated area to the east as RR-5 and M-D. Figure 2-2 shows the existing zoning for Tooele County and N-TEAD.

The MU-40 or Multiple Use District is intended as a low-density zone with limited human habitation and public utility/service requirements. The primary uses are agricultural and open space. The minimum parcel size per dwelling unit is 40 acres.

The A-20 or Agricultural District is intended to promote and preserve conditions favorable to agriculture in appropriate areas and to maintain greenbelt open spaces. The minimum parcel size for dwelling units within this district is 20 acres.

The RR-10 or Rural Residential District is intended to promote and preserve conditions favorable to large-lot family life, the keeping of limited numbers of animals and fowl, and reduced requirements for public

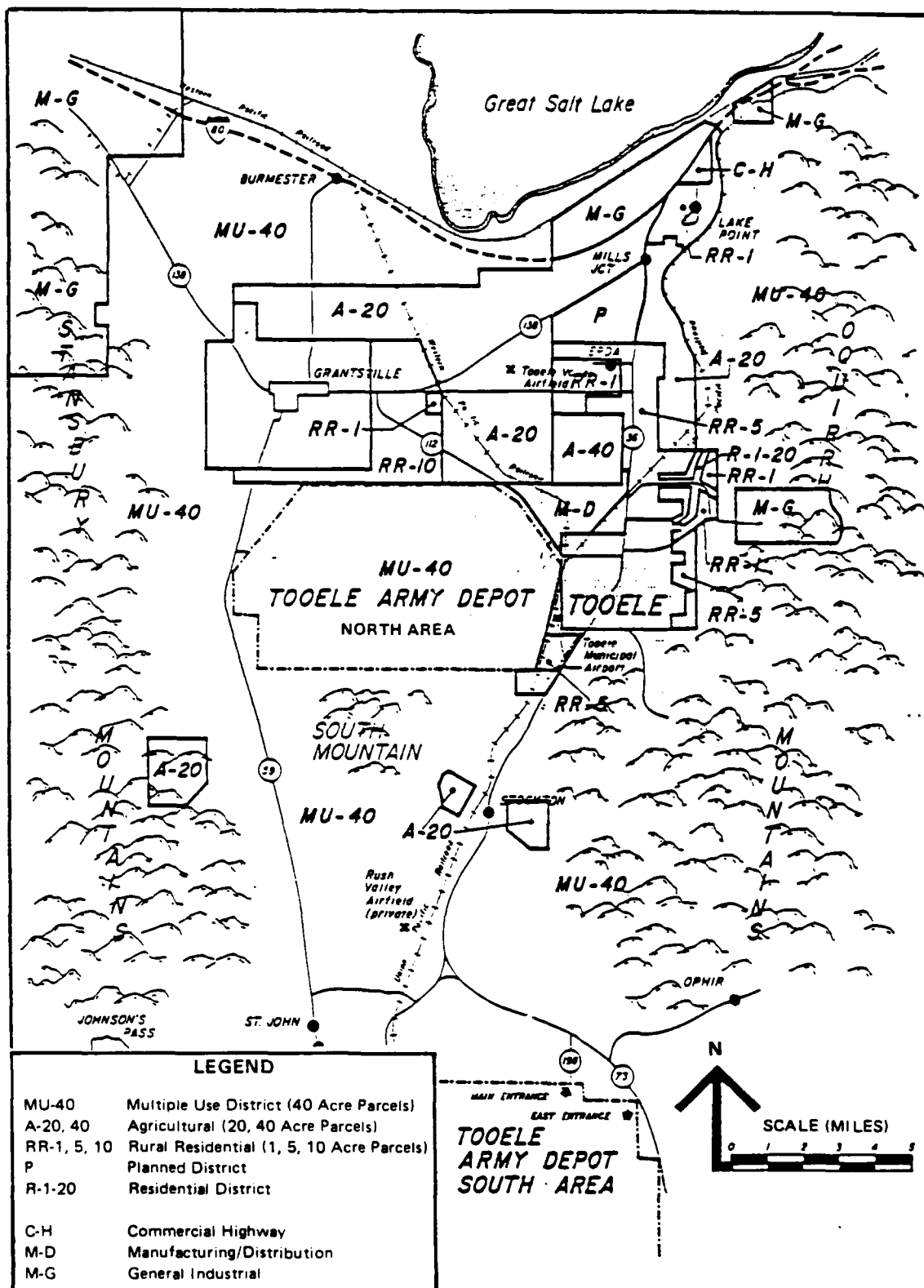


Figure 2-2. Tooele County Zoning Map.

utilities. The minimum lot size per dwelling unit is 10 acres. The RR-5 District has the same intent as the RR-10 District, but the minimum allowable lot size is five acres.

The M-D or Manufacturing-Distribution District is intended to provide areas for light manufacturing, industrial processes, and warehousing that do not produce objectionable effects (U.S. Army 1982).

Land use activity areas on N-TEAD are shown on Figure 2-3. Table 2-2 lists the major land uses and the approximate acreage devoted to each type of use. The following discussion briefly outlines the activities that take place within the designated land use areas.

The igloo storage area, located within the central portion of the Depot, constitutes the predominant land uses of N-TEAD. Various munitions are transported to and stored in this area by truck or rail. The rail system serves various loading areas, which are linked to the 960 storage igloos (over 1.8 million square feet of storage) by an internal road system.

The open revetment storage area consists of open earth revetments which have been used in the past for munitions storage. With the exception of sporadic inert materials storage (packing cases, empty cannisters) no use is presently made of this area, which is served by an internal road system.

The open storage areas, which are located around the warehouse and supply area, maintenance area, and Defense Property Disposal Office (DPDO) yard are used for storing various types of material and military equipment. Material and equipment are stored, generally on a temporary basis, for rehabilitation or future permanent storage. A grid road network also serves these areas, which are predominantly prepared earth surfaces.

The buffer areas are essentially non-use areas which extend along the periphery of the Depot. The primary purpose of these areas is to provide open buffers from the munitions storage areas. The reserve training maneuver areas are located within the southern buffer area.

The ammunition demolition area is located in the southwestern corner of the Depot. This area is used to dispose of obsolete munitions materials by demolition. The area consists of control facilities and open areas where munitions are buried for demolition. A burning area for dunnage and other contaminated materials is also located in the demolition area. Once these materials are burned, these trench pits are covered with soil.

Ammunition maintenance and ammunition workshop areas include three areas located on the southwestern periphery of the igloo storage area. These areas contain maintenance buildings and loading areas served by rail and truck where maintenance of various munitions types ranging from small arms to guided missiles takes place.

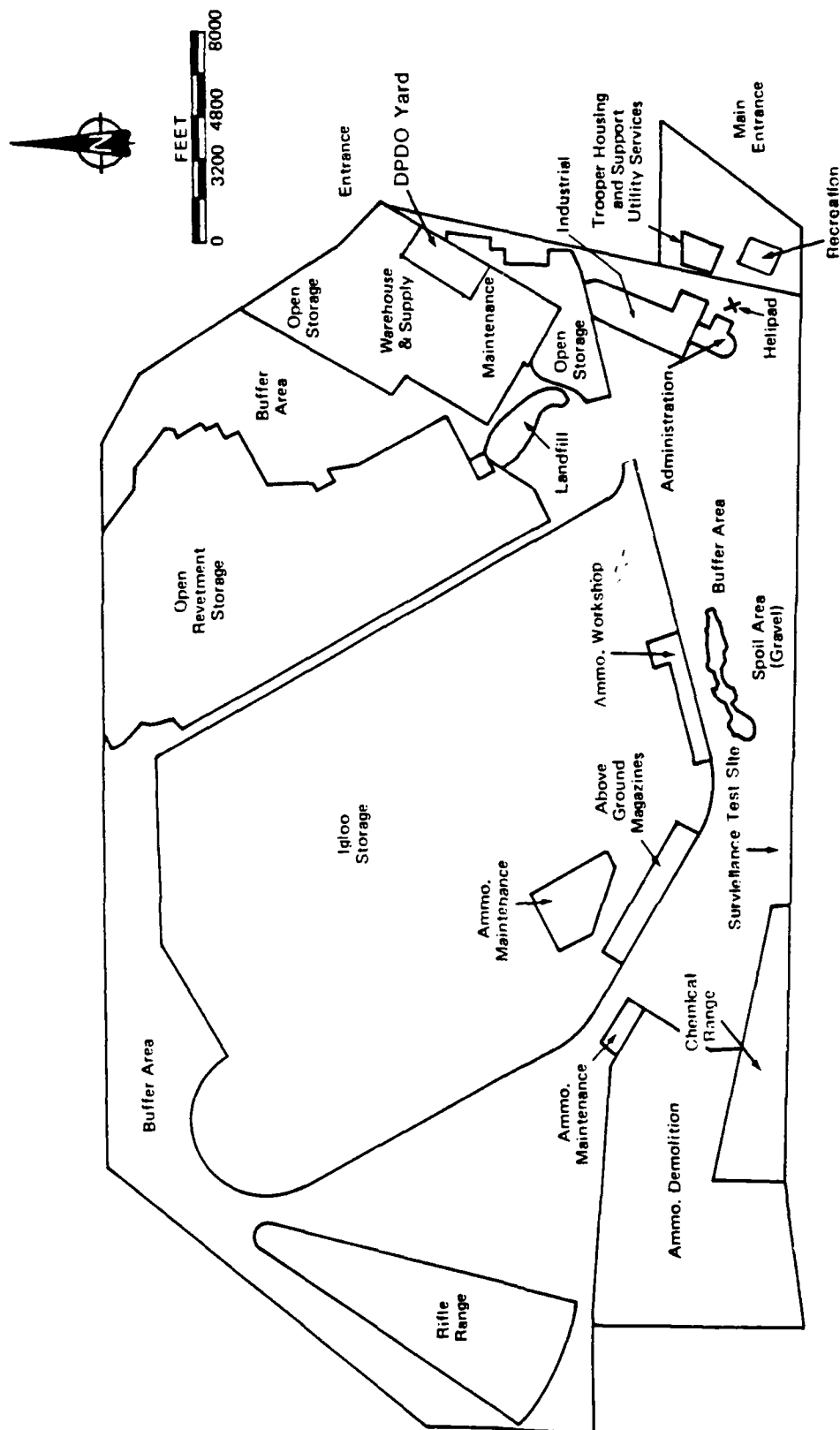


Figure 2-3. N-TEAD Land Use Map.

TABLE 2-2 LAND USE ON N-TEAD

Use	Acreage
Igloo Storage Area	9,930
Open Revetment Storage Area	2,890
Open Storage Areas	730
Buffer Areas	6,705
Ammunition Demolition	1,605
Ammunition Maintenance Areas	310
Above-Ground Magazines	130
Chemical Range	380
Rifle Range	930
Spoil Area	55
Landfill	115
Warehouse and Supply Area	345
Maintenance Area	195
DPDO Yard	35
Industrial Area	220
Administrative Areas	50
Medical Area	20
Utility Services Area	5
Troop Housing and Support Area	30
Recreational Areas	50
Total	24,730

Source: U.S. Army 1982.

Above-ground magazines are also located along the southwestern periphery of the igloo storage areas. This area consists of concrete block and reinforced block buildings which are used for munitions storage. Rail and truck access is provided to the magazines.

The chemical range is located along the western portion of the southern boundary of N-TEAD. This area is no longer in active use (except for flare usage) because the safety cone extends beyond the Depot boundaries.

The rifle range is located near the western periphery of the Depot. The range is used infrequently for small weapons (up to M-60 machine gun) target practice. The range is under control of the 96th ARCOM (stationed in Fort Douglas, Utah) and is available 24 hours per day 365 days per year. Usage in recent years has amounted to 5-10 days per year.

The spoil area is a repository for excess and unsuitable soil material.

The landfill is located south of the warehouse and supply areas. It is used to dispose of non-toxic and uncontaminated solid waste materials. Such materials are deposited in pits and overcovered by soil.

Warehouses within the warehouse and supply area are used for long-term storage of specialized vehicles. They have controlled humidity and a series of metal tanks with sealed doors which allow a controlled atmosphere for long-term storage. There are 10 warehouse "tank farms" used for long-term storage of specialized vehicles. The supply area contains 26 large general-purpose warehouses for additional storage of equipment and supplies of N-TEAD. To the north of this is located a modern tank repair facility used to support engineer equipment rebuilding. The area is served by both truck and rail.

Several maintenance buildings are located within the maintenance area. These facilities accommodate paint dunnage, equipment maintenance, repair, handling inspection, and ammunition. Altogether, there are 877,776 square feet of building space within this area, which is served by both truck and rail.

The DPDO yard, located adjacent to the eastern side of the warehouse and supply area, consists of an open storage area and several steel buildings. This area is used for temporary storage of surplus material. The area is provided with rail and truck access.

The industrial area consists of several warehouse structures which are used for Depot maintenance support activities. These activities include buildings and grounds; planning and administrative functions; electrical utilities, and sanitation systems maintenance; automotive, rail equipment, and mobile equipment maintenance; pest control; tool cribs; etc. The area between the building area (east of the supply and maintenance road) and the eastern Depot boundary is undeveloped.

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There are two administrative areas used for general Depot administrative support functions. The headquarters area is located adjacent to and south of the industrial and medical areas. This area also contains the fire station, a community club, and an officers' housing area. The other administrative area is in the southeast corner of the Depot, which houses the security division and other administrative functions.

The medical area consists of a complex of buildings housing the Depot health facilities.

The utility services area contains one of the Depot's water tanks.

The troop housing and support area is used for troop housing during reserve forces training. This area contains 25 two-story barracks, 5 mess halls, and an administration building. The reserves also use the rifle range and two maneuver areas on the Depot. The maneuver areas are located west of the main administrative area and between the Ethiopian Dam and the chemical firing range. No permanent facilities are located within these maneuver areas.

The most important of the recreational areas at N-TEAD is located in the southeast corner of the Depot. The Non-Commissioned Officer's (NCO) Club, credit union, TEAD travel club, and other facilities are located within this area. A gymnasium and pool are located adjacent to this use area in the administrative area. Other recreational facilities are located in several other parts of the Depot.

2.1.3 Historical and Archaeological Resources

Tooele Valley has supported four separate Indian cultures. The Early Desert Archaic culture inhabited the area some 11,000 years ago, followed by the Late Desert Archaic, Fremont, and Numic-speaking cultures.

The late Desert Archaic culture (ca. 3600 B.C. to ca. 600 B.C.) moved upland when the marshy areas around Lake Bonneville dried up and the lake receded. Their stone tools and artifacts are believed to have been the same as those used by the Early Desert Archaics.

The Fremont culture (ca. 700 A.D. to ca. 1400 A.D.) was the most important in the area from an archaeological perspective. The Fremonts were horticulturally oriented, augmenting their diet with hunting. Fremont hunting and recreational sites are located in the Sandy Hills Area. Pottery and bows and arrows were used by the Fremonts and some artifacts have been found in this area. The Fremonts set up a community on South Willow Creek with over 100 pit dwellings along the banks on land either owned or controlled in part by the Depot. Eight of the dwellings are within the Depot's perimeter fence and are relatively undisturbed. The dwellings off the Depot have been severely damaged by archaeological excavation in the past. An 80-acre reservoir is planned by the Utah Department of Natural Resources for South Willow Creek abutting the Depot. The planned reservoir would inundate the majority of the Fremont sites off the Depot.

The Numic-speaking culture (Shoshones) was the last Indian culture in the vicinity. This tribe appeared 100-200 years before the Freemont culture disappeared. The Numic-speaking culture, which was a more nomadic hunting culture than the Freemont peoples, adapted to the increased aridity and still live nearby on the Coshute Reservation and the Skull Valley Indian Reservation.

A 4-foot high by 5-foot in diameter rock was found in the northeast portion of N-TEAD, covered with petroglyphs in a deteriorated state. Although the petroglyph was found in an area of rock outcropping, no other petroglyphs have been found. To date, no action has been taken to protect the rock from further deterioration. The petroglyph has been nominated for inclusion in the National Historical Register.

Additional traces of prehistoric habitation have recently been uncovered near the western boundary of N-TEAD, within the limits of the installation. The extent and importance of this site have not yet been determined.

Early Pioneers in the valley planted hundreds of trees to beautify homes and streets. There were fine orchards for many years in the Tooele, Erda, and Grantsville areas, but agriculture did not flourish because of a limited water supply and an abundance of insects.

The valley continued to be used for grazing (primarily sheep) and in 1869, when the first railroad entered the valley, agriculture became a major industry. Heavy use of the valley led to overgrazing; and within 30 years from the arrival of the first settlers, major portions of the valley constituted a dust bowl.

Between 1826 and 1847, several explorers passed through Tooele Valley. James Clyman explored in the Great Salt Lake area in Tooele County by boat, seeking a water access to California. Other early explorers included Jedediah Smith, John Bidwell, Captain John Freemont, and Miles Goodyear. Beginning in 1846, the valley was also traversed by several wagon trains. Stock grazing began in Tooele Valley during 1848; and in 1849, the first permanent settlers entered the valley and built a saw mill at Settlement Canyon. Grantsville was settled soon afterward.

The county was first settled by Mormon ranchers and farmers. The first families located at Settlement Canyon Creek near Tooele, and Tooele officially became a county on 31 January 1850. The County Seat rotated among Tooele, Richville (present Mill Pond area), and Grantsville until 1867, when a Court House and a County Seat were permanently located in Tooele City.

Mining began in 1859 and has played a major economic and environmental role since. The population of miners has varied throughout the years, dependent upon demand and new discoveries. This has resulted in a creation of several "ghost towns" in the area.

There are 43 "potential" historic sites in Tooele County, including old trails, cemeteries, Pony Express stations, mills, and ghost towns. Three are in the City of Tooele: (1) a log cabin, (2) a plastered adobe house, and (3) the Tooele County Courthouse.

2.2 NATURAL RESOURCES

2.2.1 Flora

Climate has had a profound influence on the flora of Tooele Valley. Drought conditions are especially critical to plant growth and reproduction. The lack of precipitation, low humidity, and light winds have forced plants to adapt to a very high rate of evapotranspiration.

Temperature is also critical in the growth and reproduction of plants in the area. The "killing frost" period normally occurs from 25 October to 1 April. Most plants in the area are either dormant (perennials) or in seed form (annuals). The summer heat causes many of the plants to enter another period of dormancy. These climatic conditions limit the periods of growth and reproduction to the cooler and wetter periods between 1 April and 25 October, unless they are adapted, like the phreatophytes, to tap groundwater.

Soils are a significant determinant of flora in the area. Some of the soils are nearly impervious to water and root action. Other soils lack sufficient nutrients to support much plant life. Soils may also have a limiting pH; most of the area's soils are alkaline. In addition, saline soils exist in numerous areas. Many plants have adapted to these conditions, as well as low soil moisture content, lack of humus, high mineral ion content, and varying soil depths and types, but these factors also tend to limit the number of plants.

Surface water in the area is limited. Lack of surface water and topsoil moisture has forced root adaptations, such as the development of roots reaching groundwater and the development of plants with expanded shallow roots that gather precipitation quickly after a rainfall. Surface water also leaches out minerals and due to rapid evaporation, mineral salts are concentrated on the surface or just below it.

N-TEAD is in the area classified as an *Artemisia* Biome, which is characterized by sagebrush (*Artemisia*) and saltbrush. This general classification is broken down into smaller areas (ranges) based on predominant vegetation types and soil ranges (Figures 2-4 and 3-7).

The Desert Bench Range has medium surface soil and slowly permeable subsoil. The dominant vegetation is winterfat, budsage, Indian ricegrass, and western wheatgrass. There are low areas within this range that support greasewood, shadscale, and gray Molly. In areas where puddling occurs after a heavy rainfall, greasewood and inkweed are dominant.

The Sandy Hills Range has two soil types. The first and most westerly has moderately light surface soil texture and rapidly permeable subsoil. The dominant plants are juniper, low sagebrush, big sagebrush, ephedra,

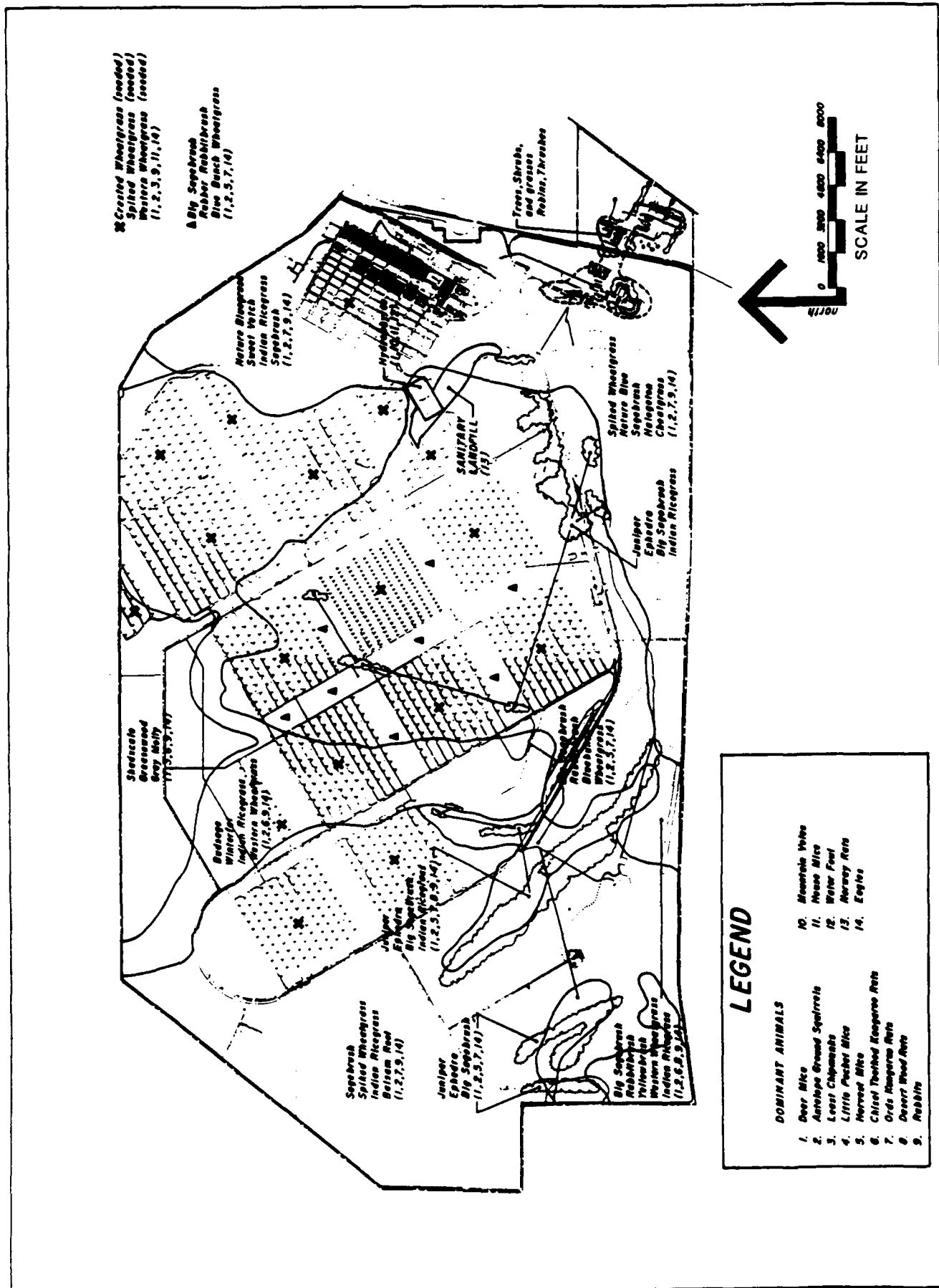


Figure 2-4. Dominant Plant and Animal Communities Within N-TEAD.

Indian ricegrass, sand dropseed, shadscale, and needle and thread grass. The second and central soil type has moderately light surface soil texture and rapidly permeable subsoil. Dominant vegetation consists of juniper, big sagebrush, ephedra, sand dropseed, and Indian ricegrass. In areas not covered by the juniper trees, the dominant vegetation is big sagebrush, rubber rabbitbrush, bluebunch wheatgrass, Indian ricegrass, and sand dropseed. The lower parts of both areas have big sagebrush, greasewood, gray Molly, shadscale, and horsebrush.

The Foothill Range has three soil types. The first is in the eastern part of the range and has a gravelly surface condition consisting of gravel or cobble mixed with medium-textured soil material. The dominant vegetation is spiked wheatgrass, nature blue, thread and needle grass, western wheatgrass, Indian ricegrass, sweet vetch, balsam root, and yarrow. This area is being invaded by low sagebrush and big sagebrush. To the southeast, the Foothill Range has medium-textured soil and moderately permeable subsoil. The dominant vegetation for this area is spiked wheatgrass, nature blue, needle and thread grass, western wheatgrass, Indian ricegrass, sweet vetch, balsam root, and yarrow. This range is also being invaded by Hologeton and cheatgrass. The third soil type is in the south and southwest areas of the range. It is gravelly or cobbly without medium-textured soil. The dominant species here are Indian ricegrass, spiked wheatgrass, nature blue, needle and thread grass, western wheatgrass, sweet vetch, balsam root, and yarrow. This area has pockets of big sagebrush and shadscale.

The Upland Loam Range has two soil types. The first, toward the southwest corner of the Depot, has medium surface soil texture and lowly permeable subsoil. The second, near the south boundary of the Depot, has moderate-texture surface soil with moderately permeable subsoil. In both areas, the dominant plants are cheatgrass, Indian ricegrass, snakeweed, and fescue; also present are big sagebrush, bitter vetch, yellow brush, lupine, rabbitbrush, and paint brush (U.S. Army 1982).

2.2.2 Fauna

The condensed growth and reproduction periods of the plant communities in Tooele Valley limit the ecological niches available to animal species. Not only is competition for food sources severe during the hot, dry summer and winter dormancy periods, but the animals must adapt to the same climatic conditions. They have adapted as hibernators, estivators, diurnals, or nocturnals, or have physiological adaptations that enable them to survive drought and heat, or cold and snow.

The vicinity of N-TEAD is inhabited by a wide variety of animal species ranging from protozoans to mammals, including 20 species of parasitic flatworms; 79 species of free-living, soil-inhabiting, or parasitic roundworms; 36 species of slugs and snails; 150 species of mites, ticks, spiders, pseudoscorpions, solpugids, and scorpions; 1,300 (and probably many more) species of insects; one species of amphibian; 6 species of lizard; 2 species of snake; 69 species of migrant birds; 11 species of winter resident birds; 71 species of summer resident birds; 63 species of birds in permanent residence; and 40 species of mammals.

Several species of game animals exist in the vicinity of N-TEAD. Mule deer, mountain cottontail, and desert cottontail inhabit the area. Fur-bearing animals include coyote and bobcat. Game birds include sage grouse, Gambel's quail, short-tailed grouse, blue grouse, ruffed grouse, and the imported ring-necked pheasant and chukar. In addition to the local game birds, there are 37 species of migratory waterfowl that use the flyways through the Depot.

Several species have been eliminated from the areas, including bison, gizzly bear, elk, black bear, pronghorned antelope, and mountain sheep. The mountain sheep, pronghorned antelope, and elk have been or are being reintroduced, mainly in the mountains.

There are 603 verified species of vertebrate wildlife in Utah. Of these, 507 are protected by the Division of Wildlife Resources of the Utah State Department of Natural Resources, including all birds, fish, amphibians, reptiles, and 29 mammals. Off-base hunting is permitted for all 57 game species (in season) and population control is largely due to hunter pressure. Management is achieved by varying the length of the season, the number of licenses, and limits. The Division of Wildlife Resources participates in range rehabilitation; studies the effects on wildlife of livestock grazing; stocks streams, ponds, and reservoirs with adapted fish; constructs desert mountain guzzlers; releases chukars and Hungarian partridge in adapted areas; develops waterfowl management areas; and surveys game. The Division of Wildlife Resources also regulates trapping under Section 23-13-2(28) of the Utah Code Annotated, as amended.

Two threatened or endangered species are known to be in the vicinity of N-TEAD: the bald eagle and the peregrine falcon. Bald eagle habitat in the area is considered critical, encompassing an extensive area in Utah, including the Depot. The area needed by the bald eagle to roost, hunt, behave normally without disruption, and provide shelter is relatively large and encompasses many smaller habitats. Bald eagles are protected by United States Code 16, Section 668-668d.

Peregrine falcons have been sighted in the area. The range of peregrine falcons has been shrinking due to housing and agricultural pressure. Its prey is being depleted by the use of pesticides and rodenticides, especially substances containing the dioxin TCDD, PCB, mercury, and/or lead. Peregrine falcons are protected by the Endangered Species Act.

Zoonotic (transmittable from animals to man) diseases reported in the area are tularemia, rabies, Rocky Mountain spotted fever, Q fever, brucellosis, encephalomyelitis, plague, psittacosis, Anthrax, and hyated disease. The instance of disease in the area is lower than in most of the country, probably due to climate and elevation. Tularemia is an exception; one of the world's epicenters for tularemia is Delta, Utah. There was an outbreak in Grantsville and Delta in 1970 (U.S. Army 1982).

2.3 CLIMATE

Tooele Valley is characterized by hot, dry summers, cool springs and falls, moderately cold winters, and a general year-round lack of precipitation. The higher elevations of the adjacent mountains experience greater amounts of precipitation and somewhat cooler temperatures.

Most precipitation occurs as snow between early fall and late spring, when the valley is affected by the continental winter storm track. Summers are generally dry, but showers and thunderstorms occur occasionally. The largest amount of precipitation occurs in the mountains, creating a potential for flash floods and erosion. Grantsville, approximately 2 miles northwest of N-TEAD, receives an average annual precipitation of 11 inches; Tooele receives an average of 16.5 inches. Figure 2-5 illustrates precipitation and prevailing winds for the area around N-TEAD.

Low humidity is a characteristic of the valley climate and visibility is generally good. During winter months, however, storm fronts are usually followed by high pressure fronts occasionally lasting for several weeks. These fronts trap the cold air in the valley, creating temperature inversions which can create significant fog and smog problems.

The Salt Lake Basin forms a large, generally enclosed air basin of 7,500 square miles. The Great Salt Lake is a shallow body of water covering approximately 2,000 square miles, which is large enough to drive a classical sea-breeze circulation. The sea-breeze circulation moving through the air basin is called the local wind circulation (LWC). The LWC is caused by the uneven heating and cooling of the land and water surface. This diurnal wind tends to blow downslope towards the lake at night, when the lake is warmer than the land. During the daytime, when the land is warmer than the lake, the winds flow upslope into the valleys and mountains. This tends to cause a mixing of air in the center of the lake along a north/south axis during the day. The LWC is the predominant wind factor in the basin and winds rarely exceed 10 mile/hour, although passing storms cause higher wind velocities. The LWC produces a constant interchange of air in the basin, but only limited exchange with air external to the basin.

The average annual temperature ranges from a high of 80° F to a low of 30° F. The highest recorded temperature during the period 1965-1975 was 110° F, while the lowest for the same period was -14° F. The average spring and fall frost dates are 1 April and 25 October, respectively (U.S. Army 1982).

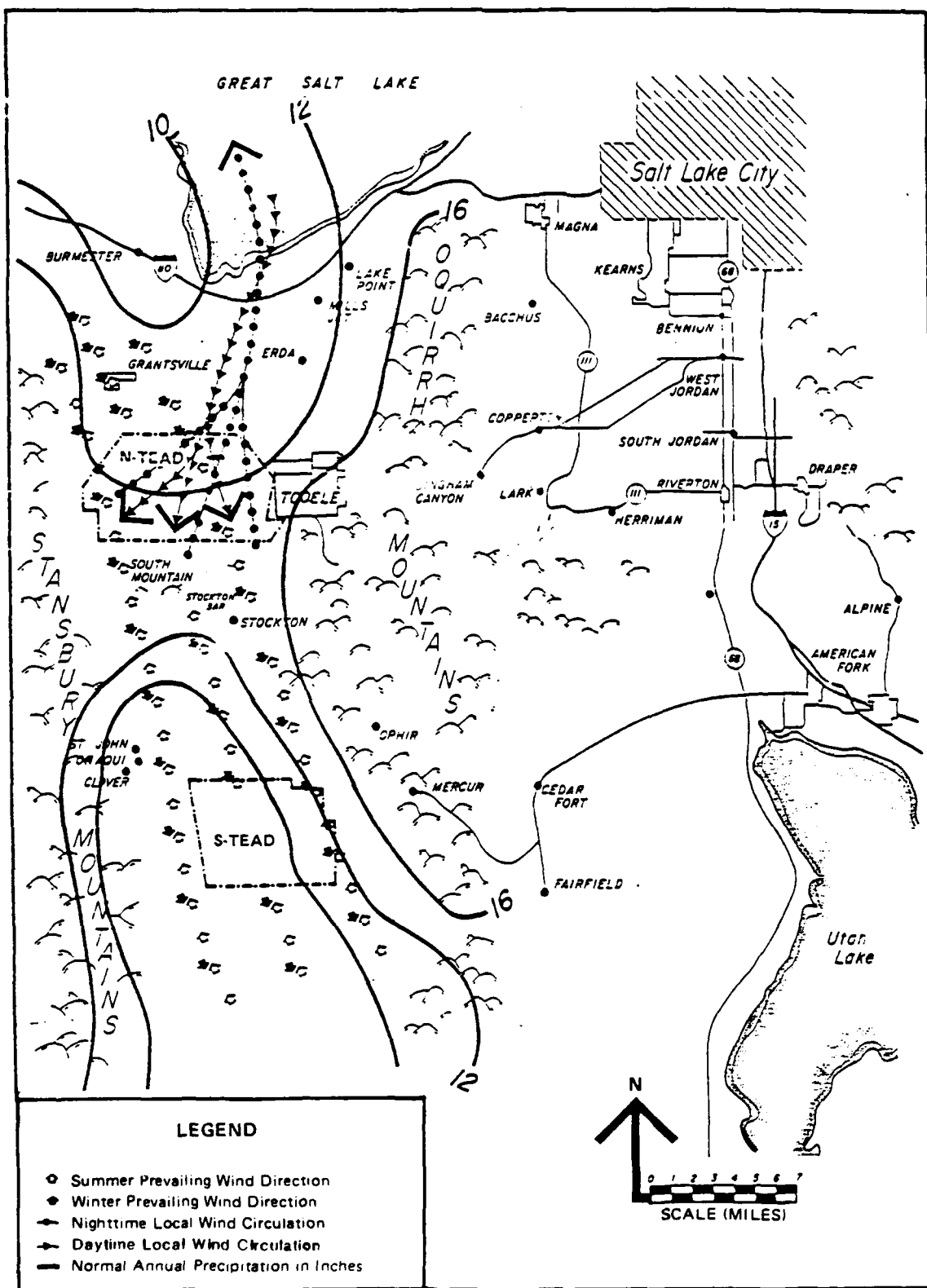


Figure 2-5. Precipitation and Prevailing Winds.

3. PHYSIOGRAPHY

3.1 REGIONAL GEOLOGY

The North Area of TEAD is located in the Basin and Range Geologic Province, approximately 35 miles west of the Wasatch Fold and Fault Belt of the Overthrust Geologic Province. The Basin and Range Province is characterized by large enechelon fault blocks bounded by "down-on-the-west" normal faults that trend approximately north to south. Movement along the faults has been extensive since the late Miocene Epoch, with displacement of hundreds to thousands of feet in places. This has promoted the formation of large interior drainage basins between the fault blocks, with extensive alluvial and lacustrine deposits forming within (Hood et al. 1969).

The North Area of TEAD is located in a large interior drainage basin (Great Salt Lake Basin), bounded on the north and east by the Great Salt Lake and Oquirrh Mountain fault block, on the south by the Sheeprock and Tintic Mountain fault blocks, and on the west by the Stansbury Mountains fault block. Displacement along the control faults has been extensive, exposing rocks ranging in age from Pre-Cambrian and Cambrian (approximately 600 million years ago) to Tertiary and Quaternary. Interspersed within these rocks are igneous (volcanic) rocks of geologically recent age (Tertiary) intruded into the fault block mountains simultaneously with fault displacement (Moore and Sorensen 1979).

Alluvial and lacustrine sediments lie in the valleys between these fault block mountains and were deposited as pediment slopes from mountain drainage courses and as lake bed deposits in the large inter-mountain Lake Bonneville of the late Tertiary Period.

The valley fill deposits consist of an older sequence of Tertiary age and a younger sequence of Quaternary age. The older sequence comprises the Salt Lake Group and consists of moderately consolidated sand, gravels, silts, and clays with an abundance of volcanic ash (Everitt and Kaliser 1980). The group is characterized by considerable deformation by tectonic processes. Razem and Steiger (1981) noted an increase in the fraction of finer-grained materials at a depth of 800-900 feet and suggest that this level may mark the top of Tertiary Age sediments.

The younger sequence of the valley fill unconformably overlies the Salt Lake Group and consists of relatively unconfined deposits of mostly unconsolidated sand, gravel, silt, and clay of Quaternary age (Everitt and Kaliser 1980). This sequence includes pre-Lake Bonneville alluvium of Pleistocene Age, Lake Bonneville deposits of Pleistocene Age, and deposits of recent age which include alluvium, lake beds, and dune sands (Gates 1965).

The sediments of the younger valley fill occur in irregular, interfingering layers. Alluvial and lacustrine deposition environments alternated several times during the Tertiary and Quaternary (Gates 1965), although alluvial processes probably dominated around basin margins, with lacustrine processes dominating toward the center. Beds of alluvial gravel thin and pinch out between beds of silt and clay towards the center of the basin (Everitt and Kaliser 1980). The regional geology of TEAD is shown in Figure 3-1.

Regional Basin and Range tectonism has resulted in the formation of a variety of mineral deposits which are extensively mined in the general area of TEAD. A listing of the mineral resources developed in the Wasatch Front is provided in Table 3-1.

3.2 REGIONAL HYDROGEOLOGY

Groundwater flow at TEAD is part of a larger regional system that includes Rush Valley and Tooele Valley. Superimposed upon the regional features, however, are local sources and sinks of water that are important in the local movement of groundwater and contaminants. Figure 3-1 illustrates this regional flow system and general directions of groundwater movement.

Groundwater within the regional flow system moves from areas of recharge to areas of discharge. The recharge areas lie along the edges of the valleys and are fed primarily by water loss from streams that originate in the mountain ranges. These streams typically disappear as they travel across the coalesced colluvial fans that slope from the mountain front generally towards the center of the valleys. Recharge from mountain streams is also concentrated along narrow zones where basin boundary faults cut across the colluvial fans.

Discharge areas for the regional flow system are of two types. Discharge may occur to adjacent flow systems through connected alluvial valleys. An example of this is the discharge of about 5,000 acre feet/year (Razem and Steiger 1981) from the Rush Valley to the Tooele Valley under the Stockton Bar. The other major type of discharge area for the regional flow system occurs in the low portions of the valleys where groundwater is lost to evapotranspiration and surface waterbodies. The major discharge area for the regional groundwater system of TEAD is the Great Salt Lake.

The quality of groundwater within Tooele Valley is generally acceptable for culinary and agricultural purposes (Gates 1965). The concentrations of dissolved solids is reported to range from 283 mg/L to 2,180 mg/L, with most of the water containing less than 1,000 mg/L. The distribution of dissolved solids in Tooele Valley is shown in Figure 3-2. Background water quality data for specific chemical compounds within groundwater of Tooele Valley are not readily available from the literature. However, the general quality of groundwater within Tooele Valley has been

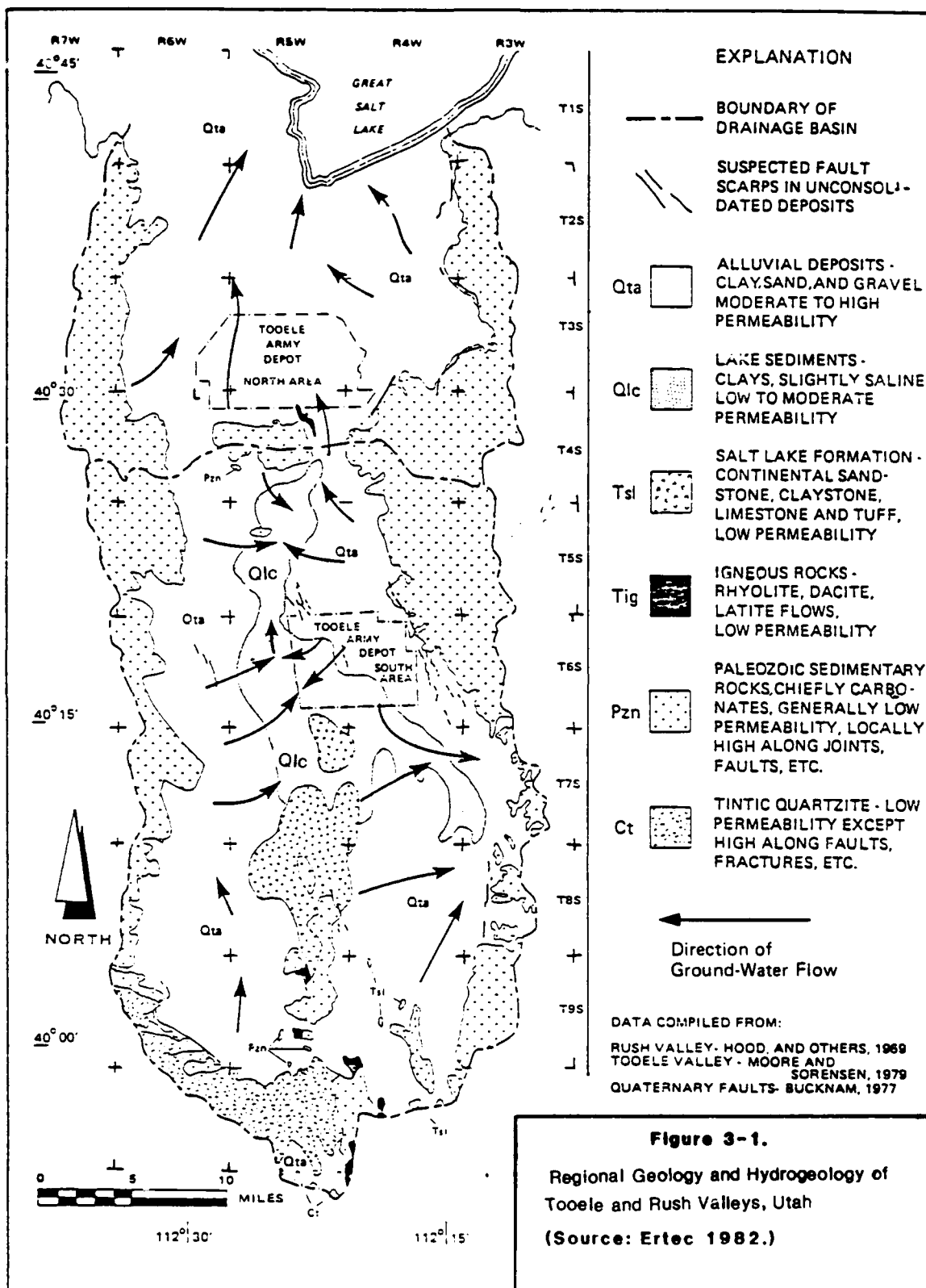


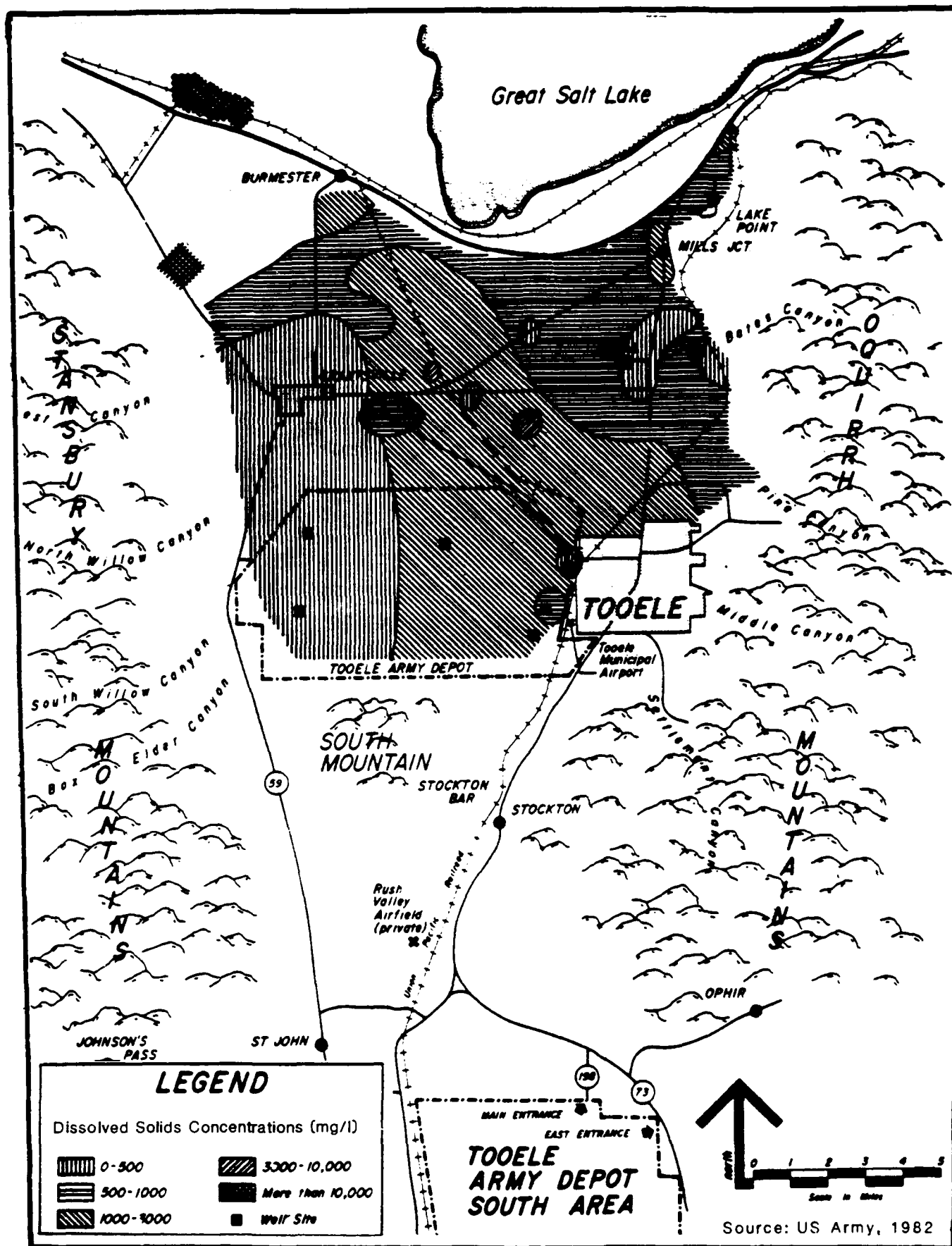
TABLE 3-1 MINERALS IN THE WASATCH FRONT

<u>Mining District and County</u>	<u>Minerals Extracted</u>
Alta, Salt Lake	Pb, Ag, Zn, Cu, Mo, Au, W, As, Bi, Sb, Mn, Ba, Fe
Big Cottonwood, Salt Lake	Pb, Ag, Zn, Cu, Au, Mo, Mg, Ba
Bingham, Salt Lake	Cu, Au, Pb, Ag, Zn, Mo, Hg, As, Bi, Sb, Se, Te, Ba
Blue Bell, Tooele	Pb, Ag, Au, Be, F, Ba
Columbia, Tooele	Pb, Ag, Cu, Zn, F
Dugway, Tooele	Pb, Ag, Zn, Cu, F, Ba
Gold Pill, Tooele	Au, Cu, Pb, Ag, Mo, W, As, Bi, Ba, Sb
Mercur, Tooele	Au, Ag, Ag, As, Sb, Te, Be
Ophir, Tooele	Cu, Au, Pb, Ag, Zn, Mn, W, Ba
Osceola, Tooele	Au, Ag, Hg, As, Sb, Te, Ba
Sierra Madre, Weber	Cu, Au, Pb, Ag, Zn, Mo, Fe
Silver Islet, Tooele	Cu, Pb, Ag, Ba
Stockton, Tooele	Cu, Au, Pb, Ag, Zn
Willow Springs, Tooele	Au, Cu, Pb, Ag, Mo, W, As, Bi, Ba, Sb

Source: Tooele Army Depot 1985b.

SYMBOLS USED:

Ag - Silver	Hg - Mercury
As - Arsenic	Mn - Manganese
Au - Gold	Mo - Molybdenum
Ba - Barium	Pb - Lead
Be - Beryllium	Sb - Antimony
Bi - Bismuth	Se - Selenium
Cu - Copper	Te - Tellurium
F - Fluorene	W - Tungsten
Fe - Iron	Zn - Zinc



**Figure 3-2. Generalized Distribution of Dissolved Solids
In Groundwater of Tooele Valley**

classified. According to Gates (1965), the principal constituents of the groundwater in Tooele Valley are calcium, sodium, chloride, magnesium, and bicarbonate. Razem and Steiger (1981) have classified groundwater in Tooele Valley into four generalized groups based on predominant cations and anions. Most of the groundwater is reportedly either a calcium magnesium bicarbonate type, a sodium chloride type, a mixture of the two types, or a mixture of the two types with sulfate as one of the major ions. The water in the southwestern part of the valley is reportedly of the calcium bicarbonate type, whereas the water in the northern and middle parts of the valley is of the sodium chloride type. The change from the calcium bicarbonate type to the sodium chloride type or a mixture of the two types occurs as a result of the dissolution of ions as the water moves from recharge areas through the valley fill, toward discharge points. A change in water-level gradients due to pumping at wells may also induce the movement of water of the sodium chloride type into areas where the water is of the calcium bicarbonate type to form a mixture of the two types. In addition, the various minerals prevalent in this region (Table 3-1) are likely resulting in the geochemical alteration of groundwater quality as it flows through Tooele Valley.

The following sections discuss the geology/hydrogeology of N-TEAD in terms of the materials comprising the aquifers; the occurrence of groundwater under confined, unconfined, and perched conditions; and the regional and local directions of movement from recharge to discharge areas, both natural and those caused by human activities at N-TEAD.

3.3 LOCAL HYDROGEOLOGY

The surficial geology of the N-TEAD is shown in Figure 3-3. The generalized composition and structure of the valley fill in Tooele Valley and at N-TEAD are shown in Figure 3-4. Valley fill deposits of lacustrine, colluvial, and alluvial sediments comprise most of the surficial geology. The valley fill is over 8,000 feet thick in the north central part of Tooele Valley and thins towards the margins (Everitt and Kaliser 1980). The valley fill is over 1,500 feet thick on the site at a well ([C-3-5]22dab) located approximately 4.5 miles northwest of N-TEAD, but it probably thins out southeast and southwest from the North Area (Razem and Steiger 1981).

The unconsolidated alluvium at TEAD is typical of alluvial fan deposits consisting of poorly sorted, clayey, silty sand, gravel and cobbles. The sand grains, gravel, and cobbles are composed of limestone, sandstone and quartzite eroded primarily from the mountains surrounding N-TEAD. Samples of the alluvium examined from this study and by James M. Montgomery (JMM) Inc., (1987) were typically yellowish brown to grayish orange with varying amounts of pink, red, black, yellow or orange quartzite fragments and/or dark gray limestone.

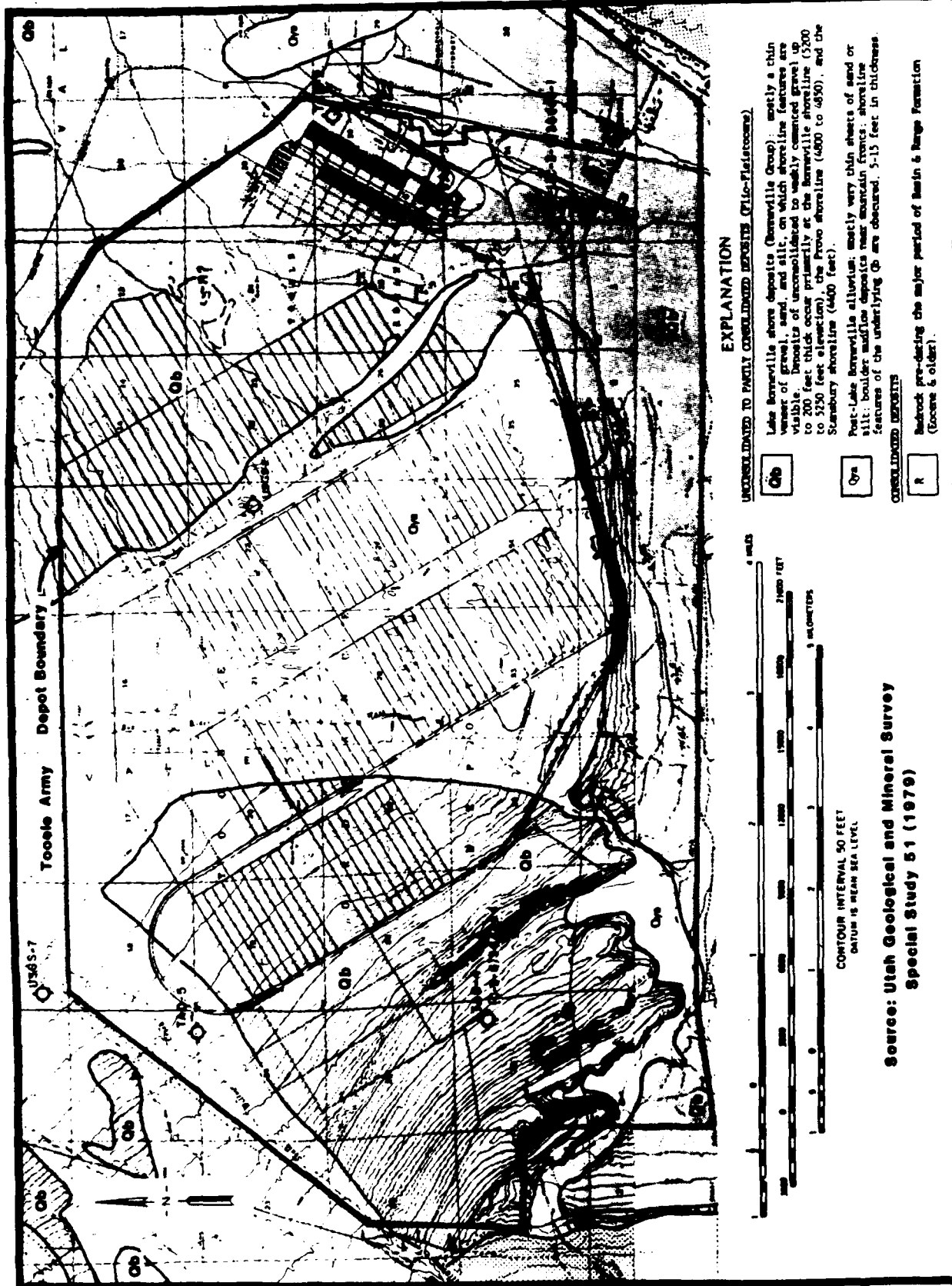
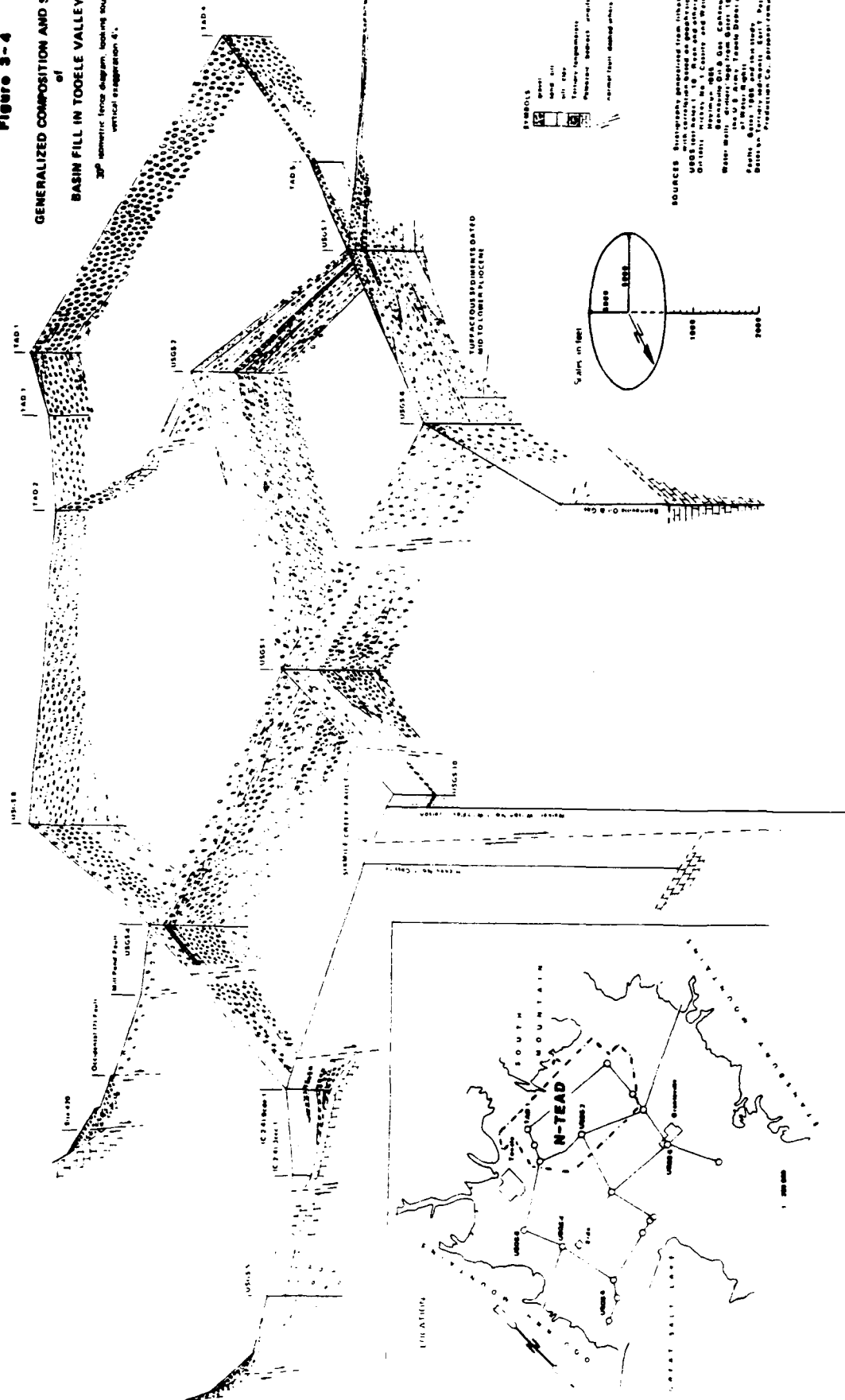


Figure 3-3. Surficial Geology of N-TEAD.

Figure 3-4



The alluvium forms a broad, gently inclined surface created by coalescing alluvial fans extending from the base of the surrounding mountains toward the center of Tooele Valley. Deposition of rock fragments, sand, silt, and clay eroded from the bordering mountains was influenced by climate, precipitation rates and periods of inundation by Lake Bonneville. Early deposited alluvial sediments were reworked or criss-crossed by erosional channels and gullies. Consequently, no alluvial units can be correlated throughout N-TEAD. Lithologic correlation is only possible between boreholes that are relatively close together.

Evidence of bedding in the alluvium is virtually non-existent, although seismic refraction surveys by Ertec (1982) indicated three distinct velocity layers which were interpreted to be colluvium, uncemented conglomerate, and cemented conglomerate in order of increasing depth. However, soil samples obtained during drilling programs by Ertec (1982), Woodward-Clyde Consultants (1985), JMM (1987), and boreholes drilled for this study have not yielded consistent evidence of cementation in the alluvium. Occasional cementation was observed in recent boreholes drilled in the easternmost third of the depot, but no correlation between boreholes was observed (JMM 1987).

Limestone and quartzite bedrock crops out in the northeastern portion of N-TEAD, and another body of rock crops out along the southern boundary. These rocks are similar to the late Paleozoic rocks that comprise the mountains on the east, south, and west of TEAD. The rocks in all three of the mountain ranges bordering the valley have been extensively folded and faulted. Gravity surveys and the many faults observed in the valley indicate that the Tooele Valley basin is probably not a single down-faulted structural depression, but is more likely a complex collection of troughs and ridges caused by several down-faulted blocks caused by Basin and Range tectonism (Ertec 1982).

Borehole and surface geophysical data obtained in the vicinity of the Industrial Waste Lagoon (IWL) indicate that bedrock in the easternmost third of the depot, occurs as an elongated block oriented generally northeast-southwest. The block is comprised of a series of northwestward dipping carbonate and quartzite strata that are bounded on the southeast by a steep escarpment, on the west by a more gradual suballuvial slope and on the northwest by a steep uniform slope (JMM 1987). The location of monitoring wells and a hydrogeologic cross-section for this area of the depot are provided in Figures 3-5 and 3-6.

Groundwater in the North Area of TEAD occurs under confined, unconfined, perched, and mounded conditions. The regional aquifer system at N-TEAD which is utilized as a water source by N-TEAD and the inhabitants of Tooele Valley, consists of both bedrock and alluvium. In the bedrock, groundwater flows through fractured sandstone, quartzite, limestone, and dolomite. In the alluvium, groundwater flows through saturated alluvial

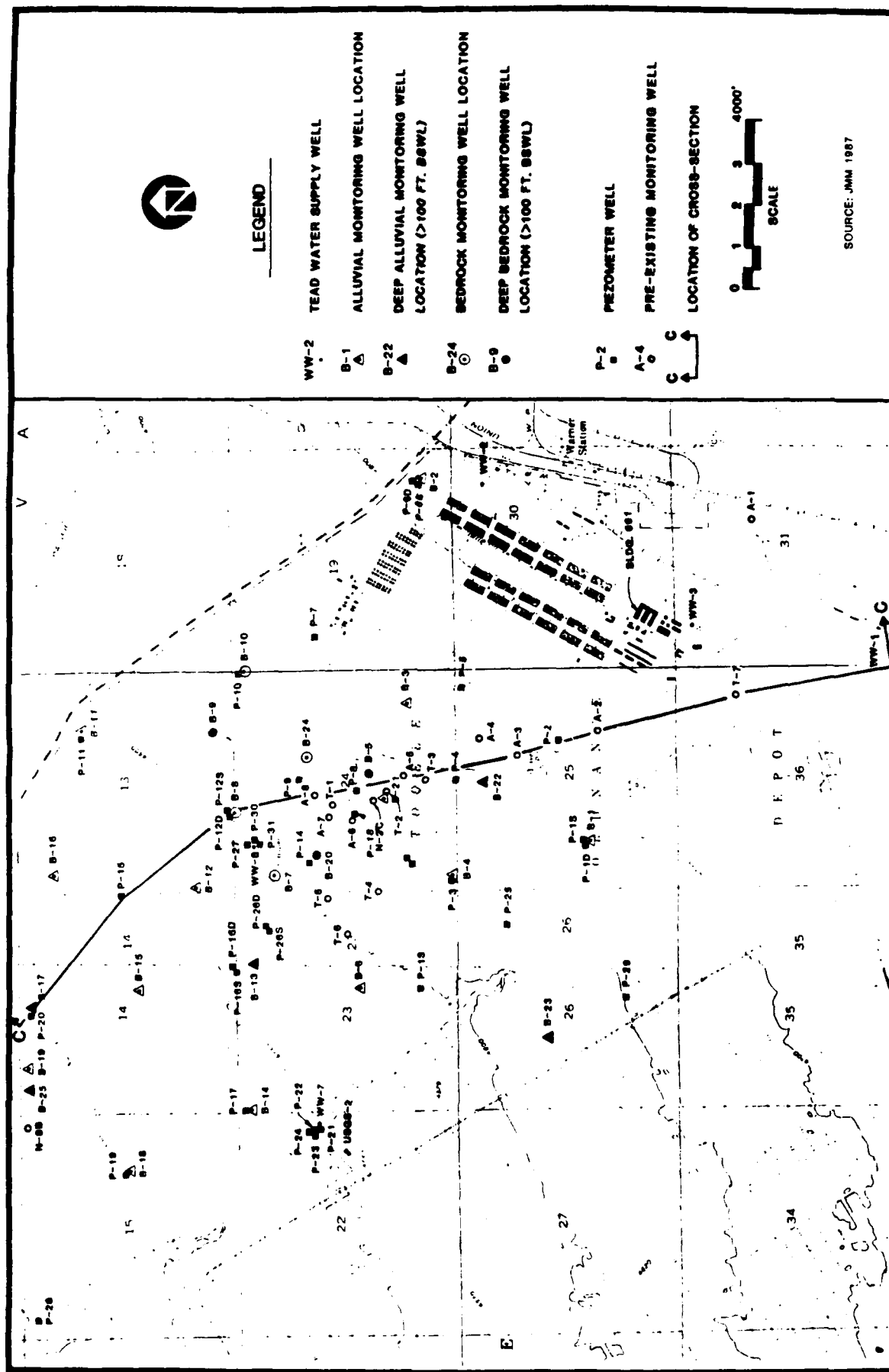


Figure 3-5. Map of Industrial Waste Lagoon Area Showing Well Locations and Cross-Section Lines.

fan deposits. This movement occurs principally as unconfined flow. Confined conditions have been reported in Tooele Valley (Razem and Steiger 1981), in bedrock along the eastern portion of N-TEAD (JMM 1987), and probably exist at depth in other areas of N-TEAD. While both the alluvium and bedrock aquifers have unique hydraulic characteristics, they readily communicate groundwater and are considered to comprise a single aquifer system (JMM 1987).

Figure 3-7 shows a generalized potentiometric contours of the unconfined regional water table aquifer, based on static water level measurement data obtained on 19 May 1986 during this study (Table 3-2). The limited number and lack of water level measurement data for the wells in the western portion of N-TEAD, prohibited contouring of that area of the depot. As is indicated in Figure 3-7, the general direction of groundwater flow is from the east and south towards the center of the valley, and ultimately north to the Great Salt Lake. The depth to static water level at N-TEAD ranges from less than 200 feet in the north central area to over 600 feet in the southwest area.

Available data regarding the rate of groundwater movement and the hydraulic characteristics of the regional aquifer system at N-TEAD are varied and conflicting. Ertec (1982) estimated the transmissivity and storage coefficient of the regional aquifer to be 60,000 square feet per day and 0.002, respectively, and estimated an average groundwater flow rate of approximately 175 feet per year. Woodward-Clyde (1985) estimated the groundwater flow rate in the eastern portion of the depot to be 665-11,000 feet per year. JMM (1987) reported hydraulic conductivities ranging from 1 gallon per day per square foot (gpd per square foot) to 30,000 gpd per square foot for valley alluvium, and 1 gpd per square foot - 200 gpd per square foot for bedrock and estimated the rate of groundwater movement to be 700-1,200 feet per year in the alluvium, and 5-600 feet per year in the bedrock, in the same area. The discrepancies in available data are likely due to such factors as lithologic and stratigraphic variability at and between aquifer test locations, differences in aquifer test methods employed, length and depth of screened interval for tested wells, and well construction/development techniques. It was not within the Work Scope of this study to evaluate the validity of available hydrogeologic data. However, due to the complexity of the hydrogeologic setting and the wide range in reported hydraulic characteristics for the underlying aquifers at N-TEAD, it appears inappropriate to extrapolate data obtained from one area of the depot and apply it to another.

Groundwater mounding from effluent seepage has been established in the vicinity of the sewage lagoons at N-TEAD. Well N-4 intercepts this mound about 1,200 feet from the lagoon. At this point, the top of the mound is approximately 34 feet above the predicted regional groundwater table. Flow lines in Figure 3-7 show the movement of groundwater away from the mounded area.

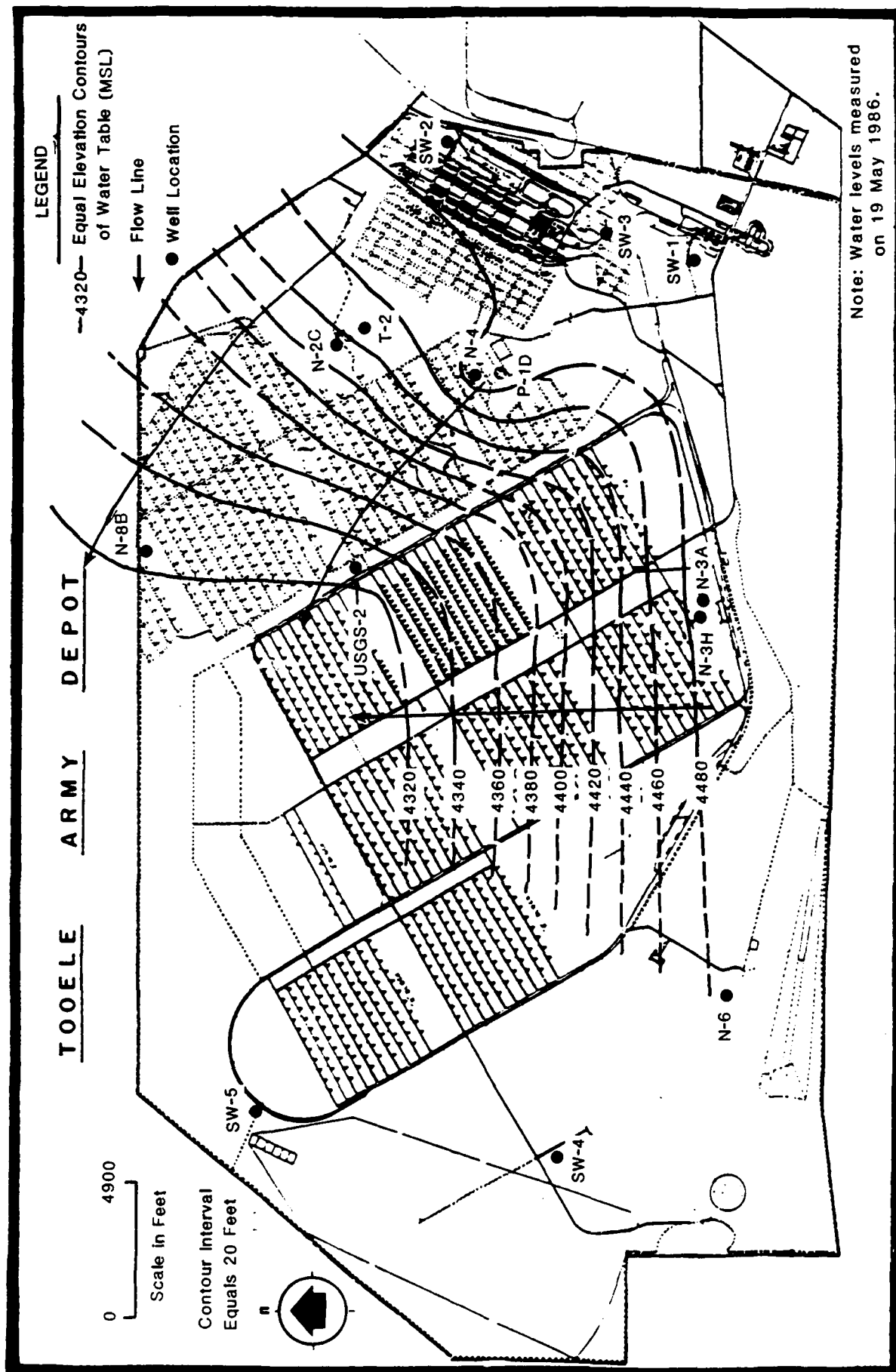


Figure 3-7. N-TEAD Potentiometric Surface Map.

TABLE 3-2 SUMMARY OF WATER LEVEL DATA OBTAINED AT N-TEAD DURING PA/SI PROGRAM

Well Number	Measure Depth (ft) to Water (BTC) ^(a)		Elevation (ft MSL) ^(b) Top of Well Casing	Water Level Elevation (ft MSL ²)	
	5/19/86	2/18/87		5/19/86	2/18/87
N-2C ^(c)	---	---	---	---	---
N-3A	242.89	242.23	4,726.63	4,483.74	4,484.40
N-3B	55.86	56.34	4,726.76	4,670.90	4,670.42
N-3C	---	dry	4,744.25	---	---
N-3D1	---	dry	4,732.07	---	---
N-3F	---	72.75	4,715.87	---	4,643.12
N-3H	---	234.38	4,716.73	---	4,482.35
N-3I	---	28.52	4,717.72	---	4,689.20
N-4	179.55	---	4,664.31	4,484.76	---
N-6 ^(c)	---	---	---	---	---
N-8B	149.93	148.22	4,473.97	4,324.04	4,325.75
P-1D	195.28	196.11	4,679.64	4,484.36	4,483.86
T-1	203.71	---	4,678.54	4,474.83	---
T-2	236.26	---	4,691.14	4,454.88	---
A-3	219.25	---	(d)	---	---
A-7	273.19	273.30	(d)	---	---

(a) BTC = Below Top of Casing.

(b) MSL = Mean Sea Level.

(c) Unable to locate well.

(d) Not available.

NOTE: Dashes (---) indicate not taken.

Continuous seepage of laundry effluent has also caused perched groundwater conditions in the area immediately beneath a small holding pond in the TNT Washout Facility Area. Perched groundwater (supported by thin clay and silt layers) was observed within surficial lacustrine deposits in this area during borehole drilling. A detailed discussion of the hydrogeology of this area is presented in Section 8.1.2.

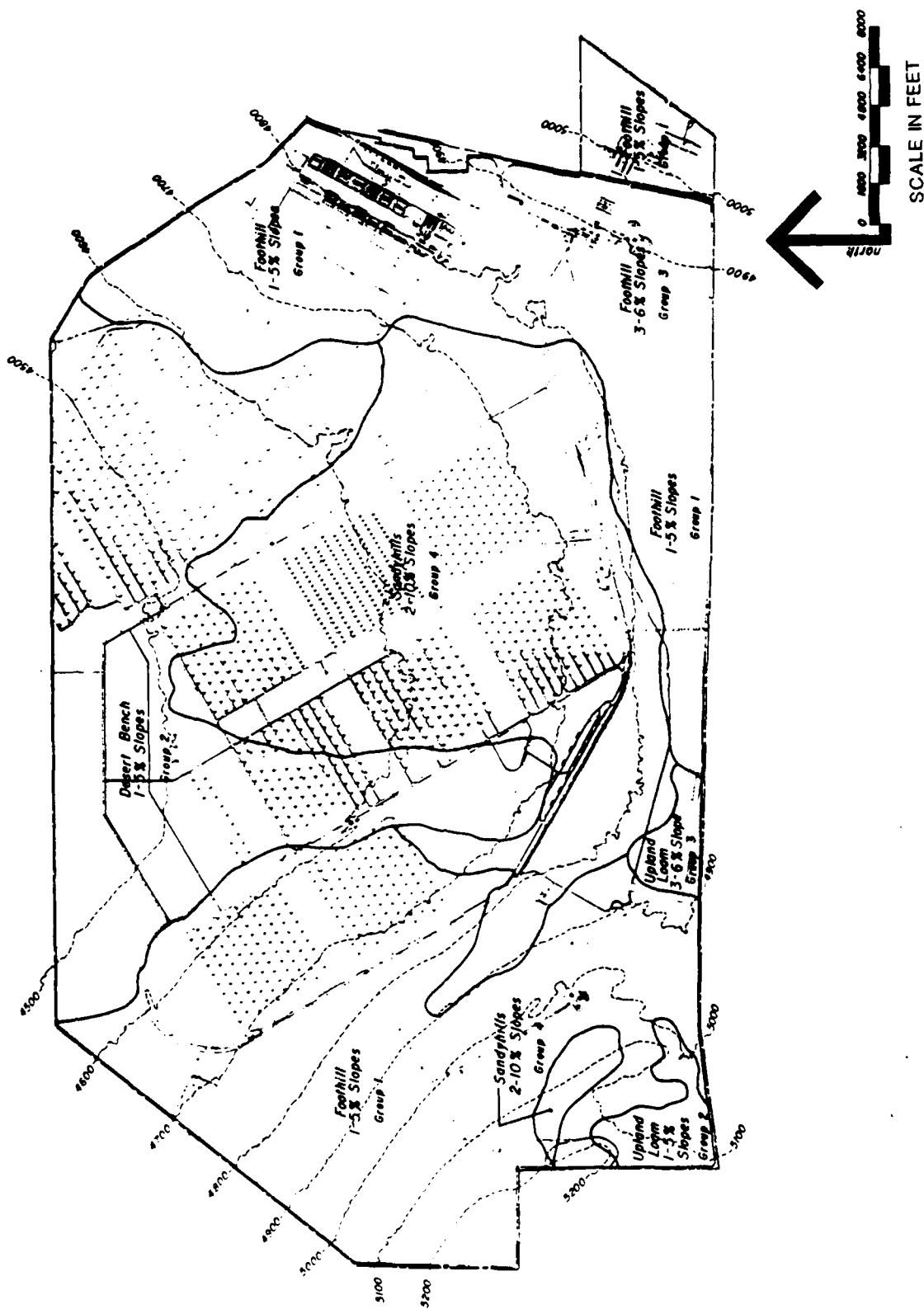
The presence of a groundwater mound and perched groundwater supported by localized clayey layers, has also been established in the vicinity of the IWL (JMM 1987). Figure 3-6 illustrates the complicated hydrogeology in this area of the depot. According to JMM (1987), groundwater enters the bedrock block in this area from the southeast, south, and northeast sides and then is retained by an apparent subsurface "dam," created by quartzite, limestone, and sandstone with clay-filled, silicified, or calcified fractures. Relatively steep potentiometric contours along the northern edge of the bedrock block reportedly indicate the presence of this dam. In an earlier study, Ertec (1982) reported the presence of a less permeable ridge in this area which was also hypothesized to "stack up" groundwater in this area. The observed pattern of relatively steep potentiometric contours along the northern edge of the bedrock block in this area may also be due to the sudden decline in hydraulic head created by fractures and faults in this area.

Distortion of regional groundwater flow through N-TEAD may also be caused by the pumping of water supply Wells 1 and 2. These wells tap the unconsolidated water table aquifer and are pumped periodically throughout the day at their rated combined capacities of approximately 560 gallons per minute (gpm). Additional groundwater discharge by large irrigation wells may occur immediately to the northwest of the northern boundary. These wells are pumped in summer months and their effect on the hydrogeology of the N-TEAD has not been determined.

3.4 LOCAL SOILS

Soil characteristics within Tooele Valley largely result from the past inundation of the valley bottoms by Pleistocene lakes. Increasing amounts of salt were deposited in the soils of Great Basin valleys by drying lakes in the Holocene Era. Today, the valley bottoms tend to be saline, the middle slopes slightly saline, and the upper parts of the valleys non-saline.

The North Area of TEAD has mostly deep soils which are arable and non-saline. However, the soils are generally low in fertility and are farmed only under irrigation (U.S. Army 1982). Four general soils groups occur on N-TEAD (Figure 3-8). Group 1 is a relatively thin loamy soil over either gravel or a sand and gravel mixture. It covers 42 percent of the site, on slopes of 1-5 percent on the higher eastern and western parts of the facility. Group 2 is a deep loam or silty loam overlying silty or gravelly clay loam. These soils are moderately saline and alkaline,



SOURCE: U.S. Army, 1982

Figure 3-8. N-TEAD Soils and Topography.

exhibit some gullying under native conditions, and may be poorly drained. They occupy one-fourth of the site, mostly in lower portions of the northern site and extending up drainages. Group 3 are medium textured deep loams over a loam subsoil, covering 8 percent of the site. Group 4 are deep sandy loams, occupying 25 percent of the site, mostly in the center. They are highly susceptible to wind erosion, and experienced heavy erosion and devegetation in the 1930s.

Group 2 soils have high water erosion potential, while the remainder have moderate water erosion potential. About 1,600 acres have been over-covered or used for open storage. Additional areas may have been impacted during the facility's operation by compaction, mechanical disruption, or contamination.

3.5 LOCAL TOPOGRAPHY AND SURFACE DRAINAGE

The topography of TEAD North and surrounding area is illustrated in Figure 3-8. The North Area of the TEAD is located in Tooele Valley, which is a northward plunging structural basin flanked by coalescing alluvial fans that slope generally to the north at about 40 feet per mile and have been greatly modified by the shoreline erosion of Lake Bonneville (Everitt and Kaliser 1980). The valley is bordered on the north by the Great Salt Lake at an elevation of 4,200 feet. The valley is bordered by the Oquirrh Mountains to the east and the Stansbury Mountains to the west. Maximum elevations of these mountains are 10,350 feet and 11,031 feet, respectively. Tooele Valley is separated from Rush Valley to the south by South Mountain, a low transverse divide, and by the Stockton Bar, which was deposited by Lake Bonneville during the Pleistocene Epoch.

There are five perennial streams in Tooele Valley, with a combined water yield of about 13,930 acre-feet per year (Razem and Steiger 1981). These streams originate in the mountains and disappear in the valley floor. Two of these originate in the central Oquirrh Mountains and enter the valley near the Town of Tooele, and three originate in the central Stansbury Mountains on the west side of the valley. South Willow Creek is on the northwestern boundary and is the largest of the streams in the Tooele Valley, with an annual flow of 4,830 acre-feet. Box Elder Wash has an annual flow of 900 acre-feet and enters the N-TEAD as an intermittent stream in the southwest, crossing from south to north. There are also four large springs in the central Tooele Valley several miles north and northeast of the facility boundary. Their combined flow is about 17,000 acre-feet. A few minor seeps also occur in the basin, but none within the N-TEAD. The streambeds located within the Depot boundaries carry intermittent flow from perennial streams originating in the surrounding mountains.

No perennial streams exist on the North Area of TEAD. However, perennial reaches of streams exist southeast and southwest of the North Area in South Willow, Box Elder, and Settlement canyons. The perennial flow of

these streams infiltrates the alluvial fan materials before reaching the valley floor which lies to the north of TEAD.

Artificial drainage systems have been constructed to transport storm runoff from several areas at TEAD. All of these systems either end in spreading areas or in natural drainage channels on base property.

4. HAZARDOUS SUBSTANCES CHARACTERIZATION

Upholding TEAD's mission necessitated that N-TEAD be engaged in a wide variety of operations which involved the use of materials with toxic and hazardous properties. Hazardous wastes were generated as a result of these operations. A summary of the type of materials used by various base operations is provided in Table 4-1. The activities performed and the type of wastes generated, and disposed, at N-TEAD are briefly discussed in the following sections.

4.1 WASTE SOURCES

The waste sources at N-TEAD include five major activities:

(1) industrial operations, (2) munitions demolition, (3) munitions demilitarization, (4) surveillance testing of munitions, and (5) nontactical generator repair and rebuild. Each of these operations and associated waste materials are briefly discussed below.

1. Industrial activity at TEAD has consisted of the care, maintenance, renovation, and rebuild of a variety of combat vehicles and support equipment. Industrial operations are conducted within the Maintenance and Supply Areas of N-TEAD (Figure 2-3). Wastewater generated by the activities performed in this area contain chromium and cadmium from metal finishing operations; detergents, grease, oil, and solvents from steam cleaning and vehicle wash facilities; and acids and caustics from metal cleaning operations.
2. Munitions demolition is conducted in the southwest corner of N-TEAD (Figure 2-3). This area consists of a number of pits and trenches referred to collectively as the Open Burn/Open Detonation (OB/OD) Area. The detonation pits are located against the bottom of a ridge that is several hundred feet high. All types of conventional ammunition are destroyed here, from small-arms up to 12,000-lb bombs, including propellants and rocket motors. On the east side of the same ridge is another demolition area where white phosphorus (WP) munitions are detonated. In the same general area, bulk explosives, explosive-filled munitions, explosive-contaminated materials, smoke pots and grenades, bulk WP, and riot-control agent munitions, as well as dunnage, packing materials, and containers, are burned in trenches. All metals recovered from these demolition and burning operations are returned to insure the removal of residual contamination. When certified clean, the metals are sent to the DPDO for salvage. The major hazardous compounds of concern at the OB/OD Area include trinitrotoluene (TNT) and its breakdown products (e.g., dinitrotoluene [DNT], dinitrobenzene [DNB]), RDX, and HMX.
3. Demilitarization of conventional munitions has been conducted at several areas of N-TEAD. The one area of major concern is the TNT Washout Facility located in the Ammunition Workshop Area in southcentral portion of N-TEAD (Figure 2-3).

TABLE 4-1 HISTORICAL SUMMARY OF ACTIVITIES INVOLVING THE USE OF HAZARDOUS MATERIALS AT N-TEAD

Building Number	Activity	Hazardous Material
8	Filling fire extinguishers	Sulfuric acid
10	Maintenance and repair of electronic equipment	Petroleum products
TL-23	Spray painting	Paint pigments
T-31	Removing base plates from bombs	Explosive dusts
S-33	Metal stripping, cleaning, anodizing and electroplating, spray painting	Chronic acid, phosphoric acid, hydrochloric acid, paint pigments
T-37	Laundering clothes	Explosive residue
T-45	Washing out bombs, pelletizing explosives	TNT, RDX, Composition B
51	Unpacking and repacking rockets; demilitarizing 120mm cartridges, inserting boosters, disassembling hand grenades	Greases and oils, doublebase propellant, black powder, nitroglycerin, Pettman cement, TNT
52	Filling and recharging Edison batteries	Sodium hydroxide
T-118	Vehicle maintenance, welding	Petroleum products, metal dust
119	Repair and maintenance of vehicles	Petroleum products
501	Mixing and dispensing of insecticides	Lindane, chlordane, malathion, and DDT
507	Filling and changing lead-acid batteries	Sulfuric acid
510	Vehicle maintenance and repair; welding	Petroleum products, cresolic acid; metal dust
511	Vapor-degreasing; Welding	Trichloroethylene, trichloroethane, metal dust
513	Spray painting	Paint pigments

TABLE 4-1 (Cont.)

Building Number	Activity	Hazardous Material
518	Mixing and dispensing pesticides	Pesticides
520	Spray painting, linking and packing 50 cal. ammunition, pulling apart small arms ammunition, demilitarizing small arms ammunition, popping primers	Paint pigments, greases and oils, propellant, tracer and incendiary powder, lead dust
532	Mixing and dispensing pesticides diazinon, warfarin, malathion, DDT, and chlordane	Pesticides including dieldrin,
533	Spray painting, cleaning metals, welding	Paint pigments, phosphoric acid, metal dust
539	Burning tracers from butts, lead recovery from tips and butts, burning of fuses, primers, and small arms ammunition	Antimony, lead dust
553	Packing and cleaning CN hand grenades including paint containers; paint stripping metal parts	CN, greases, oil, paint pigments, caustic, phosphoric acid
600	Spray painting, missile disassembly	Paint pigments, petroleum products
	Metal stripping, cleaning, anodizing and electroplating hydroxide, fluoride, nitric acid, plating wastes	Phenols, cresols, phosphoric acid, chormic acid, sodium
	Vapor-degreasing	Trichloroethylene, trichloroethane
602	Vehicle parts lubrication and preservation	Petroleum products
603	Tire repair and recapping	Rubber dusts, vulcanizing cement
604	Spray painting, vapor-degreasing; welding	Paint pigments, trichloroethylene; metal dust
607	Welding	Metal dust

TABLE 4-1 (Cont.)

Building Number	Activity	Hazardous Material
608	Machining metals, welding metal dust	Oils, coolants, and greases;
609	Metal stripping, cleaning, anodizing and electroplating	Caustic, hydrochloric acid, plating wastes
	Radiation repair, including brazing	Metal dust
611	Vapor degreasing, cleaning and lubricating parts	Trichloroethylene petroleum products
612	Spray painting	Paint pigments
	Sanding of painted surface	Paint and metal dusts
613	Welding	Metal dust
614	Etching and rinsing plates	Trichloroethylene
615	Metal stripping, cleaning, anodizing and electroplating	Zinc compounds, phosphoric acid, sodium hydroxide, phenols, cresols, chromic acid, nitric acid, fluorides, oil, plating wastes
	Vapor-degreasing	Trichloroethylene, trichloroethane
	Spray painting	Paint pigments
619	Vehicular rebuilding, tuning, and testing; welding; vapor degreasing; cleaning gunbores; machining and grinding; filling in dents	Metal fumes, trichloroethylene; petroleum products; stoddard solvent; metal dusts; benzoyl peroxide, phthalate esters
	Spray painting	Paint pigments
620	Metal stripping, cleaning, anodizing and electroplating	Alkali, phosphoric acid, chromic acid
	Vapor-degreasing	Trichloroethylene, trichloroethene

TABLE 4-1 (Cont.)

Building Number	Activity	Hazardous Material
637	Arc, acetylene and inserting-gas welding; machining and grinding; assembling transmissions; small arms repair	Metal dusts
	Metal stripping, cleaning, anodizing and electroplating	Cresylic acid, sodium hydroxide, chromic acid, plating wastes
	Vapor-degreasing	Trichloroethylene, trichloroethane
	Spray painting; axle rebuilding products	Paint pigments, petroleum
644	Acetylene cutting	Metal dust
647	Foam-in-place packaging, wood-working	Toluene diisocyanate

Source: USATHAMA 1979.

Projectiles, bombs, and rocket heads containing TNT, Composition B, RDX, and tritonal were cut and washed out at this facility. Another site, Building 1303 located north of the Chemical Range, was used from 1960 to 1976 to saw HE bombs and projectiles apart in order to determine loading characteristics of the filling. Dust from the sawing operations was collected by a vacuum cleaner directly under the saw. The material collected by the vacuum cleaner was sent to the Demolition Grounds for disposal. The building was washed down at frequent intervals and the waste water went into a leaching pond east of the building.

4. Munitions testing was performed at the Surveillance Test Site and Chemical Range, located in the southwest corner of N-TEAD (Figure 2-3). The Surveillance Test Site was used for the testing of HE (high explosive) filled munitions, fuses, and propellants. Chemical and pyrotechnic-type munitions, excluding toxic agent-filled, were tested on the Chemical Range. Munitions tested included flares, smoke grenades, smoke pots, WP (white phosphorus) filled grenades and projectiles, riot-control agent-filled munitions, and flame thrower igniters.
5. N-TEAD is responsible for receipt, maintenance, service, and storage of hydraulic and electrical equipment which is handled at the Maintenance and Supply Area (Figure 2-3). As such, TEAD receives transformers and capacitors which may or may not be filled with PCB-contaminated oil in this area of the Depot.

4.2 STORAGE AREAS

Various munitions are stored in the igloo storage area within the central portion of N-TEAD (Figure 2-3). Aside from this area of the Depot, the majority of materials with toxic and hazardous properties are stored at various locations in the easternmost portion of N-TEAD.

Transformers are stored in Building 659, located in the Maintenance and Supply Area (Figure 2-3). Prior to 1979, long-term storage of transformers was practiced at Open Storage Lot 675B, located northwest of the Maintenance and Supply Area.

Pesticides, herbicides, and fertilizers are used throughout the installation by trained army personnel. Fertilizers, such as ammonium sulfate (21 percent), are used around the administrative areas and family housing units. Herbicides, such as Hyvarx bromacil and 2,4-D have been used along railroad beds to improve visibility, and where plants are unsightly or present a fire hazard. Pesticides, such as lindane, warfarin, malathion, and chlordane have been used against the elm bore for roach control and the control of rodents (USATHAMA 1979). Pesticides, herbicides, and fertilizers are stored in Building 518 in the Maintenance and Supply Area (Figure 2-3). This storage facility is well labeled, vented, and secured with a chainlink fence.

Small quantities of sealed radioactive materials are and have been used at N-TEAD in the calibration of equipment, industrial radiography, liquid level detectors, static eliminator brushes, etc. N-TEAD also has been authorized to receive, store, and repair ship gauges, watches,

compasses, etc. containing minute quantities of radioactive materials (USATHAMA 1979). A section of Building 659, located in the Maintenance and Supply Area (Figure 2-3), has been designated as a radioactive storage facility. Stored in the facility are small quantities of tritium H_3 , radium, and uranium-238.

The fenced Radiological Waste Storage Area located northwest of the Maintenance and Supply Area, was used for temporary storage of low level radioactive waste, speedometers, radioactive tubes, watch repair parts, tools, decontamination equipment and materials, cabinets, drawers, and shelves.

Located adjacent to the eastern side of the Warehouse and Supply Area, the DPDO Yard, which consists of open storage and steel buildings, is used for temporary storage of surplus material and materials to be salvaged, recycled, sold, and disposed of.

Thousands of drums, of all sizes and types, used at the Depot were brought to a large fenced-in storage lot located in the southern end of the Maintenance and Supply Area ("Barrel Storage Area") (Figure 2-3) prior to being returned to their originating contractor. The used drums were stored upside down to empty residual contents and to keep precipitation out.

4.3 WASTE TREATMENT AND DISPOSAL METHODS

The waste treatment and disposal practices that have been employed at N-TEAD include the use of holding (evaporation) ponds, open burning, open detonation, burial, and landfilling. The types of wastes and the treatment/disposal methods employed are discussed below.

4.3.1 Holding (Evaporation) Ponds

The wastewaters generated at the Maintenance and Supply Area are discharged to a series of outfalls which in the past ended at an area referred to as the "old industrial waste spreading area" located northwest of the Maintenance and Supply Area. Wastewater discharged to the ground surface at this area was allowed to evaporate and percolate through the soil. Around 1965, an unlined lagoon (Industrial Waste Lagoon) was constructed to handle wastewater generated at the industrial area. The lagoon operates as an evaporation/percolation pond. This lagoon is still operating, however, action has been taken to close the lagoon and to construct a secure, lined facility.

Rinse water generated from the development of X-rays in Building 1223 in the Ammo Workshop Area, in the southwest periphery of the igloo storage area, is discharged to a lined (synthetic plastic liner) pond. The facility operates as an evaporation pond.

Rinse water, containing residual explosives from the TNT Washout Facility, was generated from a munitions demilitarization (washout) operation and discharged to a series of four former evaporation/percolation ponds, located north of Building S-45 in the south-central area of N-TEAD. Also in this area is a small evaporation/percolation pond which receives laundry and shower effluent from Building 67.

A shallow scooped-out area covered with gravel is located east of Building 1303 (Munition Sawing Site) where HE bombs (TNT) weighing 250 to 300 pounds each were cut. Dust was vacuumed and the structure (tin shed/cement floor) was washed down weekly; the waste water drained across the road to the ponding area.

Sanitary wastewater generated from the administrative and industrial/maintenance areas is discharged to two earthen ponds (Sewage Lagoons) located in the eastern portion of N-TEAD. Though the ponds operate as evaporation ponds, a significant quantity of the wastewater seeps through the pond bottoms. Prior to being discharged in this location, wastewater from the administrative area was discharged into an area known as the "waste water spreading area" located in the southeast corner of the Depot.

4.3.2 Open Detonation

Open detonation is conducted at the OB/OD Area in 12-15 feet deep pits. Up to 7.5 tons of material are placed in the pits, buried, and detonated. After detonation, the area is searched for unexploded ordnance, which are destroyed in place. Open detonation was also practiced at the Chemical Range and Surveillance Test areas.

4.3.3 Open Burning/Burial

Open burn trenches located in the OB/OD, Chemical Range, and Surveillance Test areas were operated by placing materials into the trenches and burning it. When the trenches were full of ash and residue, they were covered with soil.

4.3.4 Landfilling

An active sanitary landfill is located west of the N-TEAD Industrial/Maintenance and Supply Area. The landfill is unlined and is operated by the trench method. Materials known to have been placed in the landfill include general refuse generated at N-TEAD, scrap metal, rubber and tires, scrap wood and paper, paint and paint solvent containers, asbestos-containing materials, waste ethylene glycol, and pesticide/herbicide containers.

5. SUMMARY OF PREVIOUS ENVIRONMENTAL INVESTIGATIONS

This chapter summarizes previous environmental investigations conducted at N-TEAD. A description of the scope of work, findings, and conclusions of each investigation is presented. Site-specific investigations involving limited sampling and analysis are presented and discussed in the appropriate sections of Chapter 6.

5.1 ENVIRONMENTAL ASSESSMENT OF TOOELE ARMY DEPOT, REPORT NO. 141

This report was prepared for the U.S. Army Chemical Demilitarization and Installation Restoration Agency, now USATHAMA, to assess the environmental quality of TEAD with regard to the use, storage, treatment, and disposal of toxic and hazardous materials and to define any conditions which may adversely impact public health and welfare, or the environment. The assessment involved the performance of a records search to identify sites of potential environmental contamination (e.g., burial sites, testing areas, explosives washout areas, industrial areas, and OB/OD areas). The major suspected contaminants of concern included explosives, chemical agents, and plating rinse waters.

The report presented the following findings:

- . Industrial operations have generated wastewaters containing heavy metals, petroleum, oil, lubricants, and cleaning wastes. The outfall flow percolates into the soil.
- . Testing and disposal of high explosives (HE), white phosphorous (WP), and pyrotechnic material is a continuing operation at N-TEAD.
- . Mustard agent was stored at N-TEAD until 1977. Repair of luminous devices has involved radium-activated paint (Building 605).
- . No natural surface water system exists in N-TEAD. Soil beneath the Industrial Wastewater Lagoon outfalls was determined to contain 360 mg/kg of chromium. Chloride and sulfate concentrations in Supply Well No. 1 equalled or exceeded the drinking water standards.
- . The sanitary landfill reportedly contains plating wastes, PCB, and paint primer (zinc).
- . Three holding ponds (lagoons) associated with various operations were identified at N-TEAD: the X-ray lagoon (lined), the TNT washout ponds (unlined), and the industrial wastewater lagoon (gravel lined).

- . The demolition and burning ground is located in the southwestern portion of N-TEAD and is used for HE and HE contaminated items, pyrotechnics (Chemical Range), riot control agents, and WP. Facilities are available for demilitarization of small caliber ammunition (popping furnaces).
- . The following demilitarization sites were identified:
 - Building S-45 - ammunition workshop (inactive)
 - Building 520 - small arms (inactive)
 - Building 539 - experimental popping furnace (inactive)
 - Building 1303 - HE munition sawing (inactive)
 - Buildings 1351, 1320, - deactivation furnace (active)
 - Building 1356 - flashing furnace (active)
 - Building 1344 - deactivation furnace (no longer exists)
- . A transformer oil spill occurred near Igloo No. K281

The following conclusions were presented in the installation assessment report:

- . A potential exists for contaminant migration via groundwater flow from N-TEAD. The potential contaminant sources in N-TEAD are concluded to be the demolition grounds and the industrial waste outfall.
- . As a result of the wastewater discharge at the N-TEAD industrial outfall, the soil has become contaminated by heavy metals from plating operations. Since there are no adequate restraints, grazing cattle entering the area to feed may ingest contaminated vegetation.
- . The increasing chloride and sulfate levels in Supply Well 1 are compromising its use as a source of potable water.
- . The leachate potential from the landfill and the composition of surface runoff from the area cannot be characterized. This is due to lack of information, absence of NPDES permit requirements, and minimal requirements for landfill management.
- . The soil near Igloo K281 may be contaminated with PCBs as a result of a transformer oil spill.
- . Because of the thin gauge (4 mil) of the X-ray wastewater pond liner, the useful life of the pond is anticipated to be of limited duration.

The main findings and conclusions of this study, with respect to the South Area of TEAD, are presented in Volume II of this report.

5.2 ERTEC EXPLORATORY ENVIRONMENTAL CONTAMINATION ASSESSMENT REPORT

The Earth Technology Corporation (Ertec), under the direction USATHAMA, performed an investigation to identify and characterize areas of potential contamination at TEAD (both north and south areas). The investigation was conducted in a two-phase approach; the first phase involved utilizing existing data and preliminary site visits to identify potentially contaminated sites. The second phase involved the installation of monitoring wells, the performance of geophysical surveys, and the sampling/analysis of soil, sediment, and water at sites identified as having the greatest potential for environmental contamination.

The major findings and conclusions of this study, with respect to N-TEAD, were as follows:

1. Contamination and the migration of contaminants were found to be minimal at the Tooele Army Depot. Two areas of concern were identified through the collection and analysis of soil, sediment, surface water, and groundwater samples. These areas were (a) Headquarters Area, consisting of the Industrial Waste Pond, outfalls and ditches from the Maintenance Area and the Sewage Lagoon, and (b) TNT Washout Ponds/Laundry Ponds Area.
2. A contaminated zone was found to exist in the vicinity of the Industrial Waste Pond. Specific contaminants from this source were identified as having a high probability of migrating toward the Depot boundary and towards N-TEAD Supply Well No. 2. Contaminants that exceeded U.S. EPA standards were arsenic, nickel, chromium, and lead. Contaminants found to be anomalously high were zinc, chloride, fluoride, phosphate, sodium, 1,2-dichloroethane, trans-1,2-dichloroethene, trichloroethene, and possibly 2,4,6-trinitrotoluene. The travel time of contaminated groundwater from this source to the north boundary of the Depot was estimated at 55 years from the time contaminants first reached the water table.
3. Contaminated water from the Industrial Waste Pond may have entered fractures and solution channels in the underlying carbonate bedrock above the regional water table. It was determined that if this contamination existed and was extensive, it could provide a long-term source of contamination to the alluvial aquifer by slow drainage. The geometry and the impact of this contamination was not assessed under this Exploratory Study.
4. The impact of contaminated water seepage from Industrial Wastewater Outfalls B through E could not be determined.
5. A groundwater mound has built up beneath the Sewage Lagoon. This water was determined to be flowing toward the north N-TEAD boundary and toward N-TEAD water supply Wells 1 and 2. While no contaminants were found to exceed U.S. EPA standards in the one well that taps this perched zone, the levels of nickel and nitrate approach U.S. EPA standards. In addition, anomalously

high levels of zinc, chloride, fluoride, sulfate, gross beta, sodium, and trichloroethane were found. Travel time for these contaminants to reach the north boundary was estimated to be on the order of 55 years from the time they first reached the groundwater system.

6. A local perched water table was determined to exist below the TNT Washout Pond/Laundry Effluent Pond Area. Seepage of laundry effluent through soils contaminated with explosives from TNT Washout operations was identified as a continuing mechanism for flushing contaminants to the groundwater.
7. Groundwater in the regional aquifer beneath the TNT Washout ponds was contaminated with RDX and explosive derivatives such as nitrates, which were found at levels six times greater than the U.S. EPA and Utah standards. Although this groundwater was contaminated, it was estimated that it would take 125 years to reach the north depot boundary.
8. DNT and TNT have migrated at least 45 feet down through the soil beneath the contaminated area surrounding the TNT Washout ponds. A "slug" of RDX had migrated to a depth of 100 feet.
9. The areal extent of explosives contamination in the surface soil around the TNT Washout Pond Area was not determined under this Exploratory Study.
10. No evidence was found to suggest that contamination was being carried past the N-TEAD boundaries by surface water.
11. Based upon one sampling point installed in an attempt to intercept groundwater flow from the contaminated areas, contaminated groundwater was not determined to be moving past this portion of the north boundary. All groundwater flow exits N-TEAD across the north boundary.

The major findings and conclusions of this study, with respect to the South Area of TEAD, are presented in Volume II of this report.

5.3 INTERIM GROUNDWATER QUALITY ASSESSMENT REPORT

This report, prepared by Woodward-Clyde Consultants (1985) for the U.S. Army Corps of Engineers, presented the results of the first phase of an investigation to assess the extent of groundwater contamination in the vicinity of the unlined industrial wastewater lagoon (IWL) and connecting wastewater ditches at N-TEAD. The Phase I investigation included sampling and laboratory analysis of the lagoon liquid, accumulated sludge in the lagoon, soils from below the lagoon and adjacent to the wastewater ditches, and groundwater samples from existing monitoring and water supply wells in the vicinity of the lagoon. The lagoon has been used for approximately 40 years for the disposal of wastewater from metal cleaning and finishing operations. The lagoon is still active.

Groundwater contamination was found downgradient from the lagoon. However, the extent of contamination could not be established from the existing monitoring well network. Accordingly, this report was submitted as an interim report. It includes recommendations for additional groundwater monitoring wells to be drilled, developed, sampled, and analyzed within and beyond the limits of the existing monitoring well networks as part of a Phase II investigation.

The following findings were presented in the report.

- . The groundwater flow velocity was calculated to range from 6×10^{-4} to 1×10^{-2} cm/second (665 to 11,400 feet per year) in the alluvium.
- . The IWL wastewater, sludge, and soil samples contained concentrations of various volatile and semi-volatile organic compounds and metals. Soil samples from near the wastewater ditches contained lower concentrations of metals than the soil/sludge samples from the IWL.
- . Groundwater beneath the IWL was found to be contaminated with trichloroethene, tetrachloroethane, 1,1,1-TCA, and 1,1 DCA.

The following conclusions were based on the results of the first phase of this investigation.

- . Groundwater contamination was limited to volatile organic compounds. Semi-volatile organics and possibly several metals have migrated to the perched zone beneath the IWL and can potentially move into the groundwater.
- . Groundwater flows toward the northwest beneath the site. Contaminated groundwater has probably moved offsite towards the northwest in the alluvial aquifer.
- . Groundwater in both the bedrock and unconsolidated sediments contains organic contaminants. The bedrock groundwater appears to be hydraulically connected to the unconfined, sediment aquifer.
- . Water supply Well WW-2 was contaminated with low concentrations of an organic solvent (TCE).
- . Organic contaminants were found in samples from all the existing wells downgradient of the wastewater ditches and the IWL, except for Well USGS-2.
- . Contaminated groundwater has probably migrated beyond all the existing data collection points. In other words, contaminants have probably migrated beyond the northern boundary of N-TEAD.

5.4 GROUNDWATER QUALITY ASSESSMENT, MARCH 1987

Under the terms of the Consent Decree (Civil C85-C-1080G) filed 13 January 1986, in the U.S. District Court for the District of Utah, Central Division, the State of Utah has required the Tooele Army Depot to conduct a Groundwater Quality Assessment (GWQA) in the vicinity of the IWL. The GWQA Engineering Report was prepared by James M. Montgomery, Consulting Engineers, Inc., (1987) for the U.S. Army Corps of Engineers.

The purpose of the GWQA was to define the extent and magnitude of groundwater contaminated by industrial wastewater leaking from the IWL. The GWQA was divided into three phases. The objective of Phase I was to characterize the geologic conditions and groundwater flow regime in the vicinity of the IWL. Phase I activities included the installation of 28 dual-point and 3 single-point piezometers, the construction and testing of two test wells, borehole geophysical logging, a surface gravity survey, bedrock coring and permeability testing in three boreholes, and periodic groundwater level measurements in each of the piezometers. Phase I was carried out between 31 March 1986 and 28 August 1986. The objective of Phase II was to estimate the extent and magnitude of groundwater contamination in the vicinity of the IWL. The primary activities conducted during Phase II included installation of 25 monitoring wells and collection and analysis of two rounds of groundwater samples from the TEAD monitoring network. Phase II was initiated on 10 June 1986 and culminated with submittal of a GWQA Engineering Report. The objective of Phase III, which is currently in progress, is to analyze remedial alternatives to mitigate the potential threat to human health and the environment by groundwater contamination at TEAD.

The following conclusions were presented in the GWQA report:

- . Although other hazardous constituents were also present to some degree, TCE was detected in groundwater samples more often and at higher concentrations than any other contaminant. Metals such as lead, cadmium, and arsenic are attenuated by the alkaline soil and sludge beneath the IWL and wastewater ditches.
- . The extent of chromium contamination is limited to the immediate vicinity of the wastewater ditches. Few of the concentrations exceeded drinking water standards.
- . Volatile organic compounds (VOCs), especially TCA and CTC, have created areally extensive plumes in the groundwater system, but neither of the plumes approach the size of the TCE plume. In addition, few of the VOC concentrations exceed proposed drinking water standards. Therefore, because of the large plume and the low proposed maximum contaminant level (MCL) (5 µg/L), TCE is the contaminant of major concern in the groundwater system.

TCE concentrations in groundwater ranged from less than 0.1 µg/L to 230 µg/L. The highest concentrations were detected in samples from monitoring wells completed adjacent to the wastewater ditches south of the IWL. The concentrations decrease with distance from the wastewater ditches and are lowest near the northern boundary. The plume has been estimated to be at least 260 feet thick and contains an estimated 45 billion gallons of groundwater with TCE concentrations greater than 5 µg/L.

- The maximum rate of groundwater movement occurs in areas to the west and northwest of the IWL in the alluvial aquifer. In these areas, the rate of movement of the contaminant plume was estimated to be 700-1,200 feet per year. Contaminant velocities in other parts of the aquifer are much lower, specifically beneath the wastewater ditches and in the bedrock block.
- The range of contaminant velocities reported above are sufficiently high to enable TCE-contaminated groundwater to migrate offsite. TCE-contaminated groundwater may be present north of the TEAD boundary.

5.5 AEHA INVESTIGATIONS AT THE OPEN BURNING/OPEN DETONATION AREA

AEHA conducted a four-phase investigation of seven Open Burning/Open Detonation (OB/OD) facilities in the United States including the N-TEAD OB/OD Area, located in the southwestern corner of the Depot. The investigations were performed to evaluate potential environmental contamination with respect to Federal hazardous waste regulations, and to determine which sites should be used for continued OB/OD operations. The investigation was performed from March 1981 through August 1984.

Phase I involved screening installations for potential soil, surface water, and groundwater contamination in and around the OB/OD areas (AEHA 1982). Phase II involved a series of field studies to sample surface soils at the OB/OD areas (AEHA 1983). Phase III involved summarizing all of the Phase II studies into one overall evaluation of OB/OD sites (AEHA 1984). Phase IV involved resampling selected OB/OD sites to determine the horizontal and vertical extent of contamination identified during the Phase II studies (AEHA 1985).

Results of the Phase I study indicated that Tooele Army Depot presented a potential for low level contamination and was recommended to be included for Phase II. Phase II study results are summarized below:

Area Sampled	Explosives Analysis	EP Toxicity Metals Analysis
Main Demolition Area	Measurable quantities of RDX and HMX in virtually all samples, ranging up to 149 µg/g RDX.	Seven of 24 samples had Cd levels over the RCRA limit of 1.0 mg/L, 4 others were 0.97-0.98

<u>Area Sampled</u>	<u>Explosives Analysis</u>	<u>EP Toxicity Metals Analysis</u>
Main Demolition Area (cont.)		mg/L. Small amounts of Ba and Hg detected but not in concentrations approaching RCRA limits.
Cluster Bomb Demolition Area	One sample with RDX and 1 with tetryl and TNT. No concentrations over 2.2 µg/g. No others detected.	No metals detected at levels approaching RCRA limits. Small quantities of As, Ba, Hg, and Pb detected in samples.
Propellant Burn Area	Small amounts of explosives present in several samples with no concentrations exceeding 52 µg/g.	No metals detected at levels approaching RCRA limits. Small quantities of As and Hg detected in several samples.
Trash Burn Pits	One sample with 4.6 µg/g TNT.	No metals detected at levels approaching RCRA limits. Small amounts of Ba, As, and Hg detected.

Compilation and review of OB/OD investigations resulted in the following conclusions:

- . While the residues and soils were potentially reactive, in reality it is unlikely that the concentrations of explosives found in this study would present a reactive danger according to the newly accepted Bureau of Mines reactivity tests.
- . The EP Toxicity metals of concern from the study are lead, cadmium, and to a limited extent, barium.
- . The explosives most frequently encountered in the analyses were 2,4,6-TNT, RDX, and HMX.
- . The chemical content of certain explosives in residues may present a real toxicity danger to human health and to the environment which must be researched.
- . Any data on EP Toxicity metals, reactivity, or chemical toxicity must be tempered with a full geohydrological site evaluation to interpret a site's total impact to human health and aquatic biotas.

It was recommended in Phase III that an expanded Phase IV study be conducted at the N-TEAD OB/OD area. Phase IV was conducted from 27 July to 10 August 1984, and involved soil sampling and analysis from 7 boreholes (35 soil samples) and from 8 surface locations within the

OB area for determining the presence of metals and explosives. It was concluded from the soil analysis that no significant amount of explosive compounds were present and that the soil in the OB area was not hazardous as determined by the EP Toxicity tests. Refer to Table 5-1 for a summary of the analytical results. AEHA indicated that the OB operations at N-TEAD did not present any conceivable risk to the environmental quality of TEAD and recommended no remedial action be conducted at the site.

5.6 THE ENVIRONMENTAL PHOTOGRAPHIC INTERPRETATION CENTER REPORT

The Environmental Photographic Interpretation Center (EPIC), through an interagency agreement between U.S. EPA and USATHAMA, was requested to provide imagery analysis support for the USATHAMA Installation Assessment Program. This report involved historical analysis of 17 select installations to identify possible areas of past use, storage, treatment, and disposal of potentially toxic and hazardous materials (U.S. EPA 1982).

Archival black and white aerial photography of an appropriate scale was acquired from the imagery libraries of the U.S. Geological Survey and the Agricultural Stabilization and Conservation Service, in addition to other government and private sources. An attempt was made to locate imagery that would provide photo coverage for each installation every five years, spanning the period between 1940-1980. However, in some of the less populated sections of the country, where only sparse photo coverage exists, this was not possible.

Aerial photographs of N-TEAD from 1953, 1959, 1966, and 1981 were analyzed to determine the potential environmental impact of past and present installation activities. With the exception of the 1981 low altitude color infrared imagery, all analyses were performed with black and white imagery flown at scales ranging from 1:20,000 to 1:24,000. A 1:27,790 scale mosaic of Tooele Army Depot was constructed from the 1966 imagery. Potentially hazardous sites, ground scars, and surface drainage are annotated on the mosaic. A complete listing of the sites with a description of the changes that occurred between each interval of coverage was provided. Black and white enlargements of seven significant areas of the installation were also provided. Sites identified through the EPIC study are listed in Table 5-2.

TABLE 5-1 RESULTS OF AEHA 1984 SOIL CHEMICAL ANALYSIS OF THE OPEN-BURNING AREA, TEAD

	HMX	RDX	Tetryl	μg/g		mg/kg										mg/L														
				2,6	2,4	Total	Total	Total	Total	Total	Total	Total	Total	As	Ag	Se	TEP	TEP	TEP	TEP	TEP	TEP	TEP	TEP	TEP	TEP	TEP			
				DNT	DNT	As	Ag	Ba	Cd	Cr	Hg	Pb	Total	Se	Ag	As	Ba	Cd	Cr	Hg	Pb	Se	Ag	As	Ba	Cd	Cr	Hg	Pb	Se
BH1 Surface	BDL	BDL	BDL	BDL	BDL	BDL	0.25	BDL	BDL	2.47	BDL	0.45	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BH1 2-3' deep	BDL	BDL	BDL	BDL	BDL	BDL	0.25	BDL	BDL	2.41	BDL	0.30	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BH1 4-5' deep	BDL	BDL	BDL	BDL	BDL	BDL	0.30	BDL	BDL	2.28	BDL	0.48	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BH2 Surface	BDL	5.4	BDL	BDL	BDL	BDL	BDL	BDL	0.19	1.75	BDL	3.27	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BH2 1-2' deep	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.55	BDL	0.40	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BH2 4-5' deep	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BH2 8-9' deep	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.70	BDL	0.66	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BH2 14-15' deep	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.16	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BH2 18-19' deep	BDL	BDL	BDL	BDL	BDL	BDL	0.51	BDL	BDL	0.50	BDL	0.86	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Canyon drainage:																														
North	2.4	14.9	BDL	BDL	BDL	BDL	0.33	BDL	0.08	0.64	BDL	1.95	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Middle	BDL	2.2	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.53	BDL	0.96	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
South	BDL	3.4	BDL	BDL	BDL	BDL	0.35	BDL	0.10	0.70	BDL	4.47	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BH3 Surface	BDL	BDL	BDL	BDL	BDL	BDL	BDL	30.7	0.06	0.86	BDL	36.3	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BH3 4-5' deep	BDL	BDL	BDL	BDL	BDL	BDL	0.49	16.6	BDL	0.51	BDL	7.67	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BH3 9-10' deep	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BH3 14-15' deep	BDL	BDL	BDL	BDL	BDL	BDL	0.86	BDL	BDL	1.00	BDL	1.19	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BH3 19-20' deep	No Recovery																													
BH4 Surface	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.88	BDL	3.89	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BH4 4-5' deep	BDL	BDL	BDL	BDL	BDL	BDL	0.52	BDL	0.05	0.76	BDL	1.38	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BH4 8-9' deep	BDL	BDL	BDL	BDL	BDL	BDL	BDL	16.6	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BH4 14-15' deep	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BH5 Surface	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	1.12	BDL	2.30	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BH5 4-5' deep	BDL	BDL	BDL	BDL	BDL	BDL	0.52	BDL	BDL	0.97	BDL	1.71	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BH5 8-9' deep	BDL	BDL	BDL	BDL	BDL	BDL	0.67	BDL	BDL	0.72	BDL	1.19	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BH5 14-15' deep	No Recovery																													
BH6 Surface	BDL	BDL	BDL	BDL	BDL	BDL	0.38	16.9	BDL	0.84	BDL	1.91	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BH6 4-5' deep	BDL	BDL	BDL	BDL	BDL	BDL	0.51	BDL	0.08	0.95	BDL	2.34	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BH6 9-10' deep	BDL	BDL	BDL	BDL	BDL	BDL	0.66	BDL	BDL	0.71	BDL	1.00	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BH7 Surface	BDL	BDL	BDL	BDL	BDL	BDL	0.42	BDL	BDL	0.81	BDL	1.96	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BH7 4-5' deep	BDL	BDL	BDL	BDL	BDL	BDL	0.50	BDL	BDL	0.82	BDL	1.03	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
BH7 5.5-6' deep	BDL	BDL	BDL	BDL	BDL	BDL	0.47	BDL	BDL	0.97	BDL	1.30	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Canyon head:																														
North	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.65	1.18	BDL	2.33	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
South	BDL	0.65	BDL	BDL	BDL	BDL	0.30	BDL	0.30	0.80	BDL	4.67	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Downgradient																														
stream sedimen-	BDL	BDL	BDL	BDL	BDL	BDL	0.67	21.6	0.06	1.48	BDL	3.08	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Burn area																														
drainway west	BDL	BDL	BDL	BDL	BDL	BDL	0.51	BDL	BDL	0.98	BDL	1.92	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Burn area																														
drainway east	BDL	BDL	BDL	BDL	BDL	BDL	0.26	BDL	0.28	0.54	BDL	1.67	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Detection Limits	1.0	1.0	5.0	1.0	1.0	1.25	0.25	15	.05	.05	0.2	0.25	5.0	500	500	10,000	100	500	20	500	20	500	100	500	20	500	100	500	20	500

BDL = Below detection limit.

Source: AEHA 1985.

TABLE 5-2 N-TEAD SITES DELINEATED IN ENVIRONMENTAL PHOTOGRAPHIC
INTERPRETATION CENTER AERIAL PHOTOGRAPHS

Site No.	Description
1	Probable range or test site northwest, N-TEAD
2	Firing range, same area
3	Storage area within igloo storage area
4	Demolition range in southwest corner of N-TEAD
5	Chemical range adjacent east of site No. 4
6	Four buildings and two open storage areas north of OB/OD grounds
7	Tracer test site
8	Dump site off base
9	Gravel pit receiving liquid from industrial wastewater ditch
10	Radioactive waste storage facility
11	Industrial waste water spreading area
12	Gravel pit in the area of the old industrial waste water ditches
13	Storage yard in eastern portion of maintenance and supply area
14	Storage lot in same area as No. 13
15	Burrow pit, off base
16	Open storage lot, off base
17	Landfill
18	Pesticide storage lot, located at the southern end of the maintenance and supply area
19	Ammunition workshop along southwest periphery of igloo storage area
20	Demilitarization facility with holding ponds on southern periphery of igloo storage area
21	Storage yard and probable burial site in industrial area
22	Ground scar and burial area near Site No. 21.
23	Hospital
24	Unrevetted tank
25	Pit near surveillance test site
26	Surveillance test site
27	Waste spreading area behind administration area

Source: U.S. EPA 1982.

6. PRELIMINARY SITE ASSESSMENTS

This chapter provides a descriptive summary of each site evaluated as part of this PA/SI effort for N-TEAD. These sites were identified as having the potential to have an adverse impact on human health or the environment. The information presented here is based upon previous studies (Chapter 5) and information obtained through record searches, site surveys, and interviews of personnel familiar with each of the sites. Table 6-1 lists each of the sites, along with the corresponding EPIC site number, and the waste types/contaminants of concern. The location of each of the sites is shown in Figure 6-1.

The following sites identified in the EPIC study (Section 5.6) were not evaluated as part of this PA/SI effort because they were either offbase or considered to have no potential to have an impact on human health or the environment.

<u>EPIC No.</u>	<u>Site</u>
8	Dump Site - Offbase
15	Burrow Pit - Offbase
16	Open storage Lot - Offbase
23	Hospital
24	Unrevetted Tank (water tank)

6.1 TNT WASHOUT FACILITY AREA

The TNT Washout Facility Area is located along East Workshop Road near the south central boundary of TEAD North (Figure 6-1). For the ease of discussion, the TNT Washout Facility Area has been divided into four separate areas, each of which has previously been identified as either contaminated or a potential source of environmental contamination. These areas are:

1. Old TNT Washout (Percolation/Evaporation) ponds
2. New TNT Washout Basin
3. Laundry Effluent ponds
4. Area of Surface Contamination

In order to further determine the presence and extent of contamination in the Washout Facility Area, soil, groundwater, and laundry effluent samples were obtained from each of these areas during the installation PA/SI field program. A detailed description of the sampling and analytical programs conducted in the Washout Facility Area is presented in Section 8.1. Each of the previously identified areas is discussed in the following sections.

6.1.1 Old TNT Washout (Percolation/Evaporation) Ponds

The Old TNT Washout ponds were located approximately 100 feet due north of Building S-45 (Figure 6-2). They consisted of a series of four unlined, bermed, percolation/evaporation ponds encompassing a combined area of approximately 1 acre. The ponds received rinse waters containing

TABLE 6-1 POTENTIAL HAZARDOUS WASTE SITES AT N-TEAD

Site No./ Location*	Name	Waste Type/Contaminant of Concern
1	TNT Washout Facility Area (EPIC No. 20)	Laundry and washout facility effluent; explosives; TNT, RDX, and Composition B, Nitrates, phosphates, heavy metals.
2	Sanitary Landfill (EPIC No. 17)	Domestic refuse; construction rubble, paint, solvents, paint thinner and stripper, motor oil and antifreeze, and pesticide containers; sludge; scrap metals; asbestos contaminated materials.
3	Industrial Waste Lagoon (EPIC No. 9)	Wastewater from vapor degreasing; metal cleaning, stripping, cleaning, anodizing, electroplating, and other industrial operations; acids, caustic, solvents, detergents, oils, and grease; heavy metals.
4	Old Industrial Waste Spreading Area (EPIC Nos. 11 and 12)	Wastewater from vapor degreasing; metal cleaning, stripping, cleaning, anodizing, electroplating, and other industrial operations; acids, caustic, solvents, detergents, oils, and grease; heavy metals.
5	Sewage Lagoon	Sanitary wastewater
6	X-Ray Lagoon (EPIC No. 19)	X-ray development rinse water
7	Former Transformer Storage Site	PCB-contaminated oil
8	Transformer Boxing Site	PCB-contaminated oil
9	PCB Spill Site	PCB-contaminated oil
10	PCB Storage Area	PCB-contaminated oil
11	Pesticide/Herbicide Handling and Storage	Pesticides and herbicides
12	Radiological Storage Area	Radioactive material: tritium H_3 , radium, and uranium-238
13	Wastewater Spreading Area (EPIC No. 27)	Domestic wastewater

* See Figure 6-1 for site location.

TABLE 6-1 (Cont.)

Site No./ Location*	Name	Waste Type/Contaminant of Concern
14	Barrel Storage Area (EPIC No. 18)	Residual contents of used drums: solvents, petroleum products, antifreeze, etc.
15	Open Burn/Open Detonation Area (EPIC Nos. 4 and 5)	Explosives: RDX, TNT, and HMX; heavy metals
16	Chemical Range (EPIC No. 7)	Explosives
17	Surveillance Test Site (EPIC No. 26)	Explosives
18	Staging Area Near Surveillance Test Site (EPIC No. 25)	Explosives
19	AEO Demilitarization Facility (EPIC No. 6)	Explosives
20	AEO Furnace Site	Explosives
21	Ammunition Sawing Site	Explosives
22	Ammunition Maintenance Facility	Paint, explosives
23	Rifle Range (EPIC Nos. 1 and 2)	Explosives
24	DPDO Yard (EPIC Nos. 13 and 14)	Miscellaneous surplus materials
25	Radiological Waste Storage Area (EPIC No. 10)	Low level radioactive wastes
26	Burial Area Within Industrial Area (EPIC Nos. 21 and 22)	Building rubble, garbage, tires, etc.
27	Open Storage Within Igloo Storage Area (EPIC No. 3)	Unknown

* See Figure 6-1 for site location.

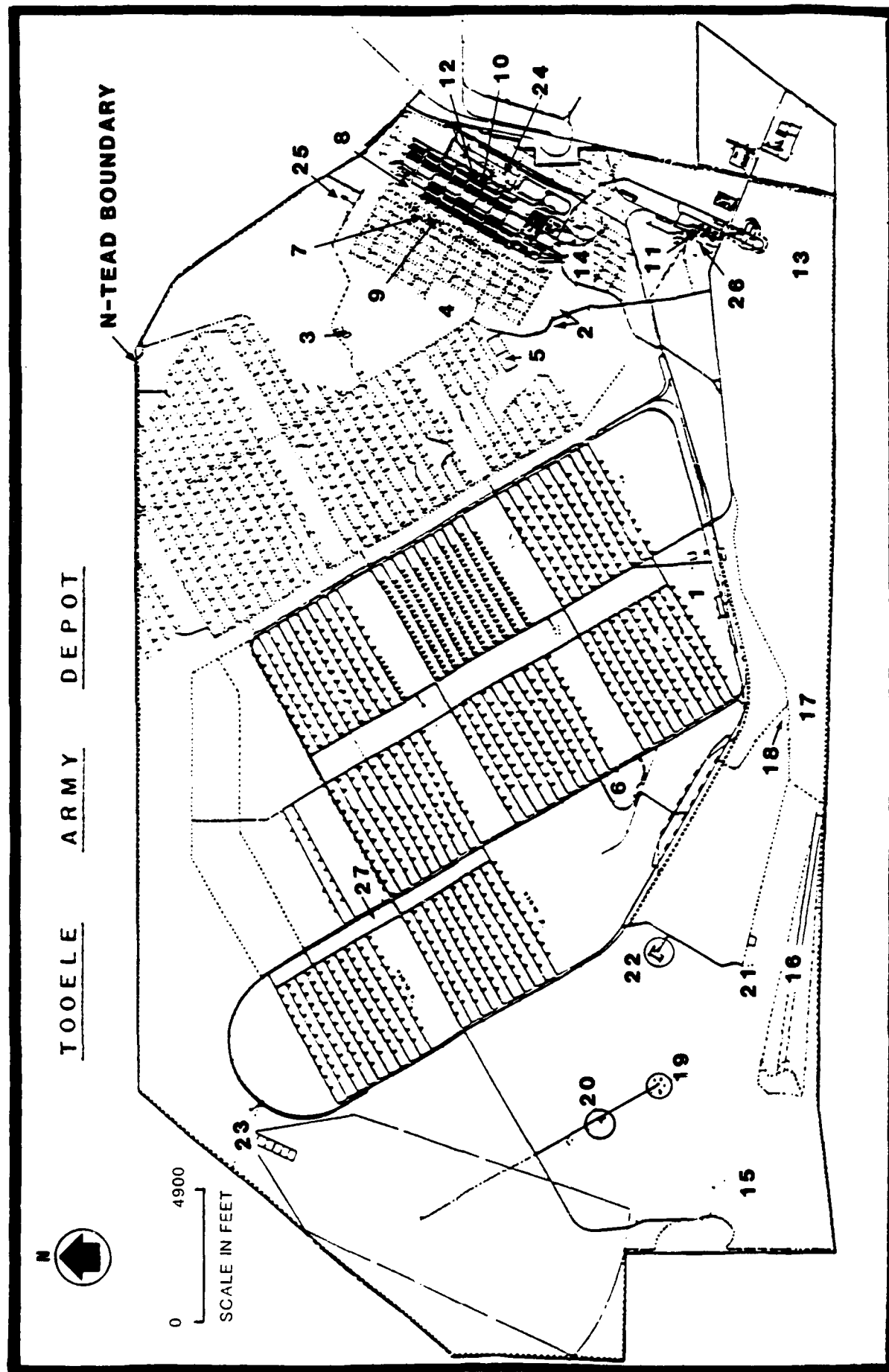


Figure 6-1. Location of Potential Hazardous Waste Sites, N-TEAD.

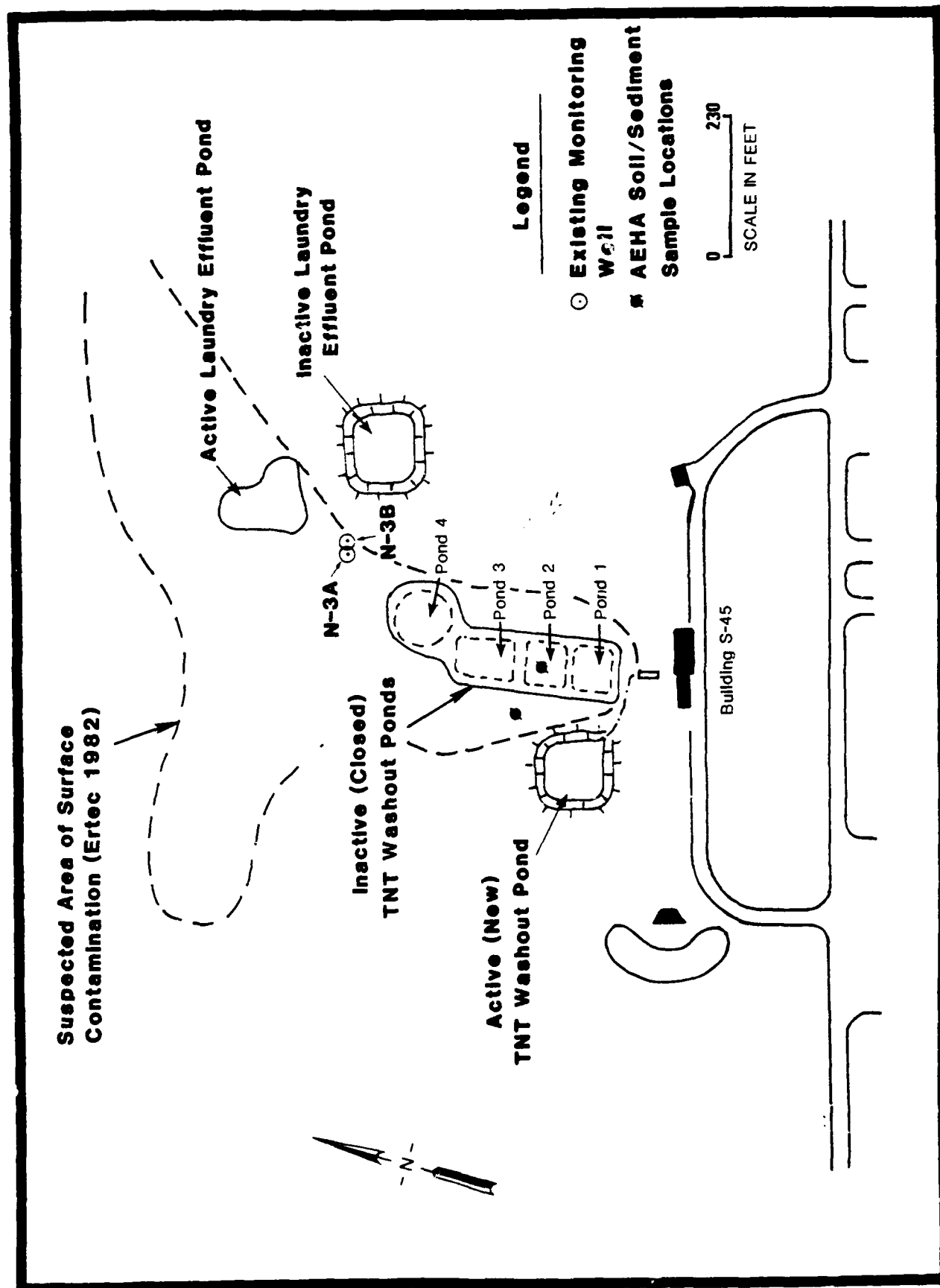


Figure 6-2. Site Map of TNT Washout Facility Area, N-TEAD

residual explosives during washout facility operation. The ponds were also reported to periodically overflow/flood onto the surrounding ground surface (Ertec 1982).

In August 1981, the U.S. Army Environmental Hygiene Agency (AEHA) conducted limited sampling and analysis of soils in the vicinity of the TNT Washout Ponds (AEHA 1981). A surface sediment sample was obtained from Pond No. 2 and a soil boring was conducted at a location approximately 35 feet west of Pond Nos. 2 and 3 (Figure 6-2). The soil samples collected were analyzed for TNT, RDX, and heavy metals, content, and physical properties determination. The analytical results are shown in Tables 6-2 and 6-3. Analysis of the pond surface sediment sample showed a high concentration of TNT (57,000 ppm). The concentration of RDX and metals in the surface sediment sample was below the detection limit. Results of analyses conducted in the boring samples showed the presence of TNT (7.1 ppm) to a depth of 15 feet. RDX was detected in subsurface soils to a depth of 50 feet below land surface (BLS). The concentration of metals in subsurface soils was below detection limits.

In 1982, USATHAMA completed an exploratory environmental assessment survey at TEAD (Ertec 1982), which included an evaluation of the TNT Washout Facility Area. The results of the exploratory study revealed the presence of RDX (0.013 ppm) and nitrates (264 ppm) in the regional aquifer downgradient of the ponds. In addition, 2,4,6-TNT (0.104 ppm), 2,4-DNT (0.017 ppm), and RDX (0.242 ppm) were detected in soil samples obtained during well installation at depths of 40, 50, and 60 feet, respectively (Tables 6-4 and 6-5).

In the Fall of 1984, TEAD implemented remedial actions on the washout ponds. The remedial actions included covering the ponds with soil (from the berms of the pond) and clean sand. A synthetic (PVC) cap was then installed over the fill and additional soil placed on top of the cap.

On 14 January 1985, U.S. EPA, TEAD, and State of Utah personnel inspected the TNT Washout Facility Area. Based on the findings of the Ertec report, on the HRS scoring of N-TEAD, and on the onsite inspection, U.S. EPA determined that the Old TNT Washout Facility ponds were CERCLA-regulated waste disposal units. The Washout Percolation/Evaporation ponds, collectively, were subsequently proposed for designation as a NPL (Superfund) site (Camp, Dresser, and McKee, Inc. 1985).

6.1.2 New TNT Washout Basin

The New TNT Washout Basin consists of an unlined square-shaped depression (approximately 125 x 125 feet) surrounded by a berm (approximately 5 feet), situated due west of the Old TNT Washout Pond Area and approximately 100 feet northwest of the TNT Washout Facility (Figure 6-2). This basin reportedly received backwash rinse water from the charcoal filtration system during facility "clean-out" operations and rinse water from a large (35,000 gal) process-water recovery (settling) tank within the washout facility. The charcoal filtration system was installed in 1983 to further aid in the recovery of residual explosives and provide for a "closed loop" washout system. At the time of EA's onsite survey (December 1985), the basin was dry and no visible evidence

TABLE 6-2 RESULTS FOR SOIL SAMPLES COLLECTED BY AEHA IN THE TNT WASHOUT AREA, N-TEAD (AUGUST 1981)

Sample Location	Sample Depth (ft)	TNT	RDI	Parameter (ppm)							
				As	Ba	Cd	Cr	Pb	Hg	Se	Ag
TNT Washout Pond 2 Sediment	Surface	57,000	<0.1	<0.50	<10	<0.10	<0.50	<0.50	<0.020	<0.10	<0.50
Bore Hole 5	8.5-10	8.7	2.8	<0.50	<10	<0.10	<0.50	<0.50	<0.020	<0.10	<0.50
Bore Hole 5	13.5-15	7.1	5.9	<0.50	<10	<0.10	<0.50	<0.50	<0.020	<0.10	<0.50
Bore Hole 5	23.5-25	<0.1	18	<0.50	<10	<0.10	<0.50	<0.50	<0.020	<0.10	<0.50
Bore Hole 5	26-28	--	--	--	--	--	--	--	--	--	--
Bore Hole 5	34-35.5	--	49	--	--	--	--	--	--	--	--
Bore Hole 5	43-44	--	--	--	--	--	--	--	--	--	--
Bore Hole 5	49-50.5	--	17	--	--	--	--	--	--	--	--
Bore Hole 5	74-75.5	--	<0.1	--	--	--	--	--	--	--	--
Bore Hole 5	76-78	--	--	--	--	--	--	--	--	--	--

NOTE: Concentrations of heavy metals were determined using EP Toxicity Methods.

Source: AEHA (1981).

TABLE 6-3 PHYSICAL PROPERTY ANALYSIS OF SUBSURFACE SOIL SAMPLES COLLECTED BY AEHA IN THE TNT WASHOUT AREA, N-TEAD (AUGUST 1981)

Borehole Number	5	5	5	5
Depth of Sample (ft)	26-28	43-44	76-78	76-78
Sample Type	Bag	Bag	Bag 3A	Bag 3B
Grain Size Analysis				
% Passing No. 4 (sieve)	99.8	100.0	100.0	100.0
% Passing No. 10 (sieve)	99.7	100.0	100.0	100.0
% Passing No. 20 (sieve)	99.4	99.9	100.0	100.0
% Passing No. 40 (sieve)	98.8	99.7	99.9	99.9
% Passing No. 100 (sieve)	96.2	99.2	98.9	99.0
% Passing No. 200 (sieve)	83.8	93.6	86.8	90.8
Atterbug Limits				
Liquid Limit W_L	24.7	28.8	26.7	27.9
Plastic Limit W_P	18.4	20.6	22.8	22.3
Plastic Index I_P	6.3	8.2	3.9	5.6
Unified Soil Classification	CL-ML	CL	ML	ML
Permeability cm/sc (k)				
Proctor Density - Remolded, Hand	3.22×10^{-6}	2.24×10^{-7}	4.42×10^{-7}	---
Specific Gravity		2.634		

Source: AEHA 1981.

TABLE 6-4 ANALYTICAL RESULTS FOR GROUNDWATER AND SURFACE WATER SAMPLES
COLLECTED BY ERTEC IN THE TNT WASHOUT AREA, N-TEAD

Parameter (µg/L)	Ground Water		Laundry Effluent	Detection Limit	EPA Water Quality Standard
	N-3A	N-3B	N-SW1		
<u>Volatiles:</u>					
1,1,1-TCE	---	---	1.8	2	18,400
<u>Semi-volatiles:</u>					
4,6-DN2C	---	27	---	40	---
<u>Explosives:</u>					
RDX	13	---	---	2	---
<u>Metals:</u>					
As	---	46	---	4	22.0
Ni	33	---	8	4	13.4
Zn	38	69	48	3	5,000
Cr	11	8	12	20	---
Cu	---	9	7	6	1,000
Pb	46	---	41	30	50
<u>Anions:</u>					
CL	872,100	>16,700	33,500	1,000	2.5x10 ⁵
F	890+	6,640	8,850	1,000	---
NO ₃	264,200	22,200	12,200	1,000	1x10 ⁴ (as N)
SO ₄	779,500	>18,500	222,000	1,000	---
Na	296,000	251,000	19,200	1,000	1x10 ⁶
<u>Gross Beta Radiation (pCi/l)</u>					
	15+6	15+3	---	6	50

Source: Ertec 1982.

TABLE 6-5 ANALYTICAL RESULTS FOR SOIL AND SEDIMENT SAMPLES COLLECTED BY ERTEC IN THE TNT WASHOUT AREA, N-TEAD (in $\mu\text{g/l}$)*

Sample Location	Explosives			RDX	Metals		Anions			
	2,4-DNT	2,6-DNT	2,4,6-TNT		Ni	Zn	NO ₃	PO ₄	SO ₄	Na
N-SD3	--	--	--	--	9	19	--	2,760	>20,400	14,700
N-3A (0.5-1.5 ft)	84	256	31	1,024	7	8	3,330	1,840	970+	1,190
N-3A (10-11.5 ft)	--	--	--	5	--	--	--	--	--	--
N-3A (20-21.5 ft)	--	--	--	19	--	--	--	--	--	--
N-3A (30-41.5 ft)	--	--	104	--	--	--	--	--	--	--
N-3A (50-51.5 ft)	17	--	--	--	--	--	--	--	--	--
N-3A (60-61.5 ft)	--	--	--	242	--	--	--	--	--	--
N-3A (70-71.5 ft)	--	--	--	11	--	--	--	--	--	--
N-3A (80-81.5 ft)	--	--	--	26	--	--	--	--	--	--
N-3A (90-91.5 ft)	--	--	--	28	--	--	--	--	--	--
Limits of Detection (Soil)	15	20	5	10	4	3	1,000	800	1,000	1,000

* Analysis performed on soil and sediment leach samples.

Source: Ertec 1982.

of TNT contamination (e.g., pink soils) was observed. However, during an onsite visit performed by U.S. EPA representatives (Camp, Dresser, and McKee, Inc. 1985) in December 1984, "a certain amount" of standing water was observed within the basin. No previous analytical data are available for this basin.

6.1.3 Laundry Effluent Ponds

Northeast of the Old (closed) TNT Washout Percolation/Evaporation ponds are two shallow unlined laundry effluent holding ponds (Figure 6-2). The northernmost of the ponds receives laundry and shower wastewaters from Building 67 at a reported rate of 7,200 gal/day (Ertec 1982). Standing water and effluent flow into the pond was observed during the PA/SI site visit in 1985. The effluent ponds reportedly overflowed onto the surrounding landscape in a northerly direction (Ertec 1982); the date or period of time when this occurred is unknown. No overflow from the holding pond was apparent during the PA/SI site reconnaissance. The southernmost effluent holding pond was originally constructed for the purpose of receiving laundry effluent. It consists of a dry, bermed, catchment on the land's surface. Because an adequate gradient was not provided for conveying effluent from the laundry facility to this catchment, it reportedly was never used as a holding pond and never received laundry effluent.

One surface water and one sediment sample were obtained for analysis from the northern laundry effluent pond as part of the exploratory survey of TNT Washout Facility Area (Ertec 1982). Analysis of these samples showed no detectable levels of explosive compounds, but relatively high concentrations of sodium, sulfate, and chloride (Tables 6-4 and 6-5). A low concentration level of 1,1,1-trichloroethane (1.8 µg/L) was also detected in the surface water. The effluent holding pond was reported to be the source and mechanism by which contaminants are continually flushed to the underlying aquifers (Ertec 1982).

6.1.4 Area of Surface Contamination

The TNT Washout Percolation/Evaporation and Laundry Effluent ponds reportedly overflowed and/or flooded, which potentially resulted in the contamination of the surrounding soils with explosive compounds. Soil samples obtained and analyzed by Ertec (1982) during borehole drilling of Well N-3A, which was installed within the reported area of surface contamination, contained 2,4-DNT; 2,6-DNT; 2,4,6-TNT, and RDX (Table 6-5). The potential area of surface contamination, as delineated by Ertec (1982), is shown in Figure 6-2.

6.2 SANITARY LANDFILL

The Sanitary Landfill is located in a natural depression approximately 1,200 feet southeast of the sewage lagoons in the eastern portion of N-TEAD (Figure 6-1). The fill area consists of two areas which are physically separated by Incinerator Road, covering a total area of approximately 75-90 acres (Figure 6-3). The major portion of the landfill is situated on the east side of Incinerator Road, where current landfilling operations are taking place. The landfilling operation

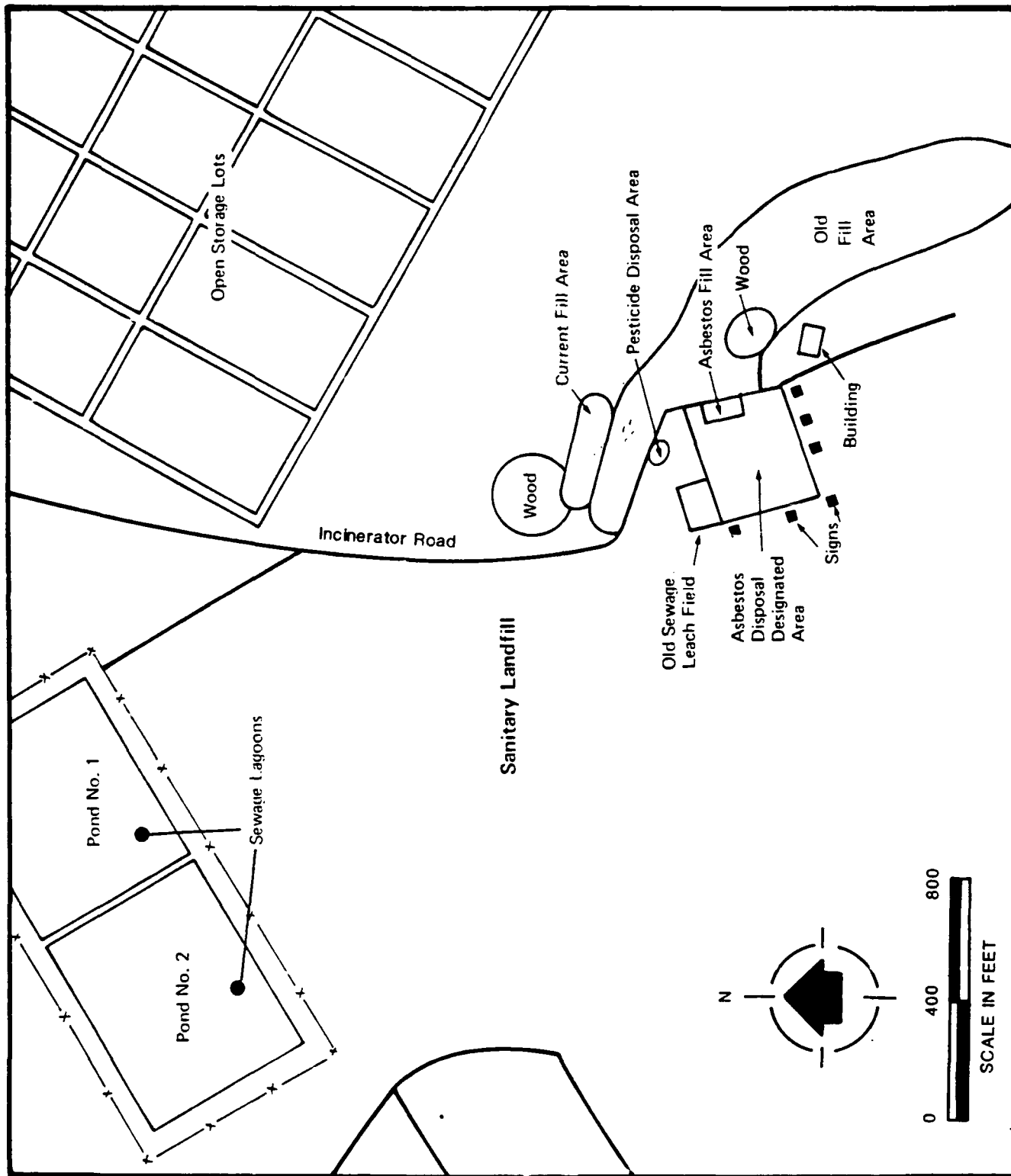


Figure 6-3. Site Map of Sanitary Landfill and Sewage Lagoons, N-TEAD.

generally consists of placing the waste material in the natural depression and then covering it with alluvial deposits which are bulldozed from the upper rim. Cover material is placed over wastes every 2-3 months. Side slopes of the landfill are unstable and have broken away into the fill area during bulldozing operations.

The Sanitary Landfill is an unlined facility that has been used for waste disposal since the Depot began operating in 1942. A wide variety of wastes are known to have been placed in the landfill, including the following:

- . Scrap metal, including steel cables and empty 55-gallon drums
- . Rubber and tires
- . Scrap wood and paper
- . Paint containers
- . Paint thinner and stripper containers (empty)
- . Battery acid containers, 5-gallon plastic, empty and full
- . Asbestos-contaminated materials
- . Pesticide and herbicide containers
- . Used ethylene glycol

Although no records exist to confirm all past waste disposal practices, it has been speculated by Depot personnel that spent solvents and other hazardous materials may have been placed in the landfill (Fuerbach 1985; Painter 1985). This is not unlikely, as disposal of these types of materials in landfills was accepted practice in the 1940s, 1950s, and 1960s.

The fill area situated on the northeast side of Incinerator Road is currently used for disposal of general refuse. Eighty percent of the fill in this area is reported to be scrap wood. The depth of fill material in this area is approximately 30 feet (Fuerbach 1985).

Located adjacent to the northernmost section of the general fill area is a small trench filled with 55-gallon drums marked "1,1,1-TCE." The drums are neatly lined up and are empty. In this same area are 55-gallon drums of ethylene glycol (antifreeze) leaking onto the soil surface. During the site visit (December 1985), EA personnel observed a large area where ethylene glycol had melted snow cover and prevented freezing of the ground surface.

Also located near the current operating fill area is a gravel pit where liquid boiler residues (black tarry substances) and fuels from the Boiler Building (Building 637) have been disposed. Disposal of these wastes was practiced intermittently for several months during the Fall of 1985 and approved by the Facilities Engineering Division. Approximately 2-3 cubic yards of this material per week were placed in the pit. The estimated total waste volume in the gravel pit is 16 cubic yards (Fuerbach 1985).

The area on the west side of Incinerator Road has been designated for disposal of pesticides, herbicides, and asbestos, and is posted with warning signs. Asbestos-contaminated materials are put in plastic bags prior to disposal. A total of 60-70 cubic yards of asbestos material

have been placed in this section of the landfill. In the past, asbestos materials were disposed east of Incinerator Road in the area designated for nonhazardous material disposal (Fuerbach 1985).

Pesticide containers observed at the landfill were empty. However, it is not known if, in the past, any full containers may have been placed in the landfill. No banned-from-use pesticides (i.e., DDT; 2,4,5-T) have been buried in the landfill (Fuerbach 1985).

Adjacent to and north of the asbestos fill area is an old sewage leach field. Sewage from the Administration Area was channeled into this area before the sewage lagoons were constructed in 1972 (Fuerbach 1985).

There is no record of any environmental investigations having been conducted at the Sanitary Landfill to evaluate the potential for soil and/or groundwater contamination. A monitoring well (N-4) was installed 1,200 feet north-northwest of the sewage lagoons during the Ertec (1982) investigations to evaluate the potential for groundwater contamination resulting from the Sewage Lagoons and the Sanitary Landfill. Analysis of a sample collected from this well showed the presence of trichloroethene, nickel, and zinc.

The valley fill deposits in the area of the Sanitary Landfill are probably over 700 feet thick. The boring logs of two wells located within 2,500 feet of the landfill (Wells 2 and N-4) show that the valley fill consists of deposits of clayey gravels, conglomerates, and coarse sand and gravel down to 700 feet.

Ertec (1982) estimated the depth to the regional water table aquifer at the Sanitary Landfill to be approximately 300 feet. A perched groundwater table may also exist at the site as groundwater was reportedly encountered at a depth of about 30 feet below ground surface in the active fill areas of the landfill during bulldozing operations. The direction of groundwater flow at this site is believed to be to the north-northwest. However, the water mound beneath the sewage lagoon may be influencing groundwater flow in the vicinity of the landfill. The sanitary landfill is considered to have a high potential to release contaminants to the environment due to the known and potential wastes which were disposed at the unlined site and the close proximity of the sewage lagoons which may be a mechanism to influence movement of leachate to the water table.

6.3 INDUSTRIAL WASTE LAGOON

The Industrial Waste Lagoon (IWL) is located in the eastern portion of N-TEAD, northwest of the Maintenance and Supply Area (Figure 6-1). The site consists of an unlined evaporation pond (approximately 125 feet by 250 feet) that receives wastewater containing solvents and heavy metals from the various industrial operations (degreasing, metal cleaning and stripping, steam cleaning, and painting) in the Maintenance and Supply Area. Industrial effluent is discharged to the lagoon via four unlined ditches (Figure 6-4). The IWL has operated for approximately 20 years and has recovered an average of more than 125,000 gallons per day of waste water. Approximately 96 percent of the wastewater reportedly

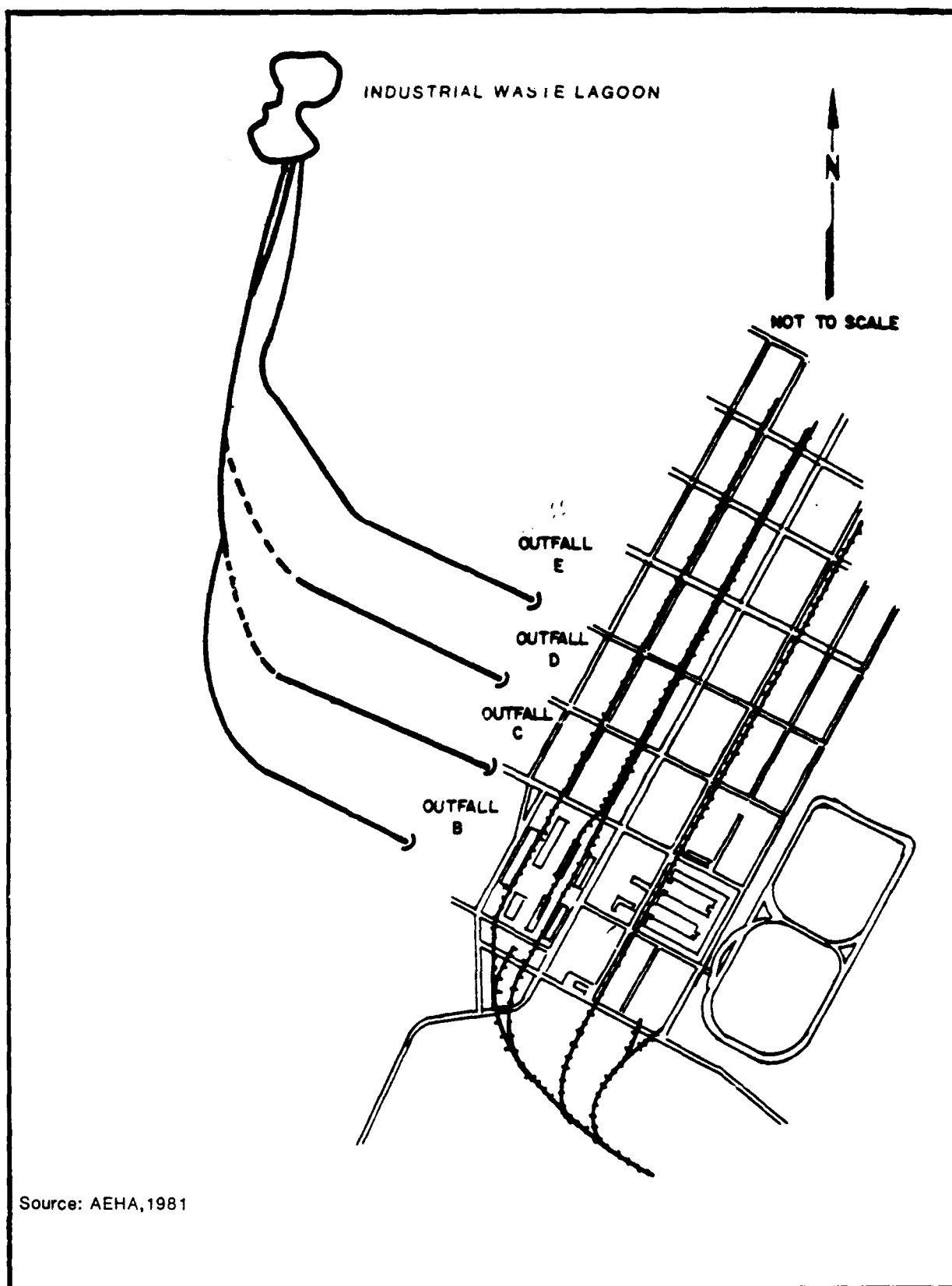


Figure 6-4. Site map of Industrial Waste Lagoon. N-TEAD.

infiltrates into the ground through the unlined pond and conveyance ditches (JMM 1987). Seepage of wastewater through the ditches and lagoon has resulted in the contamination of groundwater in this area with volatile organic compounds such as trichloroethene (TCE), 1,1,1-trichloroethane (TCA), and carbon tetrachloride (CTC), and heavy metals such as chromium, cadmium, and lead (Ertec 1982; Woodward-Clyde Consultants 1985; JMM 1987). An extensive groundwater quality assessment program was being conducted at this site by JMM under contract with the Army Corps of Engineers, during this PA/SI effort, to evaluate the extent of groundwater contamination resulting from wastewater seepage from the ditches and IWL (JMM 1987). Consequently, this site was not included in the installation PA/SI Field Program.

6.4 OLD INDUSTRIAL WASTE SPREADING GROUNDS/POND AREA

Industrial wastewater from the Maintenance and Supply Area was reportedly discharged via outfall into a wide area known as the "spreading grounds" prior to the existence of the IWL. During the late 1940s, wastewater was also discharged to a gravel lined pond north of Avenue H in the Maintenance and Supply Area (USATHAMA 1979). Installation records do not contain any information on this site (other than its prior existence). The general site area, as determined from aerial photographs for the area (U.S. EPA 1982), is shown on Figure 6-1. The area included a wide area west of the Maintenance and Supply Area. There was as many as seven ditches, one of which leaked into a gravel pit (no longer exists) along the southeast corner of the Igloo Storage Area. Several ditches also ended and spread into the eastern portion of the Igloo Storage area. An extensive groundwater quality assessment study was being conducted in the vicinity of the Old Industrial Waste Spreading Grounds by JMM under contract to the Army Corps of Engineers at the time of this PA/SI effort. Consequently, this site was not included in the installation PA/SI Field Program. The results of the investigation of the IWL area by JMM (1987) revealed groundwater in this area of the Depot to be contaminated with various volatile organic compounds (e.g., TCE, TCA, CTC) and metals (e.g., chromium, cadmium, and lead).

6.5 SEWAGE LAGOONS

The sewage lagoons are located west of the Maintenance and Supply Area (Figure 6-1) and northwest of the Sanitary Landfill (Figure 6-3) at N-TEAD. The two clay-lined lagoons were constructed in 1972, each 617 feet by 518 feet in size (18 acres) and 4 ft deep. The capacity of each pond is approximately 9 million gallons. All sewage from N-TEAD, except for the houses at the Headquarters Area and the Ammunition Exclusion Area, which are serviced by septic systems, is discharged to the sewage lagoons. Wastewater enters Pond No. 1 (northernmost pond) and overflows into Pond No. 2. The average daily flow rate to the ponds is 90,000 gallons. Treatment is provided via biological stabilization. Percolation and evaporation provides for the ultimate disposal of the wastewater. Approximately 75 percent of the effluent discharged to the ponds infiltrates through the soil (JMM 1987). As a result, a groundwater mound has built up beneath the Sewage Lagoon. Relatively high levels of nickel and nitrates were detected during past sampling efforts (Ertec 1982) which approach U.S. EPA Water Quality Standards in

Well N-4 (located approximately 1,200 ft downgradient of the Sewage Lagoon), which indicates possible past contamination from this site. Because of the proximity of the Sanitary Landfill and the Old Industrial Waste Spreading Area in this area, contamination may be complicated by seepage from these sources.

Daily measurements for pH, temperature, and flow rate are taken as required by the State of Utah. The facility is not NPDES-permitted because wastewater is not discharged from the ponds.

An extensive groundwater quality assessment study was being conducted in the vicinity of this site by JMM under contract to the Army Corps of Engineers at the time of this PA/SI effort. Consequently, this site was not included in the installation PA/SI Field Program. The results of the investigation of the IWL area by JMM (1987) revealed groundwater in this area of the Depot to be contaminated with various volatile organic compounds (e.g., TCE, TCA, CTC) and metals (e.g., chromium, cadmium, and lead). However, the extent to which this site may or may not be contributing to the contamination of groundwater in this area of the Depot was not evaluated as part of the JMM study and could not be determined from available information. Although the available data suggests that the lagoons only receive domestic sewage, the possibility exists for some hazardous waste to enter the lagoons.

6.6 X-RAY LAGOON

The X-ray lagoon is located immediately north of Building 1223 on the northern side of McIntyre Road in the Ammunition Workshop Area (Figure 6-1). The lagoon, which is approximately 50 feet x 15 feet in size, was built 10-15 years ago for the collection of rinse water from the development of X-rays in Building 1223. The lagoon is lined with a synthetic plastic liner placed over a layer of gravel. The X-ray development process is operated intermittently, running approximately 8 hours/day for 6 months out of the year. The flow rate of water through the developer is 3 gallons per minute. Approximately 99 percent of the wastewater discharged to the lagoon is rinse water from the washing of the film. There is no information which indicates that this site resulted in the release of contaminants to the environment. However, because of the unknown condition of the X-ray lagoon liner, there is a potential for release of contaminants to the environment if a leak exists.

6.7 FORMER TRANSFORMER STORAGE SITE

Transformers containing PCB-contaminated oil were stored in an open storage yard at N-TEAD until 1979. Long-term storage of transformers was practiced at Open Storage Lot 675B, located northwest of the Maintenance and Supply Area (Figures 6-1 and 6-5). In 1979, all transformers were removed from the site for storage at Building 659 or for disposal. Following removal, the TEAD Facilities Engineering Division reportedly sampled surficial soils at the site (0-3 in.) to determine PCB concentrations. According to site personnel, no soil samples contained PCB concentrations >50 ppm. The site was eventually graded and is currently used for equipment storage.

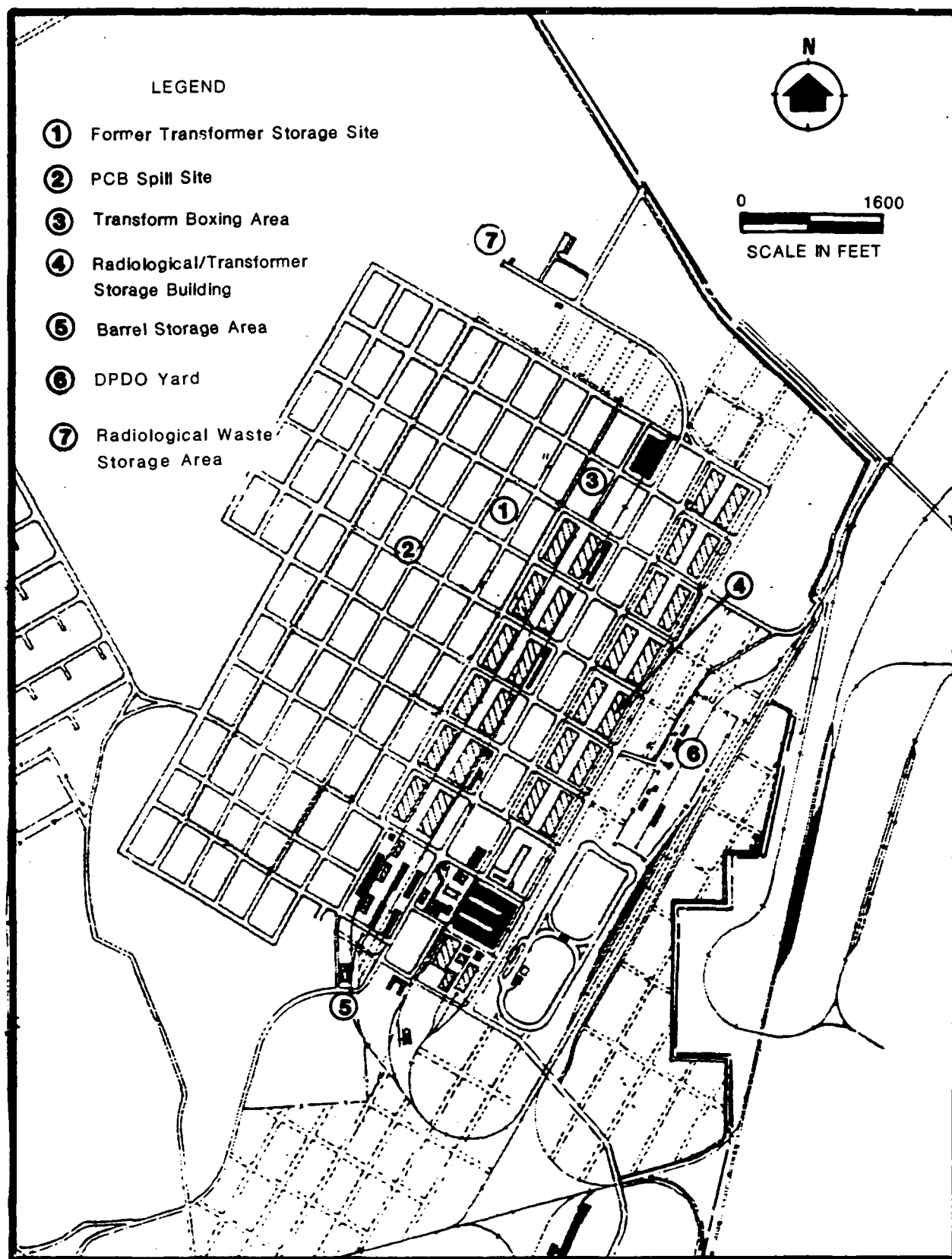


Figure 6-5. N-TEAD Maintenance and Supply Area Sites.

Due to the lack of available data confirming that soils at the site are not contaminated with PCBs, sampling of surficial soils was conducted. A detailed description of the field sampling and analytical programs conducted at this site is presented in Section 8.2.

6.8 TRANSFORMER BOXING SITE

Open Storage Lot 680, located approximately 400 feet east of the Transformer Open Storage Site, was used for boxing of transformers originally stored at Lot 675B (Figure 6-5). Use of the site for this purpose ended in 1979-1980. There is no record of any sampling and analysis of surficial soils having been conducted at this site. The site was not used for long-term storage of transformers, and there is no record of any spills having occurred. There is no information which indicates that activities performed at this site resulted in the release of contaminants to the environment. Because of the short-term use of the site and no record of any spills, the site is considered to have a low potential for release of contamination to the environment.

6.9 PCB SPILL SITE

Around October 1980, a PCB spill occurred at a site located on the southern corner of Open Storage Lot No. 665D (Figure 6-5). Two transformers, containing a total of 1,000 gallons of PCB-contaminated oil, were punctured with a fork lift blade during removal operations (U.S. EPA 1982). It was estimated by the Depot personnel that the oil covered less than 1/2 acre of ground surface. Soils saturated with the oil were excavated, drummed, and properly disposed of. Soil excavation was reported to have been conducted down to 8 feet at some spots. A total of 440 55-gallon drums of contaminated soil and eighteen 55-gallon drums of contaminated oil were removed.

Due to the lack of available data confirming that PCB-contaminated soils at the spill site were completely removed, sampling and analysis of surficial soils was conducted during the installation PA/SI field program. A detailed discussion of the sampling program and analytical results is presented in Section 8.3.

6.10 PCB STORAGE FACILITY--BUILDING 659

Following closure of the former PCB Open Storage Site in 1979, all transformers have since been stored in Building 659, located in the Maintenance and Supply Area (Figure 6-5). This facility has a sealed cement floor and diversion structures have been constructed at each entrance to contain any oil spills. There have been instances of oil spills inside the facility. When a spill occurs, oil is cleaned up and all contaminated materials (e.g., oil absorbent, protective clothing) are properly drummed and marked for disposal. This facility appeared to be well operated and maintained during the onsite visit. PCB contaminated waste disposal is coordinated through the DRMO and sent via a private contractor to an approved landfill. Currently, the wastes are removed by US Pollution Control, Inc. of West Murray, Utah and sent to Grassy Mountain Landfill in Utah. The site is considered to have a low potential for release of contaminants to the environment.

6.11 PESTICIDE/HERBICIDE HANDLING AND STORAGE

The Pesticide/Herbicide Storage and Mixing-Formulation Areas, located in Building 518 at the Industrial Area, were inspected during the onsite visit (Figure 6-1). The storage facility is well labeled and is secured with a chainlink fence. Pesticides and herbicides are stored in separate vented, locked rooms. The facility has bermed concrete floors that are sealed and the building is constructed of flame-retardant material. The mixing-formulation area, located in the same building, but separated from the storage area by bermed concrete, is vented and equipped with backflow prevention devices on the water line.

Pesticides/herbicides are used throughout the installation by certified pest control personnel, and appear to be well managed. In general, the facility appeared to be well operated and maintained in accordance with U.S. AEHA guidelines and federal standards, which are provided in Appendix I-A.

No stocks of "banned-use," outdated, or otherwise "excess" pesticides are stored in Building 518, with the exception of 12 oz. of strychnine and 19 one-liter bottles of the fumigant Vapon.

Disposal of pesticide/herbicide containers is conducted in a designated area of the N-TEAD sanitary landfill. Disposal of outdated or banned-from-use pesticides/herbicides is performed off-Depot and coordinated through the DRMO by a service contract set up by the Defense Logistics Agency. There has not been any disposal of obsolete pesticides at N-TEAD for several years. Disposal and cleanup of accidental spillage is conducted according to AEHA guidelines. There is no indication that a release of contamination has occurred and the potential is considered to be low.

6.12 RADIOLOGICAL STORAGE AREA

A section of Building 659, located in the Maintenance and Supply Area, has been designated as a radioactive storage facility (Figure 6-5). Stored in the facility are small quantities of radioactive materials including tritium H_3 , radium, and uranium-238. Radioactive materials have been stored in this building for approximately 6-7 years.

Two U.S. Nuclear Regulatory Commission (NRC) licenses have been issued to the facility, as well as two U.S. Army radiation authorizations. All materials are labeled with the appropriate NRC warning symbols. Monitoring is not conducted because the amount of radioactive material generated is very small. Due to the small amount of material generated, disposal is limited to approximately once every 5 years. The disposal process is handled by the U.S. Armament, Munitions, and Chemical Command at the Rock Island Arsenal. No radioactive releases have occurred at N-TEAD according to Depot personnel. The radiological storage area appeared to be well operated and maintained during the onsite visit. The potential for contamination release is considered to be low.

6.13 WASTEWATER SPREADING AREA

Located in the southeast corner of N-TEAD, behind the Administration Area, is a possible past wastewater spreading operation (Figure 6-1). The site inspection conducted 19 February 1987 found the site intact and inactive. Two trenches (4- to 6-feet deep) lead from an old residential area (presently the Security Office Area) through two culverts under the railroad tracks. The trenches cross a gently sloping field (approximately 2-3 percent slope) to a ravine which drops off 40-50 feet. At the base of the ravine, where the wastewater spreading occurred, is a line of trees and brush.

In the 1953 EPIC photograph for this area, liquid can be seen in the trenches and in several channels cut at the base of the ravine. The area was also active during the 1959 EPIC photo, but use of the channels declined as the residential facility was dismantled. The housing area was leveled by 1966 (U.S. EPA 1982).

This site received domestic wastewater originating from the old housing area. There is no information that the housing area was used for any purpose other than a residential facility during the time wastes were discharged to the spreading area. The potential for release of contaminants from this site is considered to be low.

6.14 BARREL STORAGE AREA

The Barrel Storage Site is a large fenced storage lot located in east-central N-TEAD (Figure 6-1) at the southern end of the Maintenance and Supply Area and immediately east of the Sanitary Landfill (Figure 6-5).

Throughout the EPIC study period (1953-1981), a variety of containers (probably drums) were placed on the storage lot, and ground staining can be observed from the EPIC photos. In the 1953 EPIC photo, a large number of drums can be seen in a lot northwest of the open storage area (U.S. EPA 1982).

Used drums of all sizes and types were brought to this storage lot prior to their return to originating contractors. The Installation's policy was to store the used drums upside down to empty residual contents and to keep precipitation out. Storage time at the site was short and thousands of drums have passed through the site. For the past 2-3 years, the drums have been cleaned before coming to the site.

A potential for soil and groundwater contamination exists at the site as many of the drums contained products used in the Maintenance and Supply Area (i.e., oils, solvents, degreasers), and the volume of residual drum contents could have been from 1/4 to as much as 2 gals. A portion of the site surface is now paved, however, most areas are still gravel covered.

6.15 OPEN BURN/OPEN DETONATION AREA

The Open Burn/Open Detonation (OB/OD) Area actually consists of a number of trenches and pits which collectively are referred to as the OB/OD Area. The activities conducted at these sites include open burning, open

detonation, and burial. The OB/OD Area is located in the southwest portion of N-TEAD (Figure 6-1). Groundwater at this location is more than 700 feet below land surface. During the 1982 exploratory survey (Ertec 1982), a boring was drilled to a depth of 709 feet, no water was encountered, and no well installed. Refer to Figure 6-6 for boring location. The specific sites associated with each type of activity are described below.

6.15.1 Open Detonation Pits

The majority of open detonation operations at N-TEAD are conducted in a series of demolition pits located at the base of a steep hill on the southwest corner of N-TEAD (Figure 6-6). All types of conventional munitions are destroyed at this site, from small arms up to 12,000-lb bombs, including propellants and rocket motors. Materials to be destroyed are placed in the pits (up to 6,804 kg per shot), the pits are closed with earth and then detonated (USATHAMA 1979). After detonation, the area is searched for unexploded ordnance (UXO); if any UXO are found, they are destroyed in place. An environmental investigation conducted by AEHA in 1981 showed significant quantities of RDX and HMX in surficial soil samples. Refer to Table 6-6 for analytical results of AEHA 1981 sampling effort. Based on the long term and continued use of this site, and on the results of the AEHA (1983) study, a potential for groundwater contamination was considered to exist. Consequently, sampling of groundwater was conducted during the installation PA/SI Field Program. A detailed discussion of the sampling program and analytical results is presented in Section 8.4.

6.15.2 Cluster Bomb Demolition Area

An area located on the eastern edge of the ridge near the open detonation pits has reportedly been used for the surface detonation of cluster bombs. AEHA (1983) conducted sampling of surficial soils at this area. Of four samples taken, only two showed detectable levels of explosives and those did not exceed 2.2 µg/g. Results of heavy metals analyses showed that concentrations did not exceed U.S. EPA hazardous waste criteria limits (Table 6-6). Based on the available information, which is limited, this site does not appear to pose a significant risk to the environment or public health, based on (1) the low concentrations of contaminants found in surficial soils (AEHA 1983), (2) the isolated location of the site, and (3) great depth to groundwater (approximately 700 feet BLS).

6.15.3 Propellant Burn Pad

A cleared area, located about 2,000 feet east of the open detonation pits and immediately north of the chemical range, has been used for open burning of propellant and for flashing projectiles (Figure 6-6). The burn pad covers an area of 27,000 square feet (90 x 300 feet in size). AEHA (1983) conducted sampling and analysis of soils (0-18 in.) at seven locations at this site. Low levels of explosives were found in four of

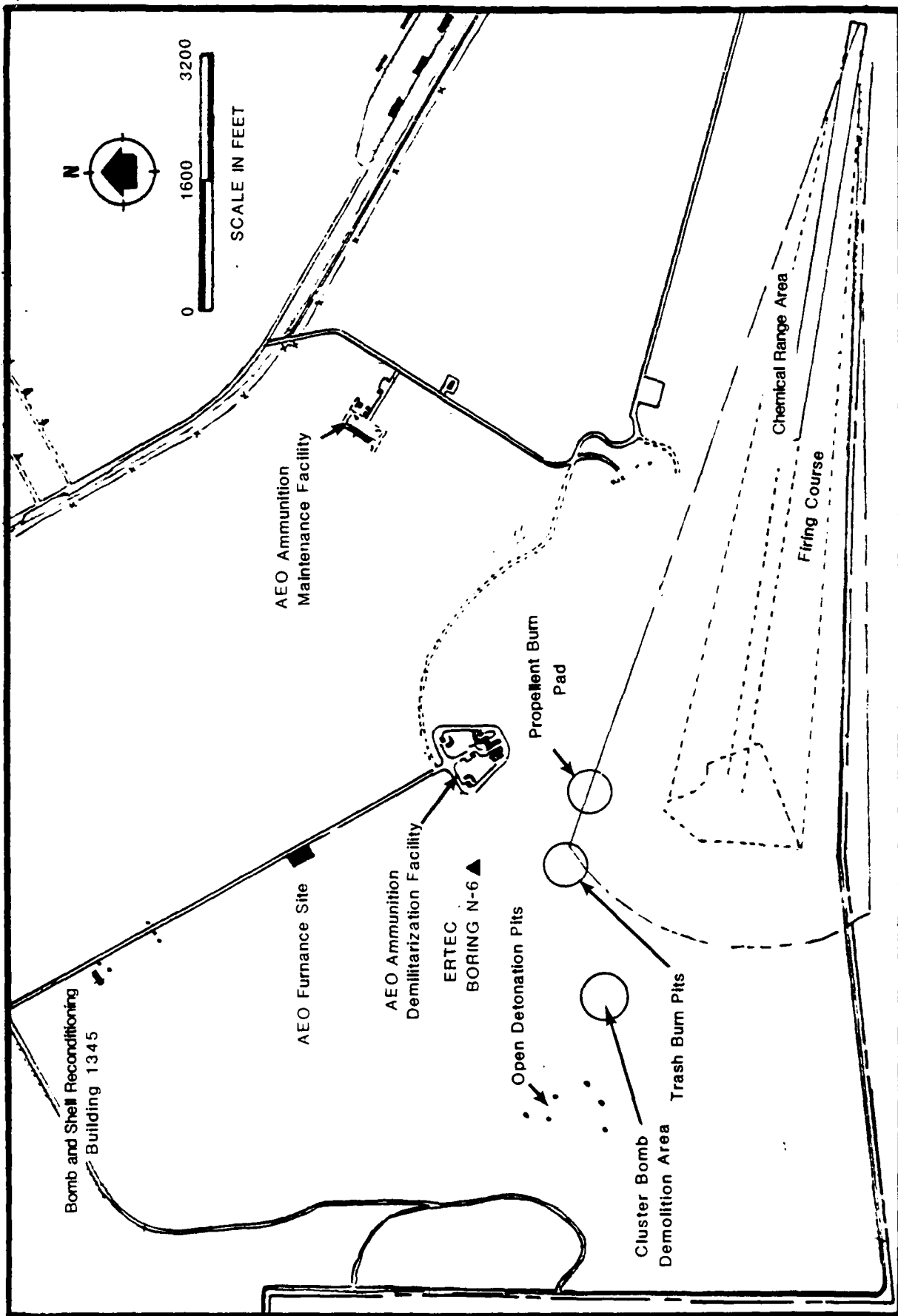


Figure 6-6. Site map of southwest portion of N-TEAD.

TABLE 6-6 ANALYTICAL RESULTS FOR SOIL SAMPLES COLLECTED BY AEHA IN OB/OD AREA, N-TEAD (SEPTEMBER 1981)

	EP Toxicity*										Explosives**		
	As		Ba		Cd		Cr		Hg		Se		Tetryl
	Ag	PB	Ag	HMX	RDX	Ag	HMX	RDX	Ag	HMX	RDX	Ag	
Demo Area Crater No. 2	ND	1.25	0.97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Demo Area Crater No. 2	ND	1.31	0.98	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Demo Area Crater No. 2	ND	1.84	1.21	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Demo Area Crater No. 2	ND	1.61	1.05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Demo Area Crater No. 2	ND	1.50	0.70	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Demo Area Crater No. 2	ND	1.55	0.98	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Demo Area Crater No. 4	ND	1.11	0.12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Demo Area Crater No. 4	ND	1.58	0.67	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Demo Area Crater No. 4	ND	ND	1.06	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Demo Area Crater No. 4	ND	ND	0.56	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Demo Area Crater No. 4	ND	1.99	0.98	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Demo Area Crater No. 4	ND	2.23	0.83	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Demo Area Crater No. 6	ND	2.34	0.86	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Demo Area Crater No. 6	ND	1.77	0.89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Demo Area Crater No. 6	ND	1.86	1.99	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Demo Area Crater No. 6	ND	2.76	0.79	ND	0.0003	ND	ND	ND	ND	ND	ND	ND	ND
Demo Area Crater No. 6	ND	1.32	0.57	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Demo Area Crater No. 6	ND	2.97	0.91	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Demo Area Crater No. 8	ND	1.53	1.34	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Demo Area Crater No. 8	ND	1.13	1.61	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Demo Area Crater No. 8	ND	1.61	2.05	ND	0.0002	ND	ND	ND	ND	ND	ND	ND	ND
Demo Area Crater No. 8	ND	2.12	0.75	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Demo Area Crater No. 8	ND	1.99	0.59	ND	0.0002	ND	ND	ND	ND	ND	ND	ND	ND
Demo Area Crater No. 8	ND	1.19	0.24	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Demo Area Cluster Bombs	0.015	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Demo Area Cluster Bombs	0.021	1.16	ND	ND	0.0004	ND	ND	ND	ND	ND	ND	ND	ND
Demo Area Cluster Bombs	0.019	ND	ND	ND	0.0003	0.32	ND	ND	ND	ND	ND	ND	ND
Demo Area Cluster Bombs	0.019	1.15	ND	ND	0.0004	ND	ND	ND	ND	ND	ND	ND	ND

TABLE 6-6 (Cont.)

	EP Toxicity*							Explosives**							
	As	Ba	Cd	Cr	Hg	Pb	Se	Ag	HMZ	RDX	Tetryl	TNT	2,4,6	DNT	2,4
Propellant Burn Area Pt. 5, 0-6 inches	0.011	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Propellant Burn Area Pt. 5, 6-18 inches	0.012	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Propellant Burn Area Pt. 6, 0-6 inches	0.014	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Propellant Burn Area Pt. 6, 6-14 inches	ND	ND	ND	ND	0.0005	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Propellant Burn Area Pt. 7, 0-6 inches	ND	ND	ND	ND	0.0005	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Propellant Burn Area Pt. 7, 6-14 inches	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Propellant Burn Area Pt. 8, 0-6 inches	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.8	2.5	ND	ND	ND	ND
Propellant Burn Area Pt. 8, 6-18 inches	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.2
Propellant Burn Area Pt. 9, 0-6 inches	ND	ND	ND	ND	0.0004	ND	ND	ND	ND	4.0	17.3	ND	2.6	1.1	ND
Propellant Burn Area Pt. 9, 6-10 inches	ND	ND	ND	ND	0.0004	ND	ND	ND	ND	ND	1.7	ND	ND	ND	ND
Propellant Burn Area Pt. 10, 0-6 inches	0.015	ND	ND	ND	0.0008	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Propellant Burn Area Pt. 10, 6-18 inches	0.017	ND	ND	ND	0.0006	ND	ND	ND	ND	ND	1.1	ND	ND	ND	ND
Propellant Burn Area Pt. 11, 0-6 inches	0.016	ND	ND	ND	0.0006	ND	ND	ND	ND	1.0	ND	52	ND	ND	ND
Propellant Burn Area Pt. 11, 6-11 inches	0.015	ND	ND	ND	0.0003	ND	ND	ND	ND	7.5	ND	10.4	ND	ND	ND
Trash Pit Soil	0.017	2.14	ND	ND	0.0003	ND	ND	ND	ND	ND	ND	4.6	ND	ND	ND
Trash Pit Residue	--	--	--	--	--	--	--	--	--	ND	ND	ND	ND	ND	ND
Trash Pit Soil	0.027	ND	ND	ND	0.0002	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

	EP Toxicity*							
	As	Ba	Cd	Cr	Hg	Pb	Se	Ag
Detection Limit***	0.01	1.0	0.05	0.25	0.0002	0.25	0.005	0.025
RCRA Criteria Limit***	5.0	100	1.0	5.0	0.02	5.0	1.0	5.0

* All units in mg/L.

** All units in ug/g.

*** Detection limit for all explosives was 1.0 ug/g.

NOTE: ND = Not Determined.

Source: AEHA 1983.

the seven samples with one sample containing 52 $\mu\text{g/g}$ of 2,4,6-TNT (Table 6-6). Based on the same criteria as the two previous OB/OD sub-areas, this site is not considered to pose a significant risk to the environment or to public health.

6.15.4 Trash Burn Pits

Located in the open burning area are trash burn pits used for open burning of explosive-contaminated waste such as dunnage, metal banding, ammunition boxes, and other similar wastes from munitions handling operations (Figure 6-6). Solvent drums and other wastes which did not appear to be related to munitions operations have also been reportedly disposed in the pits (AEHA 1983). When the pits are full of ash and residue, they are covered and new pits are dug nearby. Three "active" pits (containing recently burned residues and wastes) were observed during the onsite visit. The total number of former pits in this area is not known. Soil samples analyzed by AEHA (1983) for explosives showed concentrations were below the limit of detection with the exception of one sample which had 4.6 $\mu\text{g/g}$ of 2,4,6-TNT (Table 6-6). Based on the available data it appears that this site does not pose a high risk of contamination to the environment or to public health, based upon its remote location, low concentration of explosives, and the great depth to groundwater (approximately 700 feet).

6.16 CHEMICAL RANGE

The Chemical Range consists of a Surveillance Area, Fire Course, and Chemical Range Area located on the southern boundary in southwest N-TEAD (Figures 6-1 and 6-6).

Chemical and pyrotechnic-type munitions, excluding toxic agent-filled, were tested on the Chemical Range. Munitions tested included grenades and projectiles, incendiary items such as bombs, grenades, pouch and document destroyers, riot-control agent-filled munitions, and flame thrower igniters. The Chemical Range was used from 1942 until the late 1960s or early 1970s. Three trenches were observed during the site investigation in the northeast area near the Surveillance buildings. The trenches were filled with various types of munitions and had not been burned or covered with soil.

This site was not identified as a potential source for environmental contamination prior to submittal of the Field Sampling Design Plan. Based on the available information, this site is considered to present a potential for soil contamination.

6.17 SURVEILLANCE TEST SITE

Located in south-central North TEAD along the Depot's southern boundary, just east of the Chemical Range, is the Surveillance Test site (Figures 6-1 and 6-7). Function testing on munitions was conducted at the site from 1942 to the 1960s. Surveillance Division personnel also conducted hot and cold treatment testing of munitions.

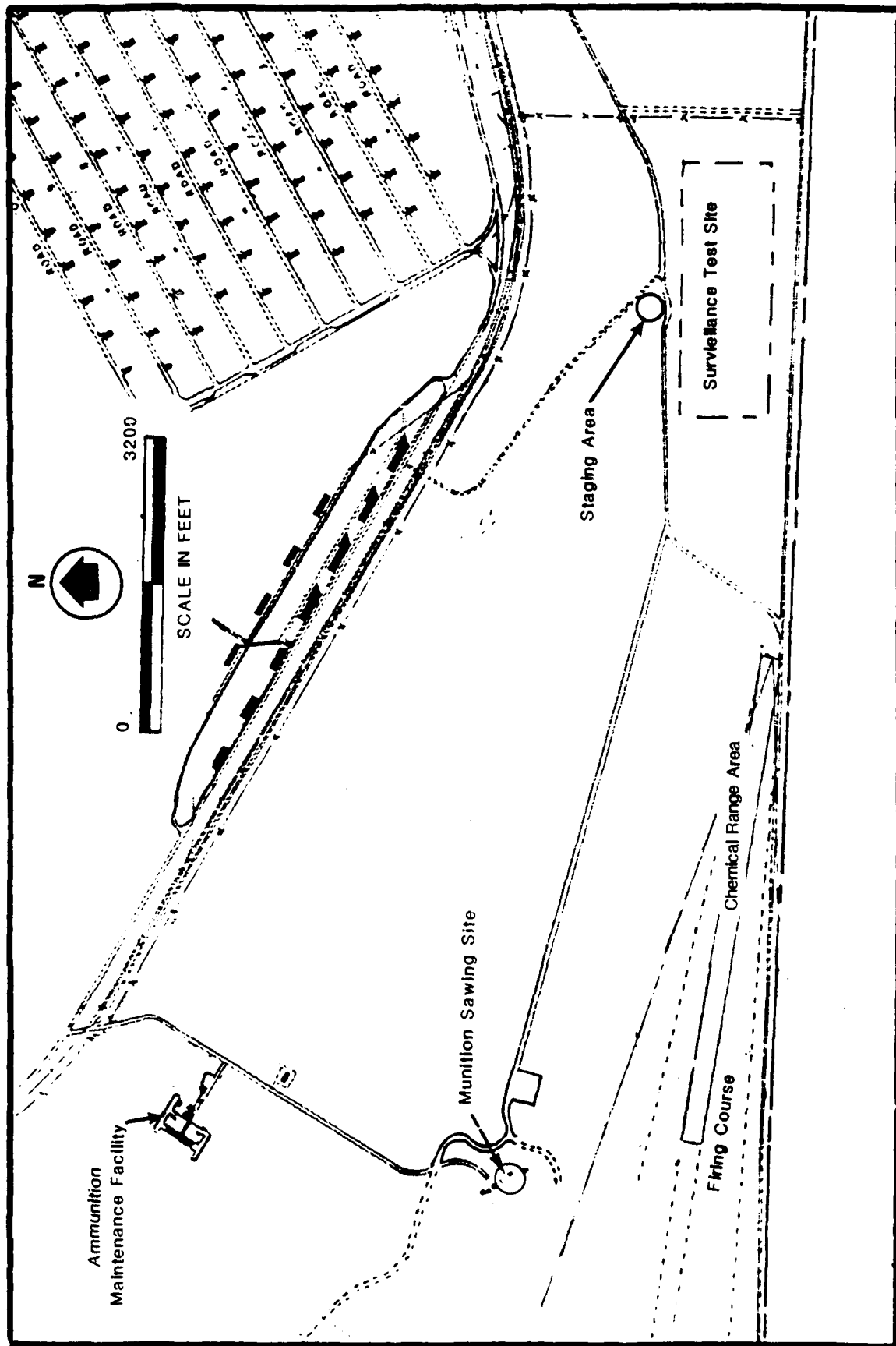


Figure 6-7. Site Map of Surveillance Test Site and Staging Area, N-TEAD.

A revetted area (test area) is located in the eastern portion of the site. Pieces of grenades, detonators, metal, and melted glass were observed during the 19 February 1987 site inspection. A large field, approximately 1/4 mile by 1/2 mile, is located just west of the test site. The area slopes from south to north and has undulating areas which appeared to be filled trenches that have been graded.

The EPIC photographs indicated that trenches were located in the field and suggests the area was used as a burning and burial area. The photos indicate trenches were also located in several other areas of the site in the past.

The site was not identified as a potential source of environmental contamination prior to submittal of the Sampling Design Plan. Based on the available information, this site is considered to present a potential for soil contamination.

6.18 STAGING AREA NEAR SURVEILLANCE TEST SITE

Located in south-central N-TEAD, adjacent and north of the Surveillance Test area, is a large pit, 8-13 feet deep (Figures 6-1 and 6-7). The pit is gravel-lined and has two cuts in the north bank with dirt roads leading into and out of the site. A small amount of scrap wood and steel bands were observed scattered throughout the site. Dark material was apparent in the 1959 EPIC photograph and was not in the 1966 and 1981 photographs. In the 1953 photograph, three small trenches were located in the center of the pit (U.S. EPA 1982). The site was used primarily as a staging area for materials used at the Surveillance Test site and not as a disposal area. Based on available information, this site is considered to have a low potential to present a threat to the environment or to public health.

6.19 AEO DEMILITARIZATION FACILITY

The AEO Demilitarization Facility is located in the southwest portion of N-TEAD just north of the western end of the Chemical Range (Figures 6-1 and 6-6). Demilitarization operations conducted in the AEO Demilitarization Facility are experimental or pilot plant type operations to determine if the operation is feasible and if any special techniques or equipment are needed to facilitate the operation. Once the equipment is designed and assembled, it is tested in this facility. Live ammunition (TNT, Composition B, tritonal, propellants) is generally used in the test of the equipment. After the test, the area is policed and cleaned and the recovered materials are taken to the Demolition Grounds or Deactivation Furnace for disposal. The site is used approximately 30 days per year. Because the site is used as a test area and not a disposal site, and the site is used only 30 days per year, the site is considered to have a low potential to release contaminants to the environment.

6.20 AEO FURNACE SITE

The Deactivation Furnace, Building 1351, and the Flashing Furnace, Building 1356, are in the Ammunition Equipment Office Furnace Site located in the southwest portion of N-TEAD just north of the OB/OD Area (Figures 6-1 and 6-6). The Deactivation Furnace is used for the destruction of HE-filled projectiles (up to 155 mm), propellants, grenades, boosters, fuzes, and bulk explosives. In 1978, a few 3.5-inch WP rockets were burned. Also, 500-pound HCN bombs have been destroyed here; the last ones in 1978. Under a formal demilitarization program directed by USATHAMA, the bombs were vented into the furnace, and the HCN was burned. The vented casings were flushed with alkaline solution to destroy the residual HCM. The salts (approximately 18.1 kilograms) from the demilitarization of the vented bomb casings were burned in the landfill. The Flashing Furnace is used to "flash" washed-out munition casings. All metals, after certification as clean, are sent to PDO for salvage. The material (explosives residue and metal oxides) from the "baghouse" filters is taken to the Demolition Grounds for disposal by burning. There is no information which indicates the activities performed at this site result in environmental contamination.

6.21 MUNITION SAWING SITE

Building 1303, located just north of the Chemical Range, was used from 1960 to 1976 to saw HE bombs and projectiles apart in order to determine loading characteristics of the filling (Figures 6-1 and 6-7). Dust from the sawing operations was collected by a vacuum cleaner directly under the saw. The material collected by the vacuum cleaner was sent to the Demolition Grounds for disposal. Dust was vacuumed and the structure (tin shed/cement floor) was washed down weekly; the waste water drained across the road to a shallow scooped-out area covered with gravel located east of Building 1303. The site is considered to have a potential to have released contamination to the environment.

6.22 AMMUNITION MAINTENANCE FACILITY

The Ammunition Maintenance Facility (Building 1375 Complex) is located on the southwest periphery of the Igloo Storage Area (Figures 6-1 and 6-6). Ammunition maintenance consists of boxing, packaging, painting, stenciling, minor maintenance on munition parts, and renovation. The Ammunition Maintenance Facility has the capability of handling everything from small arms rounds to 750 pound bombs or rockets. Currently other areas in N-TEAD are also used for ammunition maintenance. These include the following:

- Building 1251 Complex located in the Ammunition Workshop area south of the TNT Washout Facility (Area 1 on Figure 6-1) handle boxing, painting, stenciling, and minor maintenance jobs.

- . Building 1221 Complex located in the Ammunition Workshop area where the X-ray Lagoon is located (Area 6 on Figure 6-1) is used for preservation and packaging of small arms ammunition.
- . Larger artillery rounds, bombs, and large rockets have traditionally been worked on in Building 1345, the Bomb and Shell Reconditioning Building. This building is located at a remote site in the southwest portion of N-TEAD just west of the AEO Furnace Site (Figure 6-6), some distance from the rest of the ammunition maintenance buildings. The facility contains paint booths, sand blast facilities, overhead cranes and can handle up to 10,000 pound bombs with relative ease.

There is no information which indicates that the activities performed at these sites resulted in the release of contaminants in the environment. The sites are considered to have a low potential for contamination.

6.23 RIFLE RANGE

The Rifle Range is located in a remote area near the western periphery of N-TEAD (Figure 6-1). Use of the range is confined to small arms (up to M-60 Machine Gun). The range is available 365 days a year, 24 hours a day, with the restrictions that weather permitting and AEO be informed of usage to insure that no personnel visit the AEO site located within the safety cone. Usage of the range has amounted to about 5 to 10 days per year. The range itself is in good shape with 20 firing stations and targets at 25, 50, 100, and 200 meters. Due to its distant location and limited usage, the site is considered to have low potential for environmental contamination.

6.24 DPDO YARD

The DPDO Yard is located adjacent to the eastern side of the Warehouse and Supply Area. It consists of open storage and several steel buildings (Figures 6-1 and 6-5). This area is used for temporary storage of surplus material. The DPDO coordinated the sale, recycling, and disposal of Depot refuse. According to the EPIC study of the site, the site did not exist in the 1953 photo, but was in use at the time of the 1959 photo. The area has been used since then and now has areas of debris and barrel storage with a certain amount of ground staining, which would be expected in areas of truck and heavy equipment use and debris storage. There is no information which indicates that the activities performed at the site resulted in the release of contaminants to the environment. The site is considered to have a low potential for environmental contamination due to its use as a temporary storage area.

6.25 RADIOLOGICAL WASTE STORAGE AREA

A fenced lot located north of the open storage lots was used for temporary storage of low level radioactive waste, speedometers, radioactive tubes, watch repair parts, tools, decontamination equipment, cabinets, drawers, and shelves (Figures 6-1 and 6-5). All radiological waste disposal was packaged and shipped (per instruction from higher headquarters) to an approved offbase disposal site. There are no records

which indicate this site resulted in the release of any contaminants. This site is considered to have a low potential to release contamination to the environment.

6.26 BURIAL AREA

The burial area is located on the western side of the industrial area (Figure 6-1). The area presently consists of a parking area and a fenced open storage lot. Buildings 516, 517, and 527 are also located in this area. The EPIC study identified this area as a probable waste burial in the 1953 and 1966 aerial photos. Building rubble, garbage, tires, etc. were probably disposed of at this site to bring the area up to grade with the land to the east. The site is considered to have a low potential to release contamination to the environment.

6.27 OPEN STORAGE AREA IN IGLOO STORAGE AREA

The storage area is located east of a gravel pit between Areas "J" and "K" of the Igloo Storage Area (Figure 6-1). The EPIC photos identified the area as having a small amount of material and possible drums stored at the site. There is no indication in the photos of liquid or ground staining. There is no information on the activities at this site, however, the site is considered to have a low potential to release contaminants to the environment.

6.28 OFF-POST SITES

Activities performed at the Hercules Coal Resin Facility, Bauer Mine Tailings site, and Amaconda Deep Mine site, located off N-TEAD grounds, were identified as having potentially resulted in the contamination of groundwater. The location of each of these sites is shown in Figure 6-8. Groundwater contamination, if emanating from these sites, has a potential to migrate onto N-TEAD grounds, as each site is situated upgradient of N-TEAD and within aquifer recharge areas to Tooele Valley. Consequently, each of these sites were included in the PA/SI effort for N-TEAD, and are discussed in the following sections.

6.28.1 Hercules Coal Resin Facility

Blackhawk Resins and Chemical Company, a subsidiary of Hercules, Inc. owned and operated a resin extraction plant located about 1 mile south and upgradient of the southeast boundary of N-TEAD (Figure 6-7). The site, destroyed by fire in September 1980, covers an area of approximately 26 acres. The only remaining structure at the site is the plant foundation.

At the facility, extraction of naturally occurring resin from coal fines, which were mined in Carbon County, Utah, was conducted. A co-solvent, comprised of aliphatic hydrocarbons (typically hexane) and 3-5 percent benzene or toluene, was used and recycled at the plant. The period of operation of the plant is not known. Residue from the extraction process was disposed of in several pits located onsite. Wastes which were generated at the site are described below (Hercules, Inc. 1986).

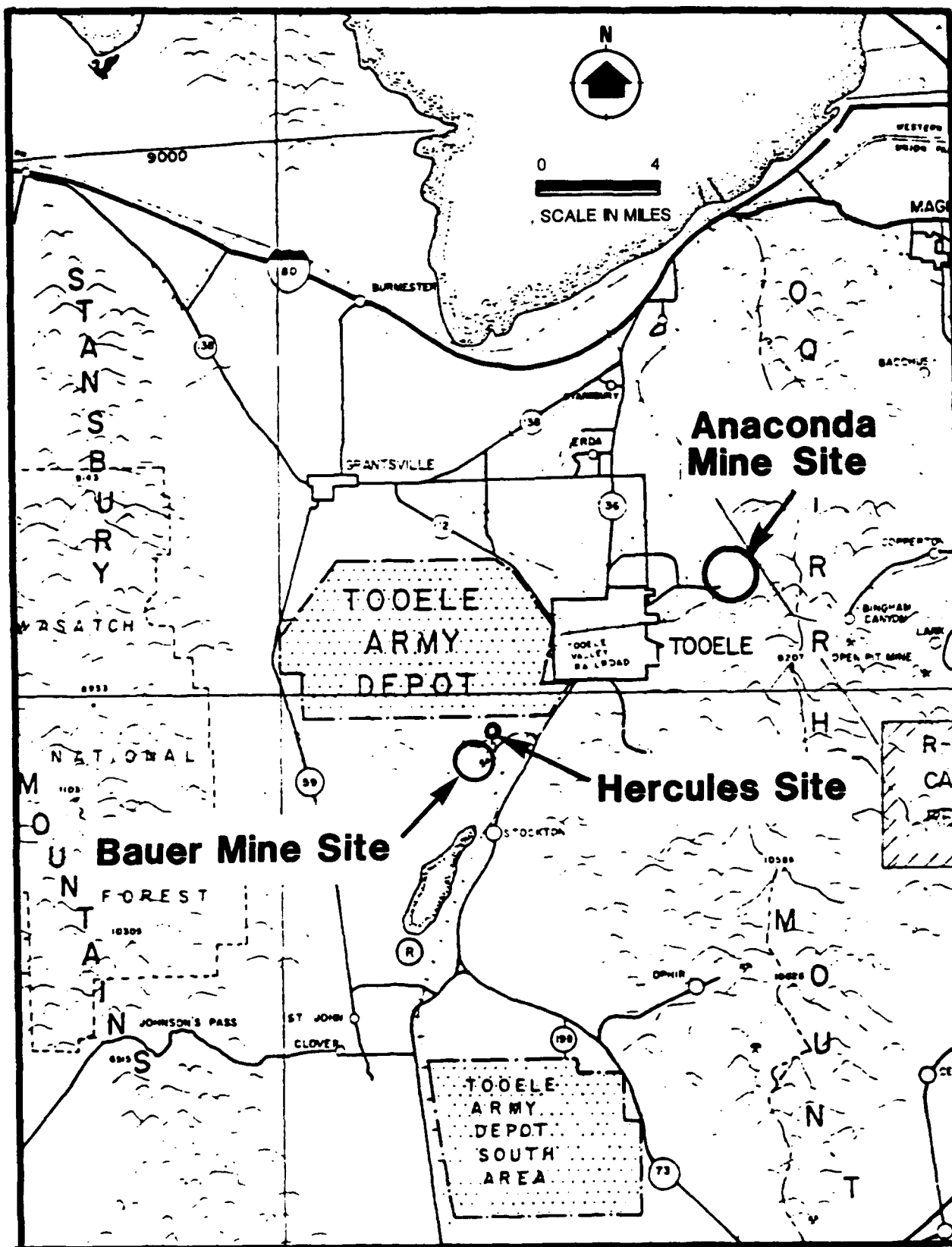


Figure 6-8. Area Map Showing Off Depot Site Locations.

1. Raw Material (Unprocessed) - A small pile of the unprocessed coal fines has been reported at the site. The location of the material is not known.
2. Spent, Steam Distilled Coal Fines (Mud) - Coal fines that were extracted with solvent and then steam distilled to recover the solvent were deposited water-wet in grade-level pits at the site. An unknown amount of the coal fines has been consumed by surface and/or subsurface combustion. Some may have been deposited in a natural depression in the north-west portion of the site.
3. Filter Cake - Additional solids were removed from the product-solvent stream by use of a "secondary" plate-and-frame filter press. Filter aid and filter papers were used, and from approximately the mid-1970s this waste was reportedly deposited at the Bauer municipal dump, located on nearby Atlantic Richfield Company property.
4. Wastewater - Wastewater from the process, some of which had been in contact with the process streams, was discharged to onsite surface pits. Some wastewater had reportedly been used for irrigation offsite.
5. Washed Coal Fines - A previous owner of the site reportedly experimented with coal washing in the large, above-grade impoundment located on the north side of the plant. Some of the coal which was abandoned in the impoundment appears to have been blown out of the impoundment to a small adjacent area to the north and west.

Spontaneous combustion of the waste residue has occurred in the past and the residue has been continuing to burn for over a year. During EA's onsite visit, smoldering residue was observed.

The State of Utah conducted a Hazardous Ranking System (HRS) scoring of the site and, according to Douglas Keilman of Hercules, Inc., the final migration score was low. However, the State of Utah requested that sampling and analysis be conducted at the site to determine if environmental contamination had occurred.

In October 1985, Hercules installed three monitoring wells at the site to evaluate groundwater flow direction and quality. Three additional wells were installed in March 1986 to provide more information on the direction of groundwater flow and groundwater quality. Water level measurements obtained in October 1985 indicated a gradient of 2-3 percent to the south-southeast. Information reported by Razem and Steiger (1981) indicated that regional groundwater flow was in the opposite direction, flowing north to the Great Salt Lake, and that depth to groundwater is 200 feet greater than found in the Hercules investigation. The groundwater levels observed in the Hercules study suggests that a shallow period aquifer flows locally south from the Hercules site to the Stockton Bar.

Groundwater samples collected from the monitoring wells installed by Hercules were analyzed for metals, volatile and semi-volatile organics, and total phenols. Results showed detectable levels of metals in all monitoring wells that were typically at or below the Federal and State drinking water standards. Benzene and toluene were also detected at low levels (<37 ppb). Acetone was found in one well at a concentration level of 850 ppb. Sampling and analysis of waste materials present onsite and of surficial soils showed high concentrations of many metals (arsenic, antimony, lead, copper, and zinc). It appears that metals present in the waste materials and soils are generally remaining bound to the solids and not leaching and migrating to the groundwater table.

Based on the available data, it appears that the Hercules, Inc. Blackhawk site does not present a threat to the groundwater quality of N-TEAD. The shallow aquifer at the Hercules site flows to the south, away from N-TEAD. However, if the shallow aquifer is hydraulically connected to the deeper regional aquifer, which flows to the north towards N-TEAD, there is a potential threat of contamination to the deeper aquifer. Based on the concentrations of contaminants observed in the shallow groundwater aquifer during the Hercules study, the Hercules site is not considered to present a significant threat to N-TEAD groundwater quality.

6.28.2 Bauer Mine Tailings Site

Located immediately adjacent to and south of the Hercules site is a large, inactive lead/zinc ore processing facility (Figure 6-7) which operated from 1924 to 1958. Ore was obtained from the mountains east of the abandoned community of Bauer. Most of the site (approximately 95 acres) is covered by tailing ponds containing processing wastes generated at the facility. It is reported that a total of 2.3 million tons of tailings were disposed of in the ponds. Debris, including empty 55-gallon steel drums and scrap wood, was observed scattered over the site during EA's visit.

The majority of the ore tailings generated were highly acidic; ponds located on the east side of Bauer were used for disposal of the acid tailings. Ponds situated to the west, at the foothills of the Stansbury Mountains, received non-acidic tailings.

The U.S. Bureau of Mines conducted studies at the Bauer non-acidic tailing ponds from approximately 1978 through 1982 to evaluate the effectiveness of revegetation of the non-acidic tailings in reducing airborne dust originating from the ponds. Analysis of the tailings and interstitial water quality were conducted during these investigations, however, results of the study have not been released for publication at this time.

The Bauer tailing ponds are located upgradient of N-TEAD's southern boundary. Based on the results of the Hercules, Inc. study at the Blackhawk facility (Hercules, Inc. 1986), the direction of flow of the shallow groundwater flow direction is away from N-TEAD to the south towards the Stockton Bar. A potential for groundwater contamination and migration of contaminants onto N-TEAD exists if the shallow aquifer is hydraulically connected to the deeper regional aquifer.

The acidic tailings present the greatest threat to groundwater contamination. The major contaminants of concern are heavy metals. There are two monitoring wells located adjacent to the Bauer tailing ponds which are screened in the deeper regional aquifer. It was reported by Hercules, Inc. (1986) that analysis of samples obtained from these wells indicated concentrations of lead, arsenic, selenium, cadmium, magnesium, sulfate, and zinc that were higher than background concentrations. The location of the background sampling point was not reported.

Without further information on the concentrations of heavy metals detected in the deep regional aquifer, the threat to the groundwater quality of N-TEAD cannot be determined.

6.28.3 Anaconda Deep Mine Site

Anaconda Corporation owns and operates a deep-shaft copper mine, referred to as the Carr Fork Mine, located at the foothills of the Oquirrh Mountains, approximately 3 miles east of the City of Tooele (Figure 6-7). The mine began operating in September 1979 (Razem and Steiger 1981) and is currently inactive. During operation, the mine produced approximately 10,000 tons per day of crude ore for concentrating and shipment to another facility for smelting. Large volumes of water were pumped from the 3,900-foot deep shafts. A portion of this water was used in the ore concentration procedure, a portion sent by flume and open ditch to Pine Canyon for agricultural irrigation, and the remainder allowed to sink into the ground for aquifer recharge.

Processing wastes (tailings) from the ore-concentration operation were discharged to tailing ponds located downgradient and approximately 1 mile south of the processing facility. The tailing ponds cover an estimated area of approximately 25 acres.

The Anaconda tailing ponds are located upgradient of (1-2 miles) the City of Tooele and N-TEAD. There is a potential for groundwater contamination at this site and for contaminant migration onto N-TEAD. The major contaminants of concern would most likely be heavy metals. However, there is no data available which indicates the existence of groundwater contamination resulting from the tailings ponds. Therefore, the impact of this site on the quality of groundwater at N-TEAD cannot be determined.

7. FIELD PROGRAM

7.1 MONITORING PLAN DEVELOPMENT

The PA/SI Field Sampling Program was developed based on (1) a review of maps, aerial photographs, and available literature provided by USATHAMA; (2) information obtained from records searches and interviews with Depot personnel during the onsite visit; and (3) observations made during site surveys and the aerial flyover. A Field Sampling Design Plan was prepared which described (site characteristics, activities/operations conducted at the site, and potential contaminants) N-TEAD sites considered to be potential sources of environmental contamination. Of the sites addressed in the Field Sampling Design Plan, four were identified as presenting a significant potential for environmental contamination: (1) the TNT Washout Facility Area, (2) the Former Transformer Storage Area, (3) a PCB Spill Site, and (4) the OB/OD Area. A Field Sampling/Analysis Program was developed for each of these sites to provide an adequate analytical database to evaluate the existence of contamination, if any, and to provide a preliminary evaluation of contaminant movement, if appropriate. The field effort involved the installation of ground-water monitoring wells and sampling/analysis of groundwater, wastewater, soils, and sediment.

7.2 MONITORING PROGRAM IMPLEMENTATION

7.2.1 Pre-Drilling/Sampling Activities

Prior to initiating the well installation and sampling/analysis programs at N-TEAD, an aqueous sample was collected and analyzed from Supply Well No. 3. Sampling was performed on 17 January 1986. The results of chemical analysis are provided in Appendix I-B. Supply Well No. 3 was designated as the drilling water source and as the water supply for decontamination of drilling and sampling equipment. A Predrilling Site Visit was then conducted from 19 to 23 May 1986. Activities conducted during the visit included: (1) obtained water level measurements at existing N-TEAD monitoring wells to determine the prevailing direction of groundwater movement and to facilitate selection of final well locations, (2) selected and staked monitoring well locations, (3) staked soil sampling locations, and (4) arranged and coordinated field activities with Depot personnel.

7.2.2 Well Installation Program

Modifications to the Well Installation Program presented in the Final Field Sampling Design Plan (EA 1986) were made due to the lack of adequate information pertaining to site conditions/locations and unanticipated field (weather) conditions. Table 7-1 summarizes the modifications to the Well Installation Program presented in the Final Sampling Design Plan.

Well installation was conducted at only one of the sites designated for field investigations--the TNT Washout Facility Area. Four lysimeters and five monitoring wells (four shallow wells and a deep well) were installed

TABLE 7-1 PLANNED AND IMPLEMENTED WELL INSTALLATION PROGRAM FOR N-TEAD

TNT WASHOUT FACILITY AREA

<u>Planned Program</u>	<u>Implemented Program</u>
. 5 Shallow Wells	. 4 Shallow Wells
N-3C	N-3C
N-3D1	N-3D1
N-3E	N-3F
N-3F	N-3I
N-3I	
. 1 Deep Well (N-3H)	. 1 Deep Well (N-3H)
. 1 Intermediate Well (N-3G)	. No Intermediate Well installed
. TNT Ponds - Borings (4)	. TNT Pond Borings (4)
. No Lysimeters	. 4 Lysimeters
	2 per borehole (N-3D2 upper and lower; N-3E upper and lower)

to evaluate the extent of contamination in the "upper-most" aquifer and to evaluate if the deep regional aquifer, which is used as a water source, was contaminated.

Well/lysimeter installation was initiated at N-TEAD on 1 July 1986. Borehole drilling and well/lysimeter installation were conducted under subcontract by Sergeant, Hauskins and Beckwith (auger drilling), and Lang Exploratory Drilling (air and hydraulic rotary drilling) of Salt Lake City, Utah, under supervision of EA personnel.

The location of each of the wells/lysimeters installed is shown on Figure 7-1. Construction data are summarized in Table 7-2. Completion diagrams, boring logs, and development logs for each of the wells/lysimeters is provided in Appendix I-C. The following sections describe the methods, procedures, and materials used for monitoring well/lysimeter installation.

7.2.2.1 Shallow Monitoring Wells

Four shallow monitoring wells (N-3C, N-3D1, N-3F, and N-3I) were installed in the TNT Washout Facility Area (Figure 7-1).

Each well was installed using a truck-mounted auger drill rig and 10-inch outside diameter (OD), 6-inch inside diameter (ID), hollow-stem augers. Split-spoon samples were taken at 5-foot depth intervals during borehole drilling in order to characterize the subsurface environment and to accurately identify the depth to water. Auger cuttings were monitored continuously and drilling was conducted without the use of water. The procedures used were as follows:

1. Set-up over the stake, and plumb the rig.
2. Advanced the auger hole to 5 feet BLS with the hollow stem auger plugged.
3. The auger plug was removed and a 2-foot split-spoon sample was obtained.
4. Replaced the auger plug and advanced another 5-foot auger flight.
5. Repeated Steps 3 and 4 until the prevailing shallow groundwater table aquifer was identified.
6. After the water table was encountered, the water level was allowed to stabilize for at least 10 minutes and its depth (in feet BLS) measured before continuing.
7. Once the depth to the prevailing water table was determined, the borehole was advanced 30 feet into the aquifer by repeating Steps 3 and 4.
8. Removed the auger plug and installed the well as described below.

TABLE 7-2 WELL/LYSIMETER CONSTRUCTION SUMMARY N-TEAD

Well/ Lysimeter	PVC Casing Diameter (in.)	Drilling Method	Finished Depth (ft BLS)	Screened Interval (ft BLS)	Water Level (ft BLS)*	PVC Riser Stick-Up (ft)
N-3C	4.0	Auger	71.0	41.0 - 71.0	Dry	2.01
N-3D1	4.0	Auger	59.0	29.0 - 39.0	Dry	1.57
N-3F	4.0	Auger	74.0	34.0 - 74.0	70.95	1.94
N-3H	5.0	Hydraulic Rotary	263.0	223 - 253.0	240.01	2.42
N-3I	4.0	Auger	46.5	16.5 - 46.5	26.10	1.63
N-3D2 (lysimeter)	2.0	Auger	58.5	46.6 - 48.5 56.2 - 58.5	---	2.00
N-3E (lysimeter)	2.0	Auger	51.8	38.9 - 41.0	---	1.75

NOTE: 1 = As measured 19 February 1987.
BLS = Below Land Surface.

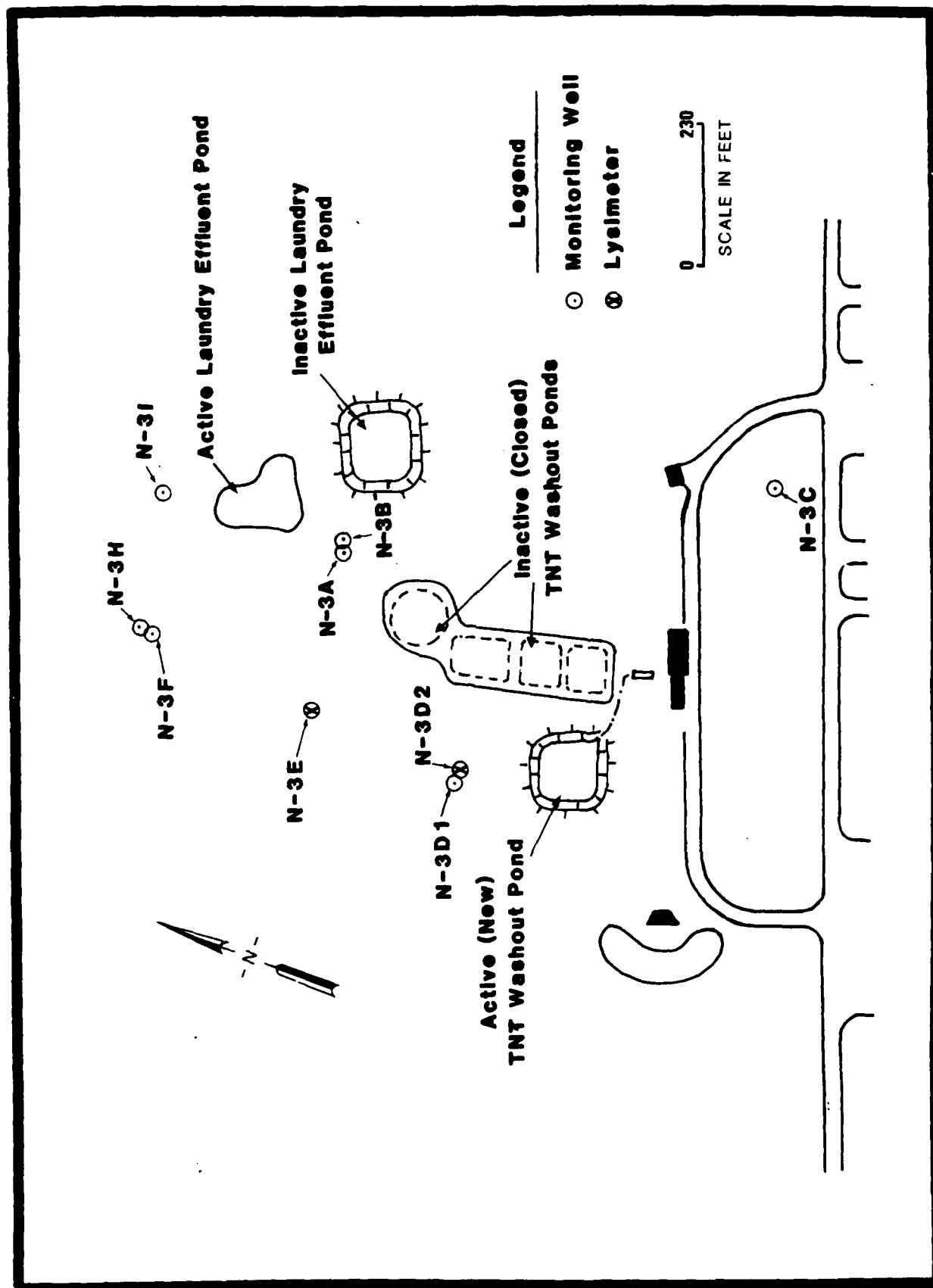


Figure 7-1. Locations of Monitoring Wells at the TNT Washout Facility Area, N-TEAD.

Decontamination procedures used during well drilling operations are addressed in Section 7.2.2.4.

All auger cutting descriptions, water-level readings, or other pertinent observations were logged by the EA supervisory geologist. All split-spoon samples were taken and described in accordance with USATHAMA (1983) requirements. Representative soil samples were placed in half- or one-pint glass jars with air-tight, screw-type lids (canning jars).

Shallow monitoring well installation was accomplished through in-place, hollow-stemmed augers. Once the augers had been advanced to the finished depth and the auger plug removed, the assembled screen and riser were lowered down the hollow-stem and the augers raised not more than 2.5 feet. Well gravel (clean silica sand backfill) was added, as needed, and its level sounded. This procedure was repeated until the sand pack extended to 5 feet above the top of the screen. The augers were then raised approximately 6 feet above the top of the sand pack and a 5-foot layer of bentonite pellets was added and allowed to hydrate to form a seal over the sand pack. Approximately 1 gal of water from the approved water source was added to hydrate the bentonite pellets. A 1-in. tremie pipe was then lowered down the annulus between the casing and augers to just above the bentonite seal and grout tremied down until all water had been flushed from the annulus and the grout extended to the surface. The tremie pipe and augers were then pulled and additional grout added until it extended to land surface.

The grout mixture consisted of water, bentonite, and Portland cement (10 gallons of water, a 94-lb bag of cement, and 5 lbs of bentonite). The grout mixture was allowed to set at least 48 hours before well development.

Each shallow monitoring well was constructed of Schedule 40, threaded, flush-joint PVC, 4-in. in diameter, and contained 40 feet of PVC screen (10 feet above and 30 feet below the water table, bottom-plugged) with 10 slots per inch at 0.01 inches per slot.

Well risers extended 2 feet above land surface (ALS) and were fitted with an over-sized PVC cap with metal eye bolt to facilitate removal. A 6-inch diameter protective steel surface casing, complete with cap, lock, and drainage vent were installed over the riser pipe. The steel casing measured 5 feet in length, extend 2.5 feet ALS and BLS, and was painted a fluorescent orange for ease of visibility. Four metal picket guard posts were placed 4 feet radially from the surface casing and strung with 3-strand barb wire to prevent grazing cattle from coming into contact with the well boring.

7.2.2.2 Deep Monitoring Well

One deep monitoring well (N-3H) was installed downgradient of the TNT Washout Facility Area and area of reported surface contamination from overflow to evaluate if the deep regional water table aquifer is

contaminated due to current and past activities in the Washout Facility Area. The location of the well is shown in Figure 7-1. Boring and well construction data for the well are summarized in Table 7-2.

Borehole drilling was performed using hydraulic rotary drilling methods. To prevent the potential downward migration of contaminants, the shallow water table aquifer was cased-off prior to drilling into or towards the deep regional aquifer. This was performed by initially drilling a large diameter borehole (approximately 14 inches) to the top of the lower confining unit of the shallow water table aquifer (approximately 135 feet BLS). Steel casing (with threaded joints), 10 inches in diameter, was then installed down the borehole and driven approximately 3 feet into the confining unit. All of the drilling fluid was purged from the borehole and water and sediment were removed from the circulation pan and clean water added. A smaller diameter borehole (8 inches) was then drilled through the steel casing to the targeted depth (approximately 280 feet BLS).

Water from the approved water source and high-yield bentonite were the only drilling fluid additives used during borehole drilling. The use of bentonite was greatly reduced near the projected screen interval. Drill cuttings were monitored continuously. An attempt was made to obtain split-spoon samples at 10-foot intervals. However, large cobbles within the valley alluvium often prevented sample collection. Due to the close proximity of this well with N-3F (which had previously been logged), sampling was only performed/attempted from a depth of 80 feet BLS to the completed depth of this well. Drill cuttings and samples obtained were visually characterized by the supervising geologist, and representative samples were jarred, as was previously described for auger drilling (shallow monitoring wells). Data were obtained and recorded by the supervising geologist during borehole drilling in accordance with USATHAMA procedures (1983).

Deep well installation was accomplished through the open borehole. The well was constructed of Schedule 80, threaded (i.e., glue not allowed), flush-joint PVC, 5-in. diameter (inside), and contained 40 feet of bottom-plugged PVC screen (installed 10 feet above and 30 feet below the water table) with slot openings of 0.030 in.

The assembled well casing was lowered down the borehole to the targeted depth (30 feet below the water table; approximately 280 feet BLS). The drilling fluid in the borehole was greatly thinned and a clean silica sand backfill was installed to 5 feet above the top of the screen. A 5-foot thick layer of bentonite pellets was applied to the top of the sand pack and allowed to hydrate. Approximately 1 gal of water from the approved water source was added to hydrate the bentonite pellets. A 1-inch tremie pipe was lowered down the borehole to just above the bentonite seal and grout was tremied down until it extended to the surface. The tremie pipe was then pulled and additional grout added until it extended to land surface. The grout mixture and well completion procedures were as was previously detailed for shallow monitoring wells. The 10-in. diameter steel casing used in the drilling

of the borehole was left in the ground extending approximately 3 feet above ground surface and used as the protective steel casing for the monitoring well by adding a locking steel cap.

7.2.2.3 Lysimeters

A total of four Teflon casing lysimeters were installed at two down-gradient locations (two tandem sets of two lysimeters installed at differing depth intervals) in the TNT Washout Facility Area. The location of each of the lysimeter pairs (N-3D2 and N-3E) is shown in Figure 7-1. Completion diagrams for each of the lysimeters are provided in Appendix I-C.

At each location, two lysimeters were installed within a wet zone identified during borehole drilling. One lysimeter was installed near the top of the wet zone and the other at a 10-foot greater depth interval. Hollow stem augers were used for borehole drilling using methods previously described for shallow monitoring well installation. After the augers had been advanced to the targeted depth, the augers were pulled and the lysimeters installed down the open borehole per the manufacturer's (TIMCO) recommended procedures (Appendix I-D). A silica flour backfill was installed around the porous filter for each lysimeter. Approximately 2 gal of water from the approved water source was added per 50 lb of silica flour to create a slurry, which was poured down the borehole around the lysimeter. A layer of bentonite pellets were installed (and allowed to hydrate to form a seal) above and below each lysimeter. Approximately 1 gal of water from the approved water source was added on top to hydrate the bentonite pellets. Grout was installed to land surface, and surface completion for each lysimeter pair was performed as was previously described for shallow monitoring well installation.

7.2.2.4 Decontamination Procedures

Before drilling the first well/lysimeter, between drilling of wells/lysimeters, and after drilling the final well/lysimeter (in each phase), all drilling, measuring, and sampling equipment that contacted potentially contaminated soils or water was cleaned to prevent cross-contamination of wells. This was accomplished by placing equipment on blocks and steam cleaning and rinsing with water from the approved source. All pumps, pipes, hoses, and other equipment that could not be internally scrubbed was flushed with clean water.

7.2.2.5 Well Development

The development of monitoring wells was performed as soon as practical after well installation (but not sooner than 48 consecutive hours after internal grout collar placement) and was accomplished in accordance with USATHAMA (1983) requirements. Development logs are provided in Appendix I-C.

7.2.2.6 Surveying

The coordinates and elevation of each well were surveyed by Forsgren-Perkins Engineering of Salt Lake City, Utah, under subcontract with EA, in accordance with USATHAMA (1983) requirements. In addition, two existing wells (N-3A and N-3B) were resurveyed (tied-in) to provide a uniform database for Depot monitoring wells. Horizontal and vertical closure were performed within +3 feet and +0.1 foot, respectively. Table 7-3 provides a list of the elevations and horizontal coordinates for each of the wells and lysimeters. Field surveying data are provided in Appendix I-E.

7.2.3 Field Sampling/Analysis Program

The sampling program at TEAD was initiated on 18 February 1986, approximately 22 weeks after well development, because of delayed laboratory certification. Table 7-4 provides a summary of the planned and implemented sampling/analytical program for each site. Table 7-5 is a summary table of the chemical constituents analyzed for the N-TEAD PA/SI effort. The sampling procedures and protocol implemented are discussed in the following sections. The certified reporting limits (CRLs) for the parameters analyzed are provided in Appendix I-A.

7.2.3.1 Groundwater Sampling

The Groundwater Sampling Program was designed to provide data on the groundwater quality both upgradient and downgradient of the site. The protocol followed for collection of groundwater samples included:

- . Physical inspection and observation
- . Water level determination
- . Well purging
- . Field analyses
- . Groundwater sampling
- . Sample handling

Physical Inspection

Upon arrival at each well, the condition of the well and surrounding area was noted. This included, but was not limited to,

- . Security
 - Is well locked?
 - Is there evidence of tampering?
 - Is there evidence of physical damage?
- . Well Integrity
 - Evidence of breakage or heaving of concrete seal, if present
 - Evidence of surface infiltration

TABLE 7-3 SURVEYED ELEVATION AND HORIZONTAL COORDINATES FOR TNT WASHOUT
FACILITY AREA MONITORING WELLS, N-TEAD

<u>Well/Lysimeter No.</u>	<u>Horizontal Coordinates*</u>		<u>Top of PVC Riser Elevation (ft above MSL)</u>
	<u>N-S</u>	<u>E-W</u>	
N-3A	792,717.46	1,750,638.93	4,726.63
N-3B	792,714.80	1,750,648.42	4,726.76
N-3C	792,086.38	1,750,926.14	4,744.25
N-3D1	792,373.12	1,750,312.79	4,732.07
N-3D2	792,372.24	1,750,339.17	4,732.77
N-3E	792,653.09	1,750,336.75	4,725.38
N-3F	792,976.81	1,750,364.51	4,715.87
N-3H	792,990.03	1,750,370.10	4,716.73
N-3I	793,045.06	1,750,610.80	4,747.72

* State Plane.

TABLE 7-4 PLANNED AND IMPLEMENTED FIELD SAMPLING/ANALYSIS PROGRAM FOR N-TEAD

<u>Sample Location</u>	<u>Aqueous Samples</u>		<u>Soil Samples</u>		<u>Analyses</u>
	<u>Planned</u>	<u>Actual</u>	<u>Planned</u>	<u>Actual</u>	
TNT Ponds Area					
Shallow Wells	3	3	5	5	A,B,C,E,G
Deep Wells	2	2	0	0	A,B,C,E,G
Lysimeters	3	0(c)	0	0	E,G
Laundry Pond	1	1	1	1	A,B,C,E,G,L
Old TNT Ponds(a)	0	0	12	12	E,G
New TNT Pond	0	0	1	1	E,G
Surficial Soils	0	0	8	8	E,G
OB/OD Area					
Supply Wells	2	2	0	0	A,B,C,E,G,H,I
PCB Spill Site					
Composites	0	0	5	5	I
Discretes(b)	0	0	20	17(d)	
PCB Storage Site					
Composites	0	0	6	6	I
Discretes(b)	0	0	30	30	
Total	11	8	38	38	

(a) Samples were collected during well installation program.

(b) Only composite samples were submitted for analysis; discrete samples were saved for possible future analysis (additional analysis not required).

(c) Only two of the four lysimeters installed would hold vacuum pressure. During two separate efforts, a vacuum was applied to the lysimeters, however, no aqueous samples were obtained.

(d) Due to the presence of equipment stored on the area to be sampled, not all discrete samples could be obtained.

ANALYSES KEY:

A - Metals	E - Explosives
B - Base neutral/acid extractable organics	G - Nitrate+Nitrite Nitrogen
C - Volatile organics	H - Pesticides
D - Inorganics	I - PCB
	L - Surfactants

TABLE 7-5 SAMPLE ANALYSIS FOR TOOELE ARMY DEPOT

A - Metals

Antimony
 Arsenic
 Beryllium
 Cadmium
 Chromium
 Copper
 Lead
 Mercury
 Nickel
 Selenium
 Silver
 Sodium
 Thallium
 Zinc
 Cyanides - Total

B - Base/Neutral and Acid Extractables(b)

N-Nitrosodimethylamine
 Bis(2-Chloroethyl)ether
 1,3-Dichlorobenzene
 1,4-Dichlorobenzene
 1,2-Dichlorobenzene
 Bis(2-Chloroisopropyl)ether
 Hexachloroethane
 N-nitroso-di-n-propylamine
 Nitrobenzene
 Isophorone
 Bis(2-chloroethoxy)methane
 1,2,4-Trichlorobenzene
 Napthalene
 Hexachlorobutadiene
 Hexachlorobutadiene
 2-Chloronaphthalene
 Acenaphthylene
 Dimethyl phthalate
 2,6-Dinitrotoluene
 Acenaphthene
 2,4-Dinitrotoluene
 Fluorine
 Diethyl phthalate
 4-Chlorophenyl phenyl ether
 N-Nitrosodiphenylamine
 1,2-Diphenylhydrazine
 4-Bromophenyl phenyl ether
 Hexachlorobenzene
 Phenanthrene
 Anthracene
 Di-n-butyl phthalate
 Fluranthene

B - Base/Neutral and acid
Extracables (Cont.)

Benzidine
 Pyrene
 Butyl benzyl phthalate
 Benzo(a)anthracene
 3,3-Dichlorobenzidine
 Chrysene
 Bis(20ethylhexyl)phthalate
 Bi-n-octyl phthalate
 Benzo(a)pyrene
 Indeno(1,2,3-cd)pyrene
 Dibenzo(a,h)anthracene
 Benzo(g,h,i)perylene
 Benzo(b)fluoranthene+
 benzo(k)fluoranthene
 Phenol
 2-Chlorophenol
 2-Nitrophenol
 2,4-Dimethylphenol
 2,4-Dichlorophenol
 p-Chloro-m-cresol
 2,4,6-Trichlorophenol
 2,4-Dinitrophenol
 4-Nitrophenol
 4,6-Dinitro-o-cresol
 Pentachlorophenol

C - Volatile Organics(a)

Acrolein
 Acrylonitrile
 Benzene
 Carbon tetrachloride
 1,2-Dichloroethane
 1,1,1-Trichloroethane
 1,1-Dichloroethane
 1,1,2-Trichloroethane
 1,1,2,2-Tetrachloroethane
 Chloroethane
 2-Chloroethylvinyl ether
 Chloroform
 1,1-Dichloroethene
 trans-1,2-Dichloroethene
 1,2-Dichloropropane
 1,3-Dichloropropene
 Ethylbenzene
 Methylene chloride
 Chloromethane
 Bromomethane
 Bromoform
 Bromodichloromethane

TABLE 7-5 (Cont.)

C - Volatile Organics (Cont.)

Fluorotrichloromethane
 Chlorodibromomethane
 Tetrachloroethene
 Toluene
 Trichloroethene
 Vinyl chloride
 Total Xylenes

D - Inorganics

Chloride
 Fluoride
 Bromide
 Phosphate
 Sulfate
 Gross alpha
 Gross beta

E - Explosives

RDX
 Nitrobenzene
 1,3-Dinitrobenzene
 1,3,5-Trinitrobenzene
 2,4-Dinitrotoluene
 2,6-Dinitrotoluene
 2,4,6-Trinitrotoluene
 HMX
 Tetryl

G - Nitrogen

Nitrite
 Nitrate

H - Pesticides

Aldrin
 Alpha-BHC
 Beta-BHC
 Delta-BHC
 Lindane
 Chlordane
 4,4'-DDD
 4,4'-DDE
 4,4'-DDT
 Dieldrin
 Endosulfan I
 Encosulfan II
 Endrin
 Endrin aldehyde
 Heptachlor
 Heptachlor epoxide
 Toxaphene

I - PCB's

PCB-1016
 PCB-1221
 PCB-1232
 PCB-1242
 PCB-1248
 PCB-1254
 PCB-1260

L - Surfactants

- (a) EPA Method 624 by GC/MS.
 (b) EPA Method 625 by GC/MS.

NOTE: All above analyses were performed for all soil and water samples unless otherwise specified. If analyses were not listed on the summary tables provided in Chapter 8, all values were below the limits of detection.

The information gathered was recorded in a bound field notebook for inclusion in the field sampling report.

Water Level Measurement

After the physical inspection, static-water levels were determined prior to initiation of purging and sampling activities. All water level determinations were made to the nearest 0.01 foot using electronic sounders. The procedure involved slowly lowering the precleaned sounder probe into the well until the indicator (light or meter) was activated. After an indication of water penetration was achieved, the probe was slowly raised and lowered until the indicator accurately registered the water surface which was referenced to the top of the well casing. The measured water level was recorded in a field notebook.

Field Measurements

Specific conductivity, temperature, and pH measurements were conducted on the first volume of groundwater purged at all monitoring wells sampled. Sample collection and analysis were conducted as described in the Installation Restoration Program (IRP) Quality Assurance Program Plan (EA 1986).

Well Purging

Prior to sample acquisition, each well was purged to ensure collection of a representative groundwater sample. Well purging was performed by Ground Water Sampling, Inc. of Englewood, Colorado under subcontract with EA, and was supervised by EA personnel. All wells were purged using a submersible pump, with the exception of Well Nos. N-3B and N-3F where a bottom-filling bailer was used. Purging continued until five casing volumes were removed or until the well was dry.

During purging, the pump was lowered into the well until it just penetrated the water surface, at which time it was energized. The pump was lowered slowly through the water column to the bottom of the well. The pump was then raised several feet above the bottom of the well and held static for the duration of purging. The purging rate was determined by recording the time required to fill a 5-gal pail. The volume to be purged (5 static casing volumes) was divided by the pumping rate in gpm to determine the required pumping duration. The pump's discharge was directed sufficiently downgradient at all times to avoid rapid re-infiltration. (A foot valve was installed in the pumps to preclude cross-contamination.)

When a well dewatered prior to evacuation of the required volume, the well was allowed 15 minutes to recover and pumping re-initiated. If the well again dewatered, the pump was removed from the well and the volume purged recorded. Well purging logs are provided in Appendix I-F.

Bailer and Pump Cleansing

To avoid cross-contamination, the pump and/or bailer used in purging was cleaned thoroughly between wells using the approved water source. Purging and sampling were conducted beginning with the least potentially contaminated well and finishing with the most potentially contaminated (the degree of contamination was based on existing available information).

Sample Collection

All field sampling equipment was thoroughly cleaned in accordance with the IRP Quality Assurance Program Plan (EA 1986) prior to use in field collections and rinsed with water from the approved water sources (N-TEAD supply wells) prior to reuse in the field. The approved water source was analyzed for all project-specific analytes at the time of sampling. Sampling material was protected from contacting the ground by spreading a clean plastic protective cover around each well prior to sampling. New protective covers were used for each well. Sampling personnel washed their hands between wells to avoid cross-contamination. Disposable gloves were used for handling sampling gear which minimized the potential for cross-contamination and also protected sampling personnel from contacting contaminants that may have been present in the samples.

Groundwater sampling was accomplished with a bailer, submersible pump (well purging only), and/or peristaltic pump. Only clean bottom-filling Teflon bailers were used. When a bailer was used for sampling, a clean, dedicated piece of nylon line was attached to the bailer and the bailer was lowered into the well. Care was exercised to ensure that the bailer and line did not contact the ground or other sources of contamination. The bailer was lowered into the well until it filled and was retrieved; the water was discarded. This process was repeated three times. The bailer was then filled and the sample was transferred to the sample containers. When the pump was used, samples were placed directly into appropriate sampling containers (Table 7-6). Each container was first rinsed three times with excess sample water in both instances. Preservatives were added as described below. Samples for volatile organics were collected using a peristaltic pump in a manner that minimized aeration, and the containers were kept free of bubbles and headspace. After the containers were filled, they were labeled, and an entry was made on the Chain-of-Custody Form. The sample container was then placed immediately on ice in a cooler. All samples were shipped, at a temperature of 4° C, to the laboratory by air freight (i.e., overnight delivery).

Sample Filtration

Aqueous samples collected for determination of sulfate and orthophosphate were filtered prior to the addition of preservatives. Sample filtration was conducted using a 0.45-micron filter. Sample bottles designated for sulfate and orthophosphate analysis were rinsed with the

TABLE 7-6 SAMPLE CONTAINERS, PRESERVATION, STORAGE, AND HOLDING TIMES

Parameter	Container (a)		Preservative (b)		Maximum Holding Time for all Matrices
	Water	Soil	Water	Soil	
INORGANIC TESTS					
Bromide	P	G	None Required	None Required	28 days
Chloride	P	G	None Required	None Required	28 days
Cyanide, Total and Amenable in Chlorination	P	G	Cool, 4° C NaOH to pH >12 0.6 g Ascorbic Acid	Cool, 4° C	14 days
Fluoride	P	G	None Required	None Required	28 days
Metals					
Chromium VI	P	G	Cool, 4° C	Cool, 4° C	24 hours
Mercury	P	G	HNO ₃ to pH <2	Cool, 4° C	28 days
Others	P	G	HNO ₃ to pH <2	Cool, 4° C	6 months
Nitrate + Nitrite	P	G	Cool, 4° C H ₂ SO ₄ to pH <2	Cool, 4° C	28 days
Oil and Grease	P	G	Cool, 4° C H ₂ SO ₄ to pH <2	Cool, 4° C	28 days
Orthophosphate	P	G	Filter Immediately Cool, 4° C	Cool, 4° C	48 hours
Phenols	G	G	Cool, 4° C H ₂ SO ₄ to pH <2	Cool, 4° C	28 days
Phosphorous (Elemental)	G	G	Cool, 4° C	Cool, 4° C	48 hours
Sulfate	P	G	Cool, 4° C	Cool, 4° C	28 days
Surfactants	P	G	Cool, 4° C	Cool, 4° C	48 hours
ORGANIC TESTS					
Chlorinated Hydrocarbons	G	G	Cool, 4° C	Cool, 4° C	7 days until extraction 40 days after extraction
Haloethers	G	G	Cool, 4° C 0.008% Na ₂ S ₂ O ₃	Cool, 4° C	7 days until extraction 40 days after extraction

TABLE 7-6 (Cont.)

Parameter	Container (a)		Preservative (b)		Maximum Holding Time for all Matrices
	Water	Soil	Water	Soil	
ORGANIC TESTS (Cont.)					
Nitroaromatics and Isophorone	G	G	Cool, 4° C Store in Dark	Cool, 4° C Store in Dark	7 days until extraction 40 days after extraction
	G	G	Cool, 4° C	Cool, 4° C	7 days until extraction 40 days after extraction
PCBs					
Pesticides	G	G	Cool, 4° C pH 5-9	Cool, 4° C	7 days until extraction 40 days after extraction
	G	G	Cool, 4° C 0.008% Na ₂ S ₂ O ₃	Cool, 4° C	7 days until extraction 40 days after extraction
Phenols					
Phthalate Esters	G	G	Cool, 4° C	Cool, 4° C	7 days until extraction 40 days after extraction
	G	G	Cool, 4° C 0.008% Na ₂ S ₂ O ₃ Store in Dark	Cool, 4° C Store in Dark	7 days until extraction 40 days after extraction
Polynuclear Aromatic Hydrocarbons					
Purgeable Aromatics	S	S	Cool, 4° C 0.008% Na ₂ S ₂ O ₃ HCl to pH 2	Cool, 4° C	14 days

(a) P = Polyethylene

G = Amber Glass with Teflon-lined cap.

S = Glass Vial with Teflon-lined septum cap.

(b) All samples cooled to 4° C.

filtrate three times before collecting the final filtered sample. Sample filtration was not performed for any of the other parameters analyzed.

Addition of Preservative

Preservatives appropriate for the analysis to be performed on each sample were added as each sample was collected. The sample containers and appropriate preservatives used at Tooele Army Depot are identified in Table 7-6.

7.2.3.2 Soil/Sediment Sampling

Soil samples were collected within designated areas (Table 7-1). Prior to sampling, surface vegetation, rocks, pebbles, leaves, twigs, and debris were removed from the area. Soil samples were collected with a clean stainless steel hand-driven corer or hand trowel. The depth of soil sample collection was site dependent.

As samples were collected, they were placed in containers of appropriate composition for the parameters to be analyzed (Table 7-6). This included laboratory-cleaned glass containers with Teflon-backed closures for organic parameters, and linear polyethylene (Nalgene) containers for trace metals and cyanide. Samples for volatile organics were placed in wide-mouth, amber glass bottles which were sealed with a Teflon septum. As each sample was collected, the containers were labeled, security sealed, and placed on wet ice in secured coolers. No preservatives were added to soil samples. As each sample was collected, the location was flagged, the security seal number recorded in the field notebook, pertinent observations (i.e., vegetation stress, depth of soil) noted and recorded, and entries made on the Chain-of-Custody Form. The samples were then shipped to EA's laboratory within appropriate holding times (Table 7-6).

Equipment used for collection of soil samples (e.g., hand trowels, soil corers) was cleaned after obtaining each sample. Equipment was cleaned by scrubbing and rinsing three times with USATHAMA-approved water.

7.2.3.3 Quality Assurance/Control

Sample collection and laboratory analysis were conducted in accordance with the methods and procedures detailed in the Field Sampling Design and Installation Restoration Program (IRP) Quality Assurance Program Plan (EA 1986), codified, and entered into the Installation Restoration Data Management System (Section 7.3).

Field sampling was performed following strict decontamination, sample handling, packaging, and chain of custody procedures. A trip blank was also included in the overall sampling program as a field quality control check. The trip blank analytical results are summarized in Table 7-7.

TABLE 7-7 TRIP BLANK ANALYTICAL RESULTS FOR N-TEAD PA/SI

<u>Parameter (µg/L)</u>	<u>Trip Blank</u>
PCBs	
Aroclor 1016	<1.3
Aroclor 1260	<2.6
PESTICIDES	
Aldrin	<0.15
Alpha-BHC	<0.17
Gamma-BHC	<0.13
4,4'-DDD	<0.11
4,4'-DDE	<0.23
4,4'-DDT	<0.27
Dieldrin	<0.17
Endrin	<0.35
Heptachlor	<0.16
Malathion	ND
Bromacil	ND
Chlordane	ND
VOLATILES	
Trichloroethene	<2
SEMIVOLATILES	
Phenol	5
AGENT INDICATORS	
Thiodiglycol	<720
p-Chlorophenylmethylsulfide	<43
p-Chlorophenylmethylsulfoxide	<80
p-Chlorophenylmethylsulfone	<31
Diisopropylmethylphosphonate	<23
EXPLOSIVES	
HMX	<5.1
RDX	<4.2
Nitrobenzene	ND
1,3-Dinitrobenzene	<9.1
1,3,5 Trinitrobenzene	<5.8
2,4-DNT	<2.2
2,6-DNT	<5.7
2,4,6-TNT	<6.3
Tetryl	<4.4

TABLE 7-7 (Cont.)

Parameter (µg/L)	Trip Blank
METALS	
Antimony	<7.0
Arsenic	<2.4
Barium	<5*
Beryllium	<0.83
Cadmium	<12
Chromium	<11
Copper	<21
Lead	<1.5
Mercury	<1.1
Nickel	<65
Selenium	<2.5
Silver	<0.14
Sodium	<400
Thallium	<1.7
Zinc	<43
ORGANICS	
Phenol	<870
Surfactants	60
INORGANICS	
Bromide	<240
Chloride	<5,000
Cyanide, Total	<30
Fluoride	400
Nitrate + Nitrite - Nitrogen	90
Orthophosphate	<57
Sulfate	5,000
EA Sample Number	1682

NOTE: ND indicates a compound not assigned a certified reporting limit (CRL) and not found above the analytical detection limit.

* Analytical detection limit is reported as it is greater than the certified reporting limit (CRL). CRLs are presented in Appendix I-G.

Prior to sample analysis, laboratory spikes and blanks were run to statistically establish the lowest sample concentration which would be reported. This concentration is the Certified Reporting Limit (CRL). For USATHAMA IR projects, CRLs are determined by using the USATHAMA program with 90 percent confidence limits. This CRL is associated with the entire method and reflects all sample preparation and measurement steps. The CRLs for the TEAD PA/SI are presented in Appendix I-G.

7.3 DATA MANAGEMENT

All required data from the installation of wells and borings, sampling of surface water, groundwater, soils and sediment, and chemical analyses were entered into the computerized Installation Restoration Data Management System (IRDMS). The following types of data were entered into IRDMS by EA data management personnel:

<u>Data Type</u>	<u>Data File</u>
Geotechnical - Map location	GMA
Geotechnical - Field drilling	GFD
Geotechnical - Well construction	GWC
Geotechnical - Groundwater stabilization	GGG
Chemistry - Groundwater	CGW
Chemistry - Soil	CSO

The IRDMS requires that the first data to be entered for a site are the map location data. Map location data were obtained from the surveyor's report, which included a detailed map. EA data management personnel entered information from this report and map directly into EA's PC-AT. After checking transmission acceptance and merging of the map location datafile into the IRDMS, EA proceeded with entry of other data types.

Data from the field program was recorded on EA field log sheets. Site types and site I.D. codes were assigned and the field log sheets were transcribed to coding sheets in the Level 1 file format. The coding sheets were used as the basis for data entry onto Level 1 files via IRDMS. Field drilling, well construction, and groundwater stabilization data were transcribed from the logs, coded, and entered on IRDMS data sheets designed for each specific data type. EA chemistry and data management personnel similarly coded the analytical chemistry results onto IRDMS chemistry data sheets.

Data management personnel then entered the coded project data on EA's PC-AT using government-furnished software. After entry at EA, data were classed as Level 1 data. These Level 1 data were checked at EA record-by-record. Once data passed this individual record check, groups of records were globally checked. EA data management personnel edited the

data and corrected any errors uncovered in either edit check. When datasets passed both edit checks at EA, they were transmitted to USATHAMA where they were temporarily stored as Level 2 data. Data were transmitted to USATHAMA using a 1200-baud mode and computer communications software. PRI, Inc., the government contractor maintaining the IRDMS, repeated both the individual record check and the global check. When datasets passed these checks, PRI merged these data into the IRDMS. At this point, the data were final or Level 3 data.

After acceptance of all project data into the IRDMS, IRDMS programs were used to produce the data summaries and tables which are provided in Appendix I-G.

8. ENVIRONMENTAL CONTAMINATION INVESTIGATIONS

This chapter presents the results of the field sampling and analysis program implemented for the PA/SI of the TNT Washout Facility Area, the Former Transformer Storage Site, the PCB Spill Site, and the OB/OD Area at N-TEAD; details the history of operations and site characteristics pertinent to evaluating the potential presence and extent of hazardous materials at each site; and provides an assessment of the site's potential impact on human health and the environment.

8.1 TNT WASHOUT FACILITY

8.1.1 Site Location and History

The TNT Washout Facility is housed in Building S-45 in the Ammunition Workshop Area located along East Workshop Road near the south central boundary of TEAD North (Figure 6-1). The facility was constructed in 1947-1948 for the purpose of decommissioning munitions and was extensively operated for this purpose from 1948 to 1958, and again from 1960 to 1965. Items decommissioned in the facility included projectiles, bombs, and rocket heads filled with TNT, Composition B, RDX, and tritonal (USATHAMA 1979).

The washout operation generally consisted of cutting the munition casing and removing and recycling the explosive material. After cutting, the casings were rinsed with water to remove residual explosive. The rinse water then passed through a series of pelletizing separators where a large portion of the residual explosive was recovered. The explosive recovered from this step of the operation was bagged and either sold or destroyed in the Demolition Area (USATHAMA 1979). The rinse water effluent was then routed outside and north of the facility through a metal gutter to a small, baffled, cement settling tank. Overflow from the cement settling tank then flowed into the first of a series of four unlined percolation/evaporation ponds, connected by overflow pipes, which encompassed a total area of approximately 1 acre (Figure 6-2). Effluent rinsewater reportedly flowed into the percolation/evaporation ponds continuously during washout operations. The typical time of operation, during which rinsewater flowed from the facility to the percolation/evaporation ponds, was reported to be 8 hours per day (occurring during a normal 5-day work week). However, for a 4-year period, the facility was reported to have been operated on a continuous basis (i.e., 24 hours a day, 7 days a week). Records of actual rinse water flow volumes were not kept. However, it was estimated that rinsewater flowed from the facility to the percolation/evaporation ponds at an average rate of 20 gpm and the flow was generally contained within the first two percolation/evaporation ponds. Based on the reported average flow rate for the facility and its history of use, it is estimated that 6.95×10^7 gal of explosives laden rinsewaters were discharged from the facility into the percolation/evaporation ponds. A water balance for the facility and percolation/evaporation ponds is provided in Table 8-1. In addition to receiving explosive-laden waters, residual explosives obtained from the settling tanks during "clean out"

TABLE 8-1 ESTIMATED RINSEWATER FLOW VOLUMES FOR TNT WASHOUT FACILITY AND
WATER BALANCE FOR PERCOLATION/EVAPORATION PONDS

Inflow to Percolation/Evaporation Ponds

1. Assumptions:

- . Average rinsewater flow rate from facility = 20 gpm (1,200 gph)
- . 8 hrs/typical work (facility operation) day
- . 2,080 hrs/typical work (facility operation) year
- . Period of operation (1948-1958/1960-1965) = 15 years
 - time facility operated under typical conditions (8 hrs/day) = 11 yrs
 - time facility operated under continuous conditions (24 hrs/day) = 4 yrs

2. Volume of flow/average operation day:

$$1,200 \text{ gph} \times 8 \text{ hrs} = 9,600 \text{ gals}$$

3. Volume of flow/average operation year:

$$1,200 \text{ gph} \times 2,080 \text{ hrs} = 2.5 \times 10^6 \text{ gals}$$

4. Volume of flow for time facility operated under typical conditions:

$$2.5 \times 10^6 \text{ gals/yr} \times 11 \text{ yrs} = 2.75 \times 10^7 \text{ gals}$$

5. Volume of flow/continuous operation day:

$$1,200 \text{ gph} \times 24 \text{ hrs} = 28,800 \text{ gals}$$

6. Volume of flow/continuous operation year:

$$28,800 \text{ gals/day} \times 365 \text{ days/yr} = 1.05 \times 10^7 \text{ gals}$$

7. Volume of flow for time facility operated under continuous conditions:

$$1.05 \times 10^7 \text{ gal/yr} \times 4 \text{ yrs} = 4.2 \times 10^7 \text{ gals}$$

8. Total estimated flow volume for facility (line items 4 plus 6):

$$2.75 \times 10^7 \text{ gals} + 4.2 \times 10^7 \text{ gals} = \underline{6.95 \times 10^7 \text{ gals}}$$

TABLE 8-1 (Cont.)

Water Balance

1. Typical flow conditions:

Inflow: 2.5×10^6 gal/yr = 335,000 ft³/yr
Area: $2/3$ acre = 29,040 ft²
Precipitation: 16.5 in./yr = 39,930 ft³/yr
Evaporation: 42 in./yr = 101,640 ft³/yr

Seepage = Inflow + Precipitation - Evaporation

Seepage = 273,290 ft³/yr = 2,044,209 gal/yr

2. Continuous flow conditions:

Inflow: 1.05×10^7 gal/yr = 1,403,700 ft³/yr
Area: 29,040 ft²
Precipitation: 39,930 ft³/yr
Evaporation: 101,640 ft³/yr

Seepage = 1,341,990 ft³/yr = 10,038,085 gal/yr

NOTE: The above estimates provide only a preliminary worst-case analysis. Not considered in flow estimate computations are such factors as start-up and down time for facility clean-out operations, and periods of intermittent use. The values given in this table are, therefore, potentially higher than would be anticipated for actual conditions.

operations were also reported to have been discharged to the percolation/evaporation ponds (Bradshaw 1985). The percolation/ evaporation ponds were also reported to have overflowed and/or flooded during its period of operation, resulting in contamination of the surrounding soils with explosive compounds (Ertec 1982).

Since 1965, the TNT Washout Facility has reportedly not been in frequent operation. The total time the facility has been in operation since 1965 is estimated to be in the order of six months (Bradshaw 1985). During the mid-1960s (approximately 1965), the facility was expanded and a 35,000-gallon indoor settling tank was installed for the purpose of recycling the rinse water and to aid in the recovery of residual explosives. In 1983, a charcoal filtration system was installed to further aid in the recovery of explosives and provide for a "closed loop" washout system; eliminating continuous effluent rinsewater flow to the percolation/evaporation ponds. In the Fall of 1984, TEAD closed the percolation/evaporation ponds by flattening the berm surrounding the ponds, and filling the depressions with clean soil and fill. A synthetic liner (PVC) was then placed over the area and covered with soil. Following installation of the charcoal filtration system in the facility and closure of the percolation/evaporation ponds, a new, small (approximately 2,500 square feet), unlined, evaporation/percolation basin was constructed approximately 100 feet northwest of the washout facility (Figure 6-2). This basin reportedly receives backwash rinsewaters from the charcoal filtration system during facility "clean-out" operations and rinsewater (periodically) from the 35,000-gallon indoor settling tank (Bradshaw 1985).

Northeast of the old percolation/evaporation ponds are two shallow unlined laundry effluent holding ponds (Figure 6-2). The northernmost of the ponds currently receives laundry and shower wastewaters from Building 67 at a reported rate of 7,200 gallons per day (Ertec 1982). For a 2-year period, effluent flow to this holding pond was diverted into the third TNT Washout Percolation/Evaporation Pond due to lint clogging problems within the effluent discharge pipe. A sump was installed to rectify the problem, and the pipe from the laundry building to the effluent holding pond was replaced in 1984 (Fuerbach 1985). This effluent holding pond has reportedly overflowed onto the surrounding landscape in a northerly direction (Ertec 1982). The date or period of time this occurred is unknown. Standing water was observed in the holding pond, however, neither a discharge pipe nor overflow from the holding pond onto the surrounding landscape was apparent during the PA/SI survey of the site in December of 1985.

The southernmost effluent holding pond (Figure 6-2) was originally constructed for the purpose of receiving laundry effluent. It consists of a bermed catchment on the land surface. Because an adequate gradient was not provided for conveying effluent from the laundry facility to this catchment, it reportedly was never used as a holding pond and has never received laundry effluent. However, standing water and lush vegetation was observed over an area of approximately 6 feet by 6 feet in the pond's center during well drilling in July 1986.

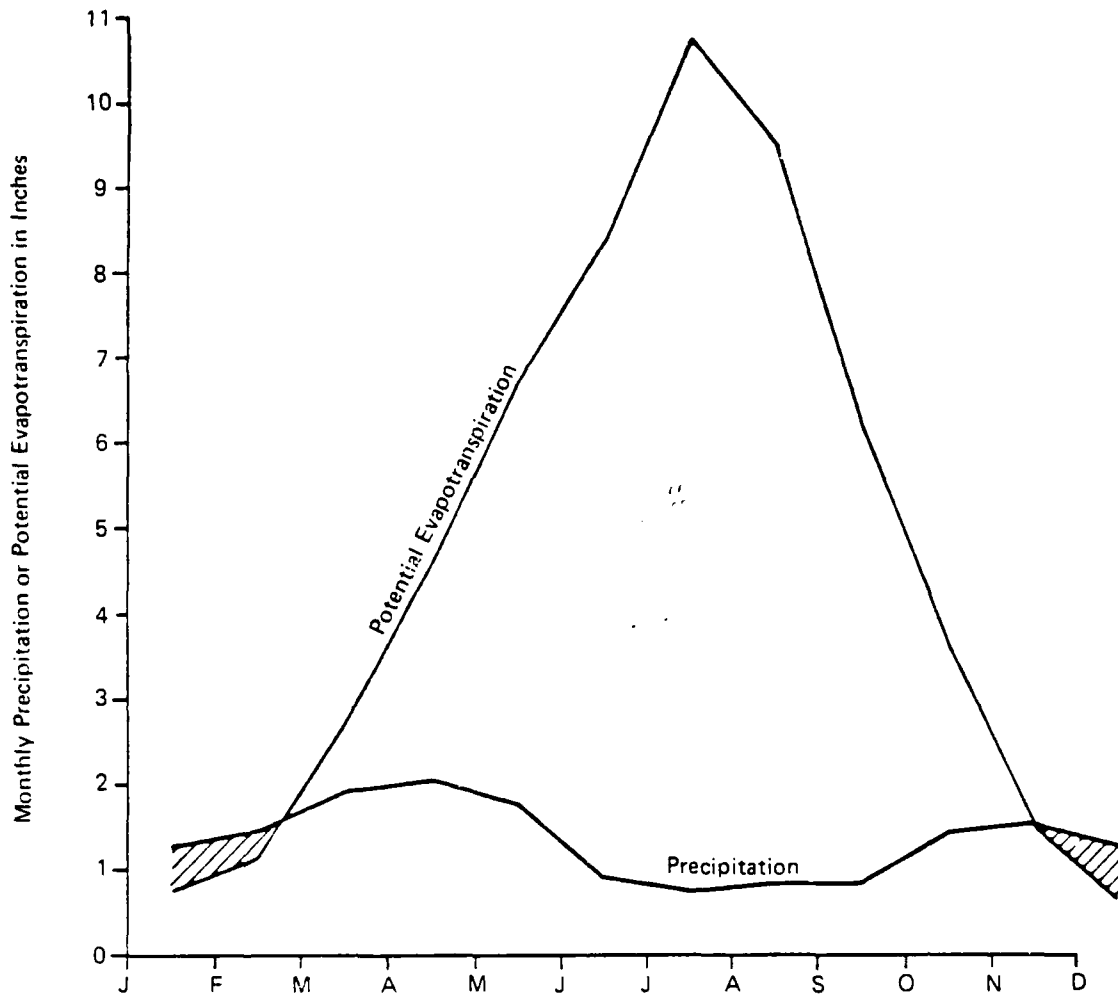
8.1.2 Site Characteristics

The TNT Washout Facility area is situated on the floor of Tooele Valley at an average elevation of approximately 4,730 feet MSL. The topography in the vicinity of the site is flat to gently undulating. Site slopes are variable, but occur in a general northerly direction (toward the Great Salt Lake) at an average gradient of approximately 3 percent. The direction of surface drainage is congruous with the topography of the area. There are no naturally occurring perennial streams or surface waterbodies in the vicinity of the site which could potentially be impacted by current or past site activities. Surface discharge does not presently occur outside the laundry effluent evaporation/infiltration pond at the site.

The climate in the vicinity of the site is consistent with that of N-TEAD, which is generally arid to semi-arid with annual precipitation ranging from 10 to 15 in. (Section 2.2). Potential evapotranspiration greatly exceeds precipitation in every month except November, December, and January (Figure 8-1). Average annual potential evapotranspiration in the area of the Washout Facility is 42 in. The potential net annual water loss (precipitation - evapotranspiration) is approximately 26-32 inches. Due to this relatively large negative water balance, the amount of surface infiltration and recharge to the underlying aquifers in the vicinity of the site is severely limited.

Soil borings performed in the TNT Washout Facility area reveal the site to be directly underlain by approximately 80 feet of unconsolidated lacustrine (former Lake Bonneville) deposits comprised of very fine sands, silt, and clay (Figures 8-2, 8-3, and 8-4). Physical property analysis of a soil boring sample obtained from the bottom depth of the former washout ponds classified the surface materials at the site as a fine sand with little or no fines (SP) having a moderate permeability of 1.2 to 1.5×10^{-3} cm/sec. Laboratory analysis of soil samples obtained by AEHA (1981) from depths of 26 to 78 feet BLS classified the subsoils as silts and clays (ML and CL), having a relatively low permeability rate of 3.22×10^{-6} cm/sec to 4.42×10^{-7} cm/sec (Table 6-2). A general fining gradation with depth was observed within the lacustrine deposits during borehole drilling in this area. Thin alternating layers of clay and sand (2-3 inches in thickness) were also observed within the lacustrine deposits from a depth interval of approximately 40 feet BLS to the terminal depth of the borings. The fine-grained lacustrine deposits at the site are, in turn, underlain by unconsolidated valley alluvial deposits comprised of coarse gravels, sand, and silt. The actual thickness of the alluvial deposits and the total depth to bedrock at the site is not known. However, based upon regional data provided in Ertec (1982), the thickness of these deposits and the total depth to bedrock in the Washout Facility area is estimated to be 1,420 feet and 1,500 feet, respectively. The lithology and stratigraphy of the deposits in the TNT Washout Facility area are graphically represented in Figures 8-2, 8-3, and 8-4.

As is indicated in Figures 8-3 and 8-4, perched groundwater conditions exist within the immediate vicinity of the laundry effluent pond at the site. In this area of the site, continuous effluent seepage from the



NOTE: Computed with the Jensen-Haise Method. Potential discharge is indicated by the cross hatched pattern and totals 1.57 inches per year.

Figure 8-1. Mean monthly precipitation and evaporation at Tooele , Utah. (Source: JMM,1987).

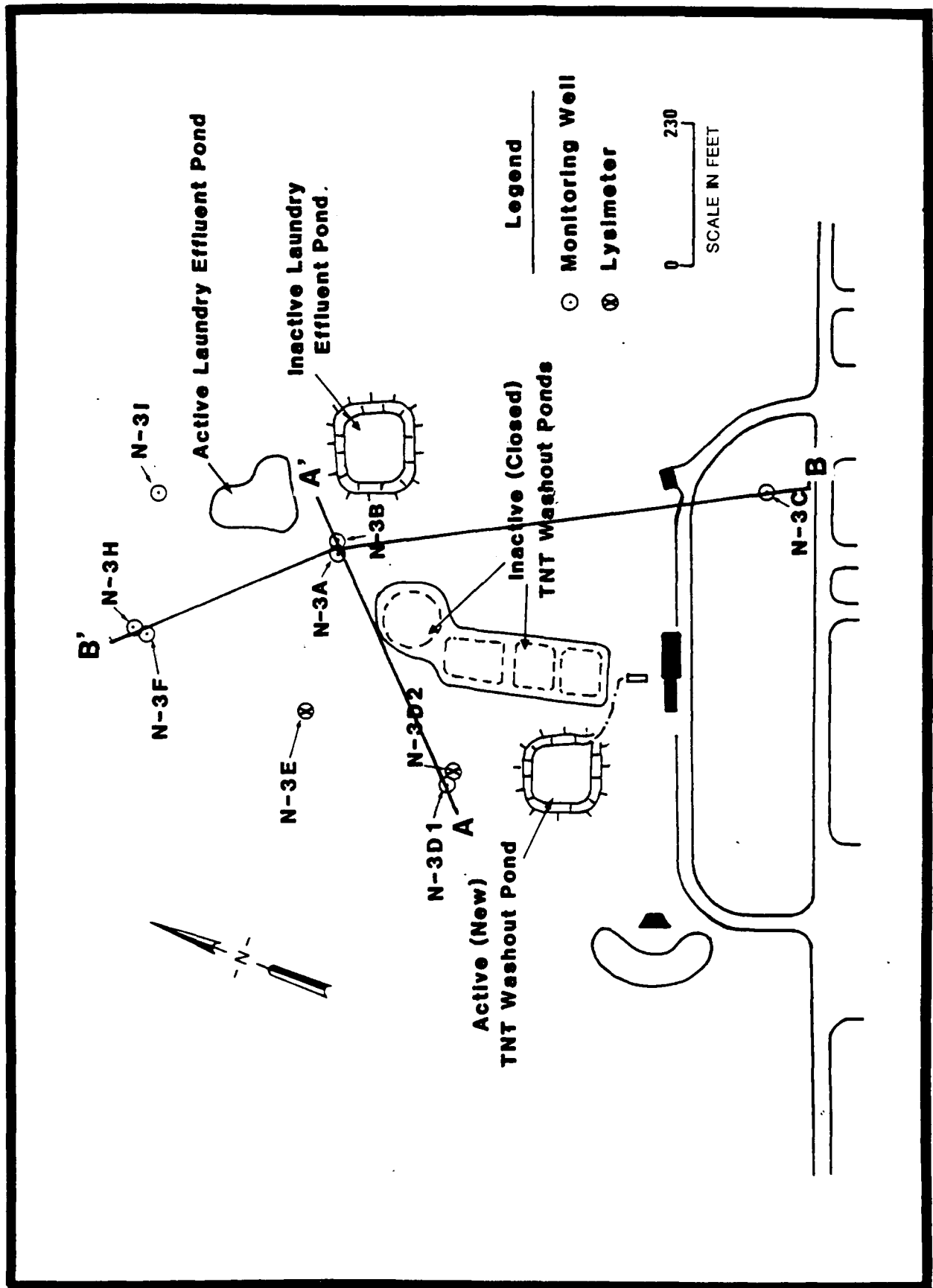


Figure 8-2. Map of TNT Washout Facility Area showing hydrological cross-section lines.

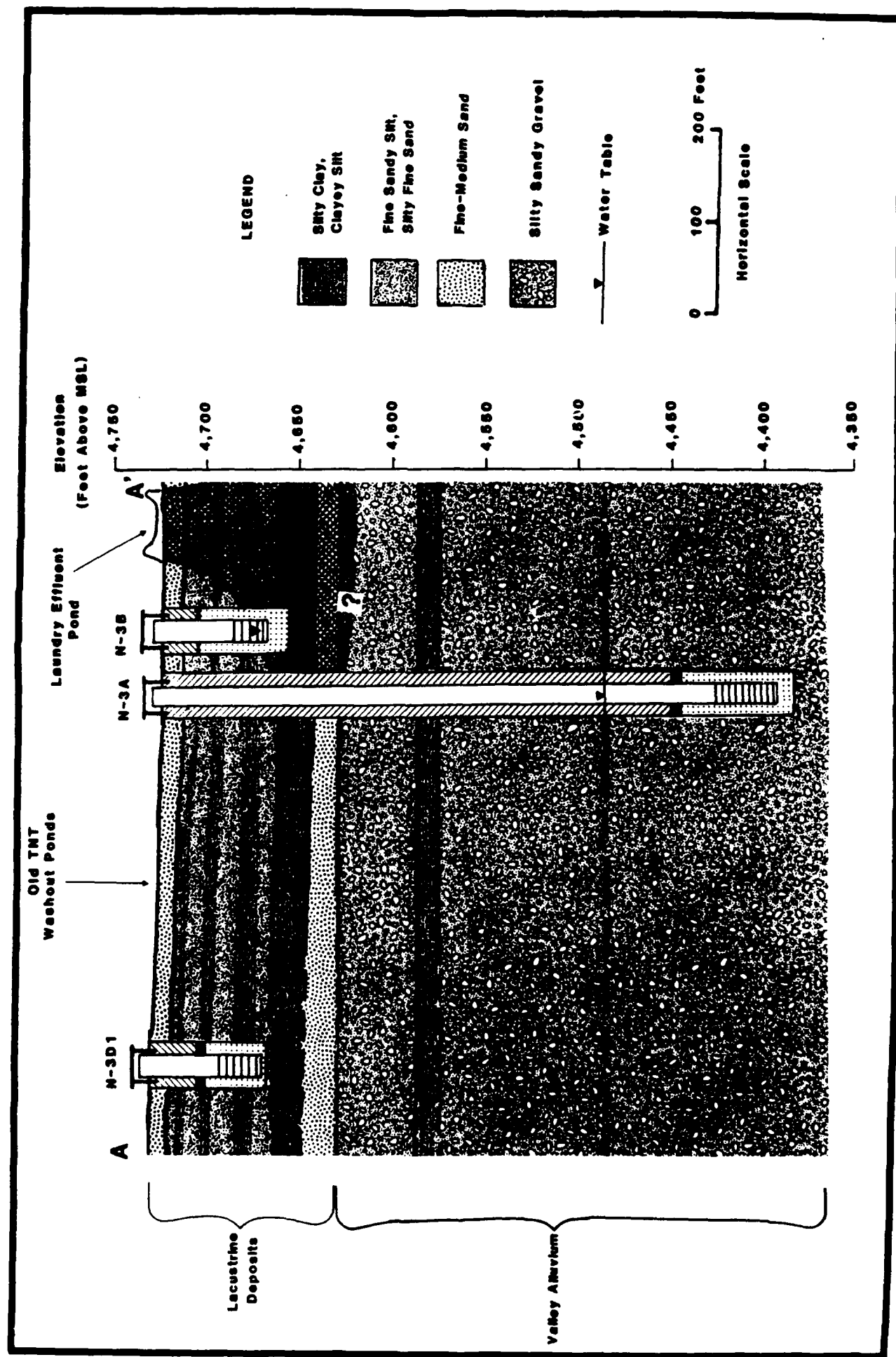


Figure 8-3. Hydrogeologic cross-section A-A', TNT Washout Facility Area, N-TEAD.

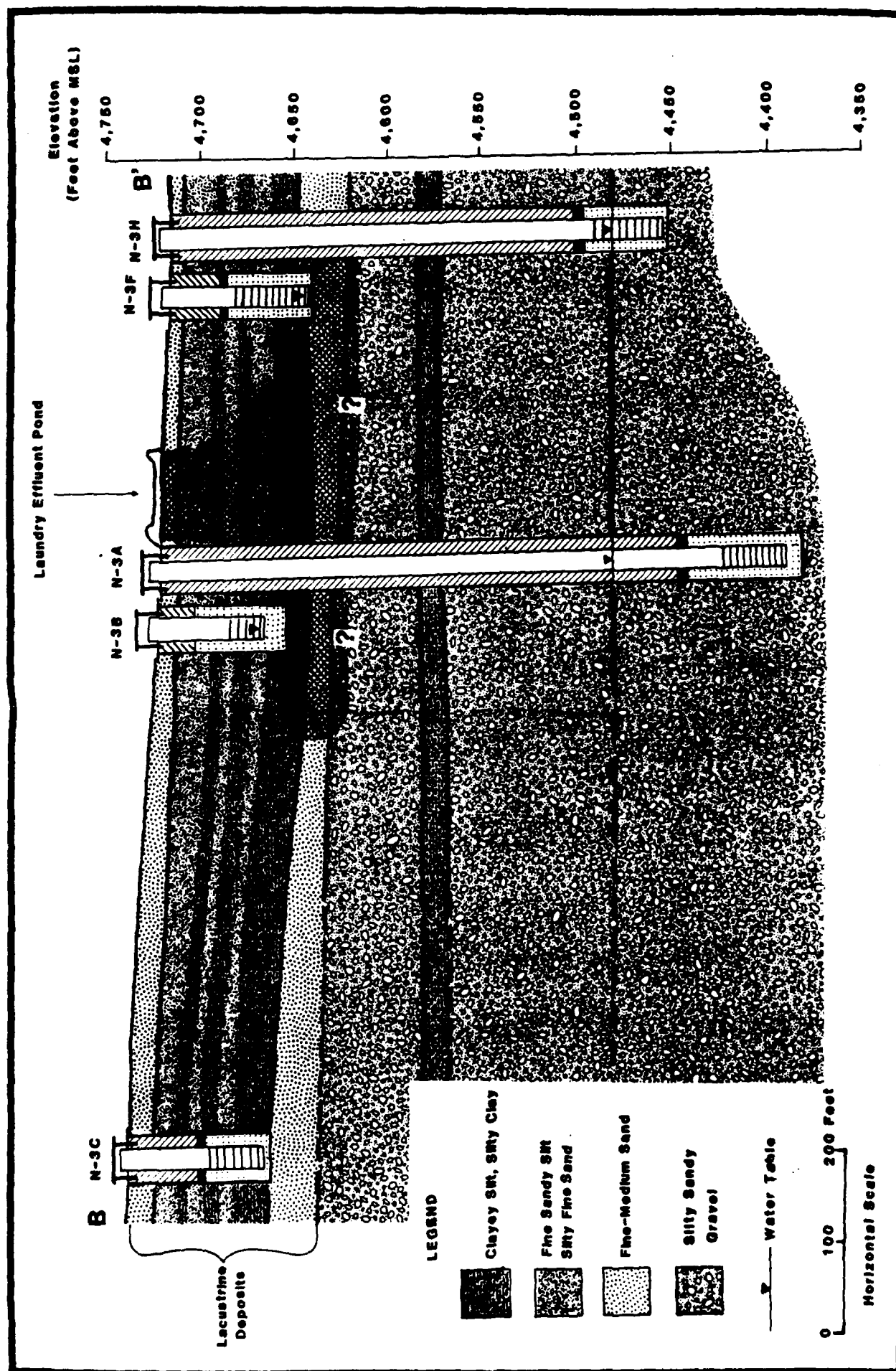


Figure 8-4. Hydrogeologic cross-section B-B', TNT Washout Facility Area, N-TEAD.

pond was sufficient to overcome the specific retention of the formation and clay smeared borehole to supply water (effluent) to Wells N-3B, N-3F, and N-3I (Figure 8-2). Naturally occurring wet to saturated formation conditions were also encountered within the screened interval of the lacustrine deposits at all other well/lysimeter locations (Figure 8-2), however, was not sufficient to overcome the specific retention of the formation and the clay smeared boreholes to supply water to the wells and lysimeters at these locations. The regional water table aquifer occurs at a depth of approximately 240 feet beneath the site. The direction of groundwater flow within the regional aquifer is assumed to occur in a general northerly direction based on regional and site-specific topographic data (Chapter 3). The nearest water supply well in a downgradient direction of the Washout Facility Area lies approximately 5 miles to the north.

8.1.3 Site Contamination Investigation

In order to characterize the potential presence and extent of environmental contamination, the following samples were obtained from within the TNT Washout Facility Area:

- . Twelve soil samples were obtained from four soil borings conducted in the Old TNT Washout ponds (one boring performed in each pond)
- . One sediment sample (composite of 5 discrete samples) was collected from the (existing) New TNT Washout Collection Basin
- . Eight surficial soil samples collected from a potential area of surface contamination defined by Ertec (1982)
- . One surficial soil sample collected at each of five locations in which monitoring wells/lysimeters were installed
- . One surface water and one sediment sample (composite of 5 discrete samples each) were collected from the Laundry Effluent Pond
- . Five groundwater samples from the existing (N-3A and N-3B) and newly installed (N-3F, N-3H, and N-3I) downgradient monitoring wells were collected.

Sampling locations in the TNT Washout Facility Area are shown in Figure 8-5.

8.1.3.1 Old TNT Washout Ponds Sampling and Analysis

Continuous core samples were obtained from within the Old (closed) TNT Washout ponds in order to characterize the waste materials and provide a preliminary assessment of their movement and potential extent of vertical migration.

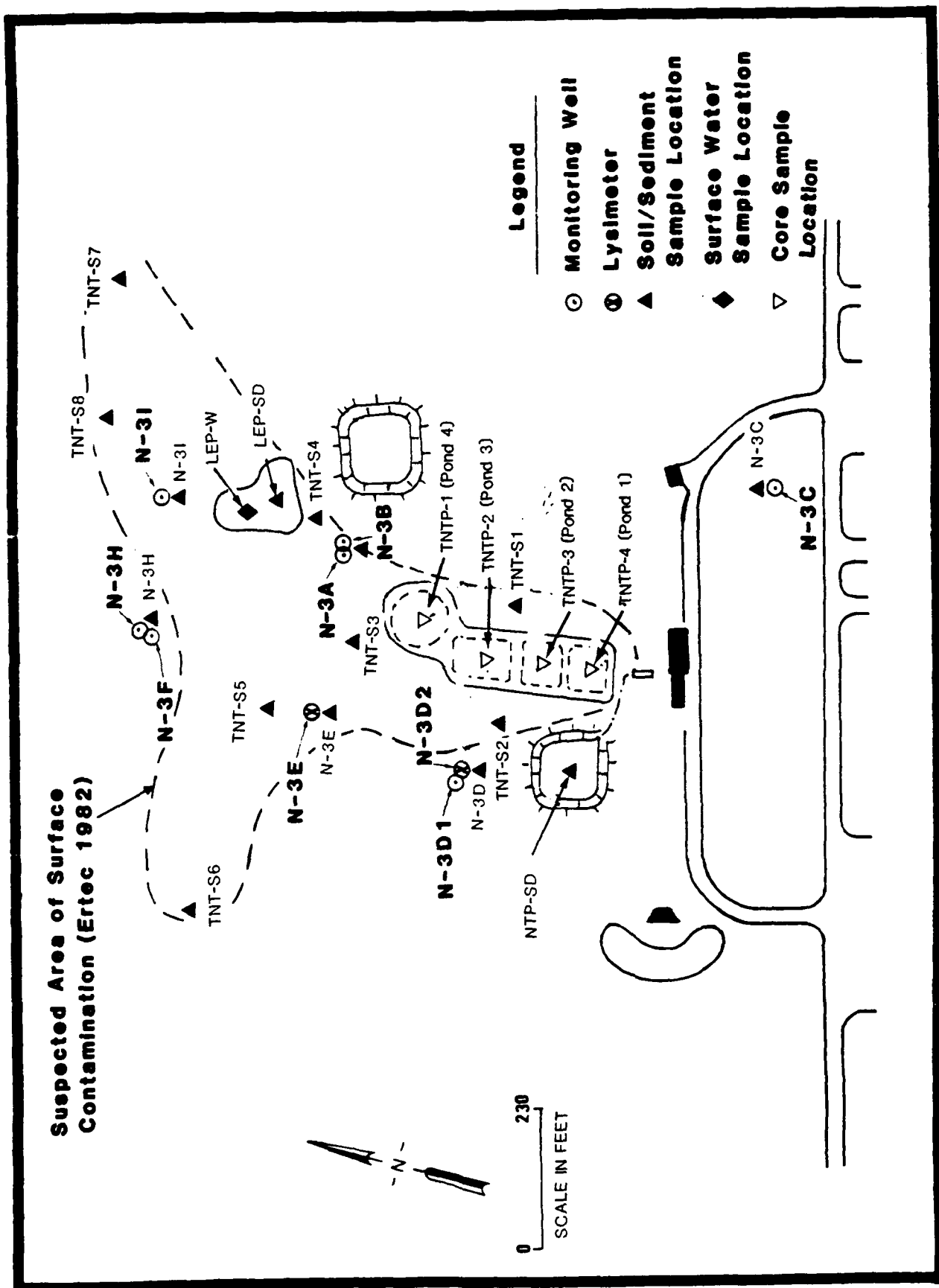


Figure 8-5. TNT Washout Facility Area Sampling Locations.

Because of the closure activities which were implemented at the old TNT ponds, the location of the individual ponds had to be ascertained. Prior to performing soil borings/sampling, the boundaries of the closed area was delineated and staked. This was accomplished through visual interpretation of the disturbed area and through light probing with a blunt shovel. Once the perimeter had been staked, perimeter distances were measured, logged, and the area photographed. Aerial photos (EPIC) were then used to scale the dimension and location of each of the ponds within the delineated closed area.

Soil core sampling locations were then selected within the center of each pond. Coring locations were staked and, as a precautionary measure, each of the delineated locations was swept with a pipe and cable locator to check for potentially obstructing buried metallic objects.

A 10- to 12-inch hole was then cut and opened in the PVC cap covering the ponds where the core sample was to be obtained. Continuous core sampling was then performed through the opened hole using a truck-mounted auger drill rig which was used to drive a 5-foot length, 3-inch OD bronze split spoon sampler to a depth of approximately 5 feet. The sampler was retrieved and the depth of the original pond bottom was determined through visual examination of the continuous core sample obtained.

At all four ponds, soil samples were collected for analysis at a depth of 0-4 inches (bottom sediment) and at a depth of 1 foot below the original bottom of the pond. At Pond No. 1, additional samples were collected at a depth of 2, 3, 4, and 5 feet below the original pond bottom (Figure 8-5). A total of 12 soil samples were obtained for explosives and nitrate+nitrite nitrogen determinations. At Pond No. 1, an additional soil sample was collected for textural (sieve) and permeability analysis. Samples obtained were visually characterized by the supervisory geologist, logged, placed in appropriate sampling containers, labeled, packaged, and shipped to EA's laboratory in accordance with U.S. EPA standard procedures and DOT requirements for shipping hazardous/reactive materials.

Upon completion of sample collection, coreholes were backfilled and the PVC cap patched. The patched coring location was then covered with surface soil, and the site returned to near pre-existing conditions.

Each of the core sampling locations is shown in Figure 8-5. The analytical results for the samples obtained are summarized in Table 8-2. Results of the textural and permeability analysis classified the material directly underlying the former pond bottoms as a fine sand with little or no fines (SP), having a permeability of 1.2 to 1.5×10^{-3} cm/sec (Ertec 1987).

As is indicated in Table 8-2, quantifiable levels of 2,4,6-TNT, HMX, 1,3,5-TNB, and 2,4-DNT were detected in soil samples obtained from each of the ponds, with the most elevated levels of these compounds appearing in samples obtained from Pond Nos. 1 and 2 (e.g., the highest TNT concentration levels ranged from 8.6 $\mu\text{g/g}$ and 201 $\mu\text{g/g}$ in samples

TABLE 8-2 ANALYTICAL RESULTS FOR SUBSOIL SAMPLES OBTAINED FROM THE OLD (CLOSED) TNT WASHOUT PONDS, N-TEAD*

Sample Location/No.	Sample Interval (ft below pond bottom)	2,4,6-TNT	HMX	1,3,5-TNB	2,4-DNT	2,6-DNT	1,3-DNB	NB	NO ₃ + NO ₂
Pond No. 1									
TNTP-4A	0-0.42	1,292	17.6	18.0	<3.4	<0.54	<0.83	<9.2	18.9
TNTP-4B	1.0-1.33	15,080	<9.2	15.3	<3.4	<0.54	<0.83	<9.2	52.8
TNTP-4C	2.0-2.33	8,119	<9.2	11.3	<3.4	<0.54	<0.83	<9.2	48.9
TNTP-4D	3.0-3.33	4,268	17.2	9.5	<3.4	<0.54	<0.83	<9.2	58.5
TNTP-4E	4.0-4.33	68.5	<9.2	7.4	<3.4	<0.54	<0.83	<9.2	55.6
TNTP-4F	5.0-5.33	132.8	<9.2	5.9	<3.4	<0.54	<0.83	<9.2	20.1
Pond No. 2									
TNTP-3A	0-0.42	20,700	95.2	47.0	8.2	<0.54	<0.83	<9.2	60.8
TNTP-3B	1.0-1.33	822	18.2	14.4	<3.4	<0.54	<0.83	<9.2	57.2
Pond No. 3									
TNTP-2A	0-0.33	5.1	<9.2	10.0	<3.4	<0.54	<0.83	<9.2	17.1
TNTP-2B	1.0-1.42	201.0	<9.2	18.4	<3.4	<0.54	<0.83	<9.2	18.9
Pond No. 4									
TNTP-1A	0-0.33	8.6	<9.2	<0.5	<3.4	<0.54	<0.83	<9.2	8.81
TNTP-1B	1.0-1.33	<0.5	<9.2	<0.5	<3.4	<0.54	<0.83	<9.2	18.9

* Units are in µg/g (ppm).
CRLs are provided in Appendix I-G.

NOTE: TNT = trinitrotoluene
HMX = octahydro-tetranitro-tetrazocine
TNB = trinitrobenzene
DNT = dinitrobenzene
DNT = dinitrobenzene
NB = dinitrotoluene
NB = nitrobenzene
NO₃ + NO₂ = nitrate+nitrite nitrogen

The parameters listed were determined according to methods not certified by USATHAMA.

obtained from Pond Nos. 4 and 3, respectively, to 20,700 µg/g and 15,080 µg/g in Pond Nos. 2 and 1, respectively). Concentration levels for nitrobenzene, 2,6-DNT, and 1,3-DNB were below the certified reporting limit (CRL) for all samples. 2,4-DNT was detected at a concentration of 8.2 µg/g at Pond 2 only, and was less than the CRL in all other cases. In addition to a general decrease in explosive concentrations horizontally from south to north (Pond Nos. 1-4) for the compounds detected, a general decrease in explosive concentrations with depth (vertically) is also evident, in most cases.

Nitroaromatic compounds such as TNT, DNT, MNT, and RDX are highly stable in the environment and degradation processes can be relatively slow (Syracuse Research Corp. 1979). Little data concerning the mechanisms of transport of these compounds in soils are available in the literature.

Laboratory column leaching tests have shown that over a 6-month study period, very little RDX, TNT, and tetryl moved through the test columns. The concentrations of RDX and TNT in the column effluent was less than 0.05 mg/L (Hale et al. 1979). This was attributed to the low solubility of these compounds in water coupled with their high soil sorption potential. Generally, the higher the organic content of a soil, the larger its potential to sorb organic compounds such as nitroaromatics (Syracuse Research Corp. 1979).

Microbiological degradation studies have shown that DNT, RDX, MNT, and TNT can be broken down, at least to a limited degree, by a wide range of micro-organisms. These studies have shown that depending on the experimental conditions, mixed cultures of organisms under aerobic conditions can remove up to 65 percent of the TNT from the wastewater (Syracuse Research Corp. 1979).

Photolysis (destruction by sunlight) was found to be a mechanism which causes destruction of RDX and TNT. Nitrite and nitrate are produced as breakdown byproducts of RDX through photolysis. Photolysis was found to be the most effective mechanism to remove RDX from the environment, however, once water laden with RDX has penetrated the soil surface, the destruction of RDX ceases. Nitroaromatic compounds also show appreciable destruction by photolysis. Photo-decomposition products of 2,4,6-TNT catalyze further 2,4,6-TNT destruction. Destruction of TNT in washout ponds similar to those located at Tooele Army Depot is dependent upon the concentration of TNT in solution and the depth of sunlight penetration. Products generated during photolysis of 2,4,6-TNT are nitrate ions, nitrite ions, and methyl-based compounds such as methanol and formaldehyde. Photolysis does not appear to induce breakage of the benzene ring, so various aromatic compounds with nitrate and methyl groups would also be byproducts of TNT and toluene, and would evaporate from washout ponds leaving nitrated or methylated aromatic byproducts such as 1,3,5-TNB, 2,6-DNT, 2,4-DNT, and 1,3-DNB. Other reported photo-products such as 2,4,6-TNT include 4,6-dinitroanthranil, 2,4,6-trinitrobenzaldehyde, 2,4,6-trinitrobenzonitrile, and 2,4,6-trinitrobenzoic acid. Therefore, although 2,4,6-TNT appears to be more photoactive than RDX, it generates toxic byproducts while RDX photolysis is a more complete reaction (Ertec 1982).

The Washout ponds are underlain by a thick (approximately 80-foot) layer of lacustrine deposits comprised of silt and clay, and since TNT is highly stable and readily sorbed onto the surface of soil particles, it is reasonable to assume that these factors have served to restrict the vertical movement of explosive compounds at the site. However, the actual vertical extent to which explosive compounds may have migrated through the soil beneath the site (prior to site closure) cannot be determined from the available data, due to the limited depth to which sampling was performed.

It is likely that the disparity in horizontal TNT concentration levels observed in sediment taken from Pond Nos. 1-4 (greatest in 1 and 2 and least in 3 and 4) is indicative of differential settling of solids between the pond and time of pond inundation. The contaminated water level within Pond No. 1 would have to rise to the level of the drain pipe before draining into Pond No. 2, which in turn would have to rise before draining into Pond No. 3. Because TNT is relatively insoluble in water at normal temperature (0.013 grams/100 grams water at 20 C), larger amounts would tend to settle out of suspension in Pond Nos. 1 and 2, with less deposition in Pond Nos. 3 and 4. This process would result in a gradation at TNT quantities and concentration levels between the ponds. Therefore, the horizontal extent of explosives contamination within soils appears to be greatest within the area formerly encompassed by Pond Nos. 1 and 2.

8.1.3.2 New TNT Washout Basin Sampling and Analysis

In order to preliminarily determine whether the existing (New) TNT Washout Basin provides a source of environmental contamination in the Washout Facility area, one composite sediment sample (of 5 discrete samples) was obtained from the bottom of the basin with a stainless steel hand trowel and analyzed for explosives and nitrate+nitrite nitrogen content (Figure 8-5). The analytical results for sample NTP-SD are provided in Table 8-3.

The concentration levels for all explosive compounds analyzed were less than the CRL. Nitrite+nitrate nitrogen level was also less than the CRL of 11.1 ppm. Based on the results of the sampling and analysis performed, the New TNT Washout basin does not appear to provide a source of explosives contamination in the Washout Facility Area.

8.1.3.3 Surficial Soils Sampling and Analysis

A total of 13 surface soil samples were obtained throughout the Washout Facility Area for explosives and nitrate+nitrite nitrogen content determination to provide a preliminary evaluation of the potential presence and extent of surface contamination, if any. Eight samples (TNT-S1 through TNT-S8) were collected from within an area defined by Ertec (1982) as having a high potential for surface contamination and a total of five additional samples (N-3C, N-3D, N-3E, N-3H, and N-3I) were obtained at each of the well/lysimeter locations. Samples were obtained from a depth of approximately 1 foot using a stainless steel hand trowel. The sampling locations are shown in Figure 8-5. The analytical

TABLE 8-3 ANALYTICAL RESULTS FOR SURFACE SOIL SAMPLES COLLECTED IN THE TNT WASHOUT FACILITY AREA, N-TEAD, 3 MARCH 1987

Parameter ($\mu\text{g/g}$)	TNT-S1	TNT-S2	TNT-S3	TNT-S4	TNT-S5	TNT-S6	TNT-S7	TNT-S8	N-3C	N-3D	N-3E	N-3H	N-3I	N-WTP
EXPLOSIVES														
HMX	<9.2	<9.2	<9.2	<9.2	<9.2	<9.2	<9.2	<9.2	<9.2	<9.2	<9.2	<9.2	<9.2	<9.2
RDX	<6.69	<6.69	<6.69	<6.69	<6.69	<6.69	<6.69	<6.69	<6.69	<6.69	<6.69	<6.69	<6.69	<6.69
Nitrobenzene	<9.2	<9.2	<9.2	<9.2	<9.2	<9.2	<9.2	<9.2	<9.2	<9.2	<9.2	<9.2	<9.2	<9.2
1,3-Dinitro- benzene	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83	<0.83
1,3,5-Trinitro- benzene	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2,4-DNT	<3.4	<3.4	<3.4	<3.4	<3.4	<3.4	<3.4	<3.4	<3.4	<3.4	<3.4	<3.4	<3.4	<3.4
2,6-DNT	<0.54	<0.54	<0.54	<0.54	<0.54	<0.54	<0.54	<0.54	<0.54	<0.54	<0.54	<0.54	<0.54	<0.54
2,4,6-TNT	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Tetryl	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
INORGANICS														
Nitrite+Nitrate -Nitrogen	<11.1	<11.1	<11.1	<11.1	<11.1	<11.1	<11.1	<11.1	<11.1	<11.1	<11.1	<11.1	<11.1	<11.1
EA Sample Number	1627	1628	1629	1630	1631	1632	1633	1634	1539	1540	1541	1538	1542	1543

ND indicates a compound not assigned a certified reporting limit (CRL) and not found above the analytical detection limit.

CRLs are provided in Appendix I-G.

The parameters listed were determined according to methods not certified by USATHAMA.

results are provided in Table 8-3. The concentration of explosive compounds in all samples collected were below the CRL. Nitrate+nitrite nitrogen concentration levels were less than the CRL of 11.1 µg/g in all samples.

8.1.3.4 Laundry Effluent Pond Sampling and Analysis

One composite surface water sample and one composite sediment sample (each comprised of five discrete samples) were obtained from the Laundry Effluent Pond to determine if it was providing a source for groundwater contamination in the Washout Facility Area. Samples were obtained using grab-sampling methods. The sampling locations are shown in Figure 8-5.

Determinations for volatile and semi-volatile organics, explosives, metals, surfactants, and nitrate+nitrite nitrogen were conducted on both samples. Results of parameters detected in the water and sediment samples are summarized in Table 8-4. No volatile organics, semi-volatile organics, or explosives were detected in the water or sediment samples. A number of metals were found at detectable concentrations, however, no concentrations exceeded the Federal or State drinking water standards. Nitrate+nitrite nitrogen was detected in the pond's water at a concentration level of 1,180 µg/L. Nitrate+nitrite nitrogen concentration levels in the sediment were less than the CRL of 11.1 µg/L. The disparity in the results between the aqueous and sediment sample indicate that these forms of nitrogen are present mainly in the dissolved state. The elevated level of nitrate+nitrite nitrogen detected in the aqueous sample is likely due to detergents and is not uncommon for laundry effluent.

Elevated levels of sodium were detected in both the water (320,000 mg/L) and sediment (400 µg/g). It is likely that the levels of sodium are due to the natural saline soil conditions prevalent at TEAD (Sections 3.2 and 3.4).

8.1.3.5 Groundwater Sampling and Analysis

The location of groundwater monitoring wells installed in the TNT Washout Facility Area are shown in Figure 8-5. Monitoring well Nos. N-3A and N-3H were screened in the deep regional aquifer, which is used as a water supply source at the Depot and surrounding area. All other monitoring wells at the site were screened at a depth interval which intercepts perched groundwater at the site.

Well Nos. N-3C and N-3D1 were dry at the time of sampling, therefore, groundwater samples were not collected at these locations. Also, samples could not be obtained from the lysimeters (N-3D2 and N-3E) at the time of sampling. The localized presence of groundwater in shallow monitoring well Nos. N-3B, N-3F, and N-3I is likely the direct result of effluent seepage from the Laundry Effluent Pond. This seepage may extend partially (horizontally) beneath the TNT Washout ponds, but does not extend all the way as borings/monitoring wells N-3C and N-3D1 and boring N-3E were dry.

TABLE 8-4 ANALYTICAL RESULTS FOR A WASTEWATER AND SEDIMENT SAMPLE COLLECTED FROM THE LAUNDRY EFFLUENT POND, TNT WASHOUT FACILITY AREA, N-TEAD, 3 MARCH 1987

<u>Parameter</u>	<u>Sediment N-LEP-SD (ug/G)</u>	<u>Effluent N-LEP-W (ug/L)</u>
EXPLOSIVES	BCRL	BCRL
VOLATILE ORGANICS	BCRL	BCRL
SEMI-VOLATILE ORGANICS	BCRL	BCRL
INORGANICS		
MBAS	---	120
Cyanide, Total	---	<29.5
Nitrite + Nitrate Nitrogen	<11.1	1,180
METALS		
Antimony	<0.35	11.2
Arsenic	4.3	2.7
Barium	39.8	61
Beryllium	<0.042	<0.83
Cadmium	<0.6	<11.9
Chromium	5.5	15
Copper	4.0	32
Lead	2.44	4.4
Mercury	<0.22	<1.1
Nickel	5.1	<65.2
Selenium	<0.13	<2.53
Silver	0.020	0.15
Sodium	400	320,000
Thallium	<0.085	<1.7
Zinc	16.2	80
EA Sample Number	1626	1623

NOTE: BCRL = Below Certified Reporting Limit for all parameters tested.
 CRLs are provided in Appendix I-G.
 The parameters listed were determined according to methods not certified by USATHAMA.

Groundwater samples were analyzed for volatile and semi-volatile organics, explosives, metals, cyanide, and nitrite+nitrate nitrogen. Table 8-5 is a summary of the parameters detected. A listing of parameter certified reporting limits is provided in Appendix I-G.

Perched Aquifer

Quantifiable levels of various explosive compounds (HMX; RDX; 1,3,5-TNB; 2,4-DNT; 2,4,6-TNT) were detected in each of the three shallow monitoring well samples obtained from the site (Table 8-5). Elevated levels of sodium and nitrate+nitrite nitrogen were also detected. The nitrate+nitrite nitrogen concentrations in N-3F (35,000 µg/L) and N-3I (12,700 µg/L) were above the federal and state drinking water standard of 10,000 µg/L for nitrates. The arsenic concentration in the samples obtained from Well Nos. N-3B (110 µg/L) and N-3I (74 µg/L) were above the Federal and State drinking water standard (50 µg/L). Chloroform (2 µg/L) and toluene (6 µg/L) were detected in the sample from well N-3I, however, the source of their detected presence is not known. There is no evidence to suggest that operations conducted at the TNT Washout Facility would contribute these types of contamination.

An explanation for the presence of explosive compounds in the samples obtained from the shallow monitoring wells (and the lack of explosives in the laundry pond effluent) is that percolation of laundry effluent through the soil is mobilizing (leaching or flushing) explosive compounds which may be present in subsurface soils at the site. Furthermore, the relative distribution pattern of explosive compounds from the samples obtained from each of the wells suggest that the explosive compound plume created by this mechanism is, in general, relatively limited in horizontal and vertical extent. The elevated level of arsenic detected in Wells N-3B and N-3I is somewhat anomalous and may be due to a localized geochemical aboration (dissolution of arsenic from an indigenous mineral such as realgar or arsenopyrite (Section 3.2) or a cumulative effect from seepage of laundry effluent. Both Well Nos. N-3B and N-3I are within the zone of influence of effluent seepage from the laundry effluent pond and are (and have been) more readily subject to continued effluent seepage and flushing. Well N-3F is located a greater distance to the northwest, and provides a greater potential for the arsenic to adsorb to the soil prior to reaching the well.

Regional Aquifer

An explosive compound, 2,4-DNT, was detected at a concentration of >20 µg/L in Well N-3H downgradient of the site. All other explosive compounds were below CRLs (Table 8-5). The levels of semi-volatiles and cyanide were below the limit of detection in both deep aquifer well samples. Total metal concentrations in the deep aquifer samples were less than Federal and State primary drinking water standards. Concentrations of cadmium (<11.9 µg/L) and nickel (<65.2 µg/L) were below the CRLs, however, the CRLs were above the federal primary drinking water standard of 10 µg/L and 13.4 µg/L, respectively. Elevated levels of sodium (220,000 ppb and 180,000 µg/L) and nitrate+nitrite nitrogen (61,000 µg/L and 9,400 µg/L) were detected in the groundwater samples

TABLE 8-5 ANALYTICAL RESULTS FOR SAMPLES COLLECTED FROM MONITORING WELLS LOCATED AT THE TNT WASHOUT FACILITY AREA, N-TEAD,
28 FEBRUARY 1987

Parameter (µg/L)	Monitoring Wells					Utah Standards	U.S. EPA Water Quality Criteria*
	N-3A (Deep)	N-3H (Deep)	N-3B (Shallow)	N-3F (Shallow)	N-3I (Shallow)		
VOLATILE ORGANICS							
Chloroform	ND	ND	ND	ND	2	---	100
Toluene	2	13	ND	ND	6	---	15,000
SEMI-VOLATILE ORGANICS							
Benyl alcohol	ND	ND	ND	ND	8	---	---
Butyl benzyl phthalate	ND	ND	ND	ND	ND	---	---
Bis(2-ethylhexyl phthalate	ND	10**	ND	ND	ND	---	---
Phenol	ND	1	ND	ND	3	---	3,500
EXPLOSIVES							
HMX	<5.07	<5.07	17.6	<5.07	12.2	---	---
RDXX	<4.19	<4.19	100	>160	76.1	---	---
1,3-Dinitrobenzene	<9.08	<9.08	<9.08	<9.08	<9.08	---	---
1,3,5-Trinitrobenzene	<5.84	<5.84	>100	<5.84	<5.84	---	---
2,4-DNT	<2.22	>20.0	7.5	<2.22	<2.22	---	---
2,6-DNT	<5.7	<5.7	<5.7	<5.7	<5.7	---	---
2,4,6-TNT	<6.25	<6.25	37.4	<6.25	<6.25	---	---
Tetryl	<4.39	<4.39	<4.39	<4.39	<4.39	---	---
METALS							
Antimony	<7.0	<7.0	<7.0	<7.0	<7.0	---	146
Arsenic	7.1	5.2	110	18.3	74	50	50
Barium	52	46	81	23	94	1,000	1,000
Beryllium	<0.83	<0.83	<0.83	<0.83	<0.83	---	---
Cadmium	<11.9	<11.9	<11.9	<11.9	<11.9	10	10
Chromium	<10.8	15	12	12	<10.8	50	50
Copper	<21.3	<21.3	33	28	<21.3	1,000***	1,000
Lead	<1.5	9.8	2.3	<1.5	<1.5	50	50
Mercury	<1.1	<1.1	<1.1	<1.1	<1.1	2.0	2.0
Nickel	<65.2	<65.2	<65.2	<65.2	<65.2	---	13.4
Selenium	<2.5	<2.5	<2.5	<2.5	<2.5	10	10
Silver	0.46	<0.14	0.23	0.60	0.18	50	50
Sodium	220,000	180,000	320,000	1,400,000	600,000	---	---
Thallium	<1.7	<1.7	<1.7	3.4	<1.7	---	13
Zinc	20	90	30	30	30	500***	500

TABLE 8-5 (Cont.)

Parameter ($\mu\text{g/L}$)	Monitoring Wells					Utah Standards	U.S. EPA Water Quality Criteria*
	N-3A (Deep)	N-3H (Deep)	N-3B (Shallow)	N-3F (Shallow)	N-3I (Shallow)		
INORGANICS							
Cyanide, total	<29.5	<29.5	<29.5	<29.5	<29.5	---	200
Nitrite + Nitrate - Nitrogen	61,000	9,400	780	35,000	12,700	10,000***	10,000***
EA Sample Number	1537	1536	1622	1621	1535		
* Groundwater levels were evaluated using U.S. EPA Drinking Water Standards - Maximum Contaminant Limits (MCLs). If MCLs were not available, the Clean Water Act, Water Quality Criteria for Human Health - Fish and Drinking Water are provided (U.S. EPA 1985).							
** Probable laboratory contamination.							
*** Secondary standards.							
**** For Nitrate (AS N).							
NOTE: ND indicates a compound not assigned a certified reporting limit (CRL) and not found above the analytical detection limit.							
Dashes (---) indicate not available.							
CRLs are provided in Appendix I-G.							
The parameters listed were determined according to methods not certified by USATHAMA.							

* Groundwater levels were evaluated using U.S. EPA Drinking Water Standards - Maximum Contaminant Limits (MCLs). If MCLs were not available, the Clean Water Act, Water Quality Criteria for Human Health - Fish and Drinking Water are provided (U.S. EPA 1985).

** Probable laboratory contamination.

*** Secondary standards.

**** For Nitrate (As N).

NOTE: ND indicates a compound not assigned a certified reporting limit (CRL) and not found above the analytical detection limit.

Dashes (---) indicate not available.

CRLs are provided in Appendix I-G.

The parameters listed were determined according to methods not certified by USATHAMA.

obtained from both Well Nos. N-3A and N-3H, respectively. The elevated levels of sodium detected in both samples is likely due to the natural saline soil conditions prevalent at TEAD. The levels of nitrate+nitrite nitrogen observed are likely the result of direct seepage from the laundry effluent pond, explosives decomposition, and/or a combination of both. Toluene was the only volatile organic compound detected in deep Wells N-3A and N-3H at levels of 2 µg/L and 13 µg/L, respectively. The source of toluene is not known. There is no evidence to suggest that operations conducted at the TNT Washout Facility would contribute this type of contamination. The lack of an upgradient monitoring well precludes a more definitive interpretation of the parameters detected and a more precise determination of the direction of groundwater flow beneath the site.

8.1.4 Environmental and Public Health Impacts

Ground Water

The results of this investigation indicate that the deep regional aquifer, which is used as a drinking water source by the Depot and communities in the area, has been contaminated as a direct result of past activities in the TNT Washout Facility Area. Explosives and toluene were detected in the deep regional aquifer and in a localized perched groundwater zone in the proximity of the Laundry Effluent Pond. The occurrence of elevated levels of nitrate-nitrite nitrogen concentrations was also detected in the groundwater system and is probably due to a combination of natural processes, seepage from the Laundry Effluent Lagoon, and as a result of explosives degradation. However, the degree to which each of these sources have/are effecting the groundwater quality cannot be determined with certainty from the available database. Seepage from the Laundry Effluent Pond appears to provide the major mechanism for mobilization of explosives both vertically and horizontally. The perched groundwater and deep regional aquifer appear to be in direct communication.

Nitrate is a very mobile pollutant in groundwaters. It does not adsorb on aquifer materials nor does it precipitate as a mineral. These two factors allow large quantities of dissolved nitrate to remain in the groundwater. The only control on nitrate in the subsurface is nitrate reduction or denitrification. Nitrate reduction is a naturally occurring reaction in which the harmful nitrate is reduced to harmless nitrogen gases by bacteria. Nitrate reduction has been shown to occur in shallow unconfined sand aquifers underlying agricultural land, thus preventing nitrate from contaminating deeper aquifer systems. Where nitrate reduction is not occurring, nitrate will persist and water supplies are at risk. Excess dissolved nitrate in samples of well water have been documented as causing nitrate poisoning of infants (infant cyanosis or methemoglobinemia). This disease, which can be fatal, occurs when an infant consumes formula or breast milk high in dissolved nitrate. It is not, however, a problem for older children or adults unless nitrate is present at very high concentrations (Water Well Journal 1988).

Based on available information, and considering the site's remote and distal location with respect to potential groundwater discharge sources and users (i.e., supply wells and surface water bodies), no immediate risk to human health is considered to exist via groundwater routes. However, contamination of the regional aquifer at the site severely impacts future use and development of groundwater as a much needed resource.

Surface Water

There are no naturally occurring surface waterbodies, which could potentially be impacted, located near to the site. However, the Laundry Effluent Pond is unsecured and has a potential to adversely impact wildlife and cattle which may utilize it as a source of drinking water.

Soils

Ertec (1982) reported that wastewater discharged to the Old TMI Ponds had overflowed onto the surrounding ground surface and visibly stained the ground. However, Ertec did not perform sampling and analysis of the surficial soils. Sampling and analysis performed during the PA/SI investigation of surficial soils in the immediate vicinity of the site did not indicate any contamination. Since no contamination was detected in the surficial soils, no immediate health risk to the public or the environment from the soils is considered to exist.

8.2 FORMER TRANSFORMER OPEN STORAGE SITE

8.2.1 Site Location and History

N-TEAD is responsible for receiving, storage, maintenance, and shipment of oil-containing hydraulic and electrical (transformers and capacitors) equipment. Up until 1979, long-term storage of transformers and capacitors received at N-TEAD was conducted at Open Storage Lot No. 675B. Many of the transformers and capacitors contained PCB-contaminated oil. This open lot is located at the northern end of the Maintenance and Supply Area (600-series buildings), approximately 500 feet northwest of Building S-670 (Figure 6-5). This storage lot covers an area of approximately 5 acres (350 feet X 600 feet).

In 1979, all transformers were removed from this area. According to Depot personnel, sampling of surficial soils for determination of PCB concentrations was conducted after the transformers were removed. Apparently, the analysis did not reveal any significant PCB contamination of the soils, however, no records are available to confirm this. The site is currently used for open storage of vehicle-related equipment.

8.2.2 Site Characteristics

Open Storage Lot No. 675B is an open, unpaved area that is relatively flat. The area does not appear to have received any fill material in the past. The geology in the general area of the site consists of colluvial and alluvial valley fill deposits. Boring logs provided in

James M. Montgomery, Consulting Engineers, Inc. (1987) indicate that the underlying material are comprised of fine-to-coarse grained gravels and sands. The regional groundwater table occurs at a depth of 260 feet BLS and flows in a northwesterly direction (JMM 1987). A drainage ditch parallels the northern perimeter of the storage lot. This ditch appears to collect stormwater runoff from the adjacent road.

8.2.3 Site Contamination Investigation

PCBs and PCB items (which includes contaminated soils) are regulated under the Toxic Substances Control Act (TSCA) (40 CFR 761). According to Subpart 761D of the Federal regulations, which addresses disposal requirements of PCBs and PCB items, only PCBs and PCB items containing ≥ 50 ppm of PCB are regulated.

The sampling program at the former Transformer Open Storage Site was developed to address the federal requirements for disposal of PCB items, which includes contaminated soils. The program was designed to provide a sufficient number of sample points to cover the entire site while minimizing analytical costs.

At the site, 30 discrete samples were collected and composited to six samples (each composite was comprised of five discrete samples). Only composite samples were submitted for analysis. However, if a composite sample contained >10 ppm PCB, the discrettes comprising the composite would be analyzed. This concentration was based on the assumption that if a composite sample contained >10 ppm PCB, one of the discrete samples could potentially contain 50 ppm PCB (a 1:5 dilution of the discrete sample would result in a composite concentration of 10 ppm).

Due to the long-term use of this site for storage of transformers/capacitors potentially containing PCB-contaminated oil, and to the lack of available analytical data, sampling of surficial soils was conducted to confirm if oil leakage from electrical equipment had resulted in environmental contamination and/or present a threat to human health. The site was gridded into 30 quadrants approximately 70 feet X 100 feet in size, as shown in Figure 8-6. Discrete surficial soil samples (0- to 6-inch depth) were obtained from the midpoint of each quadrant. Discrete samples were placed in separate sample bottles and labeled. Equal portions of five discrete soil samples were placed in a separate sample bottle that was designated as a composite sample. Figure 8-6 shows the discrete soil sample locations and the discrete samples which made up each composite sample. The soil at the site was very gravelly; prior to placing samples into sample bottles, large cobbles were removed from the soil sample.

Composite soil samples were analyzed for PCB Aroclors 1016, 1254, and 1260. The analytical results are summarized in Table 8-6. PCB Aroclor 1016 was below detection limits in all composite samples. Composite samples, N-PCB-CST3 showed a detectable level of Aroclor 1254, at 0.0191 $\mu\text{g/g}$. Aroclor 1260 was detected in only two composite soil samples, N-PCB-CST5 and N-PCB-CST6, at 0.108 and 0.100 $\mu\text{g/g}$, respectively.

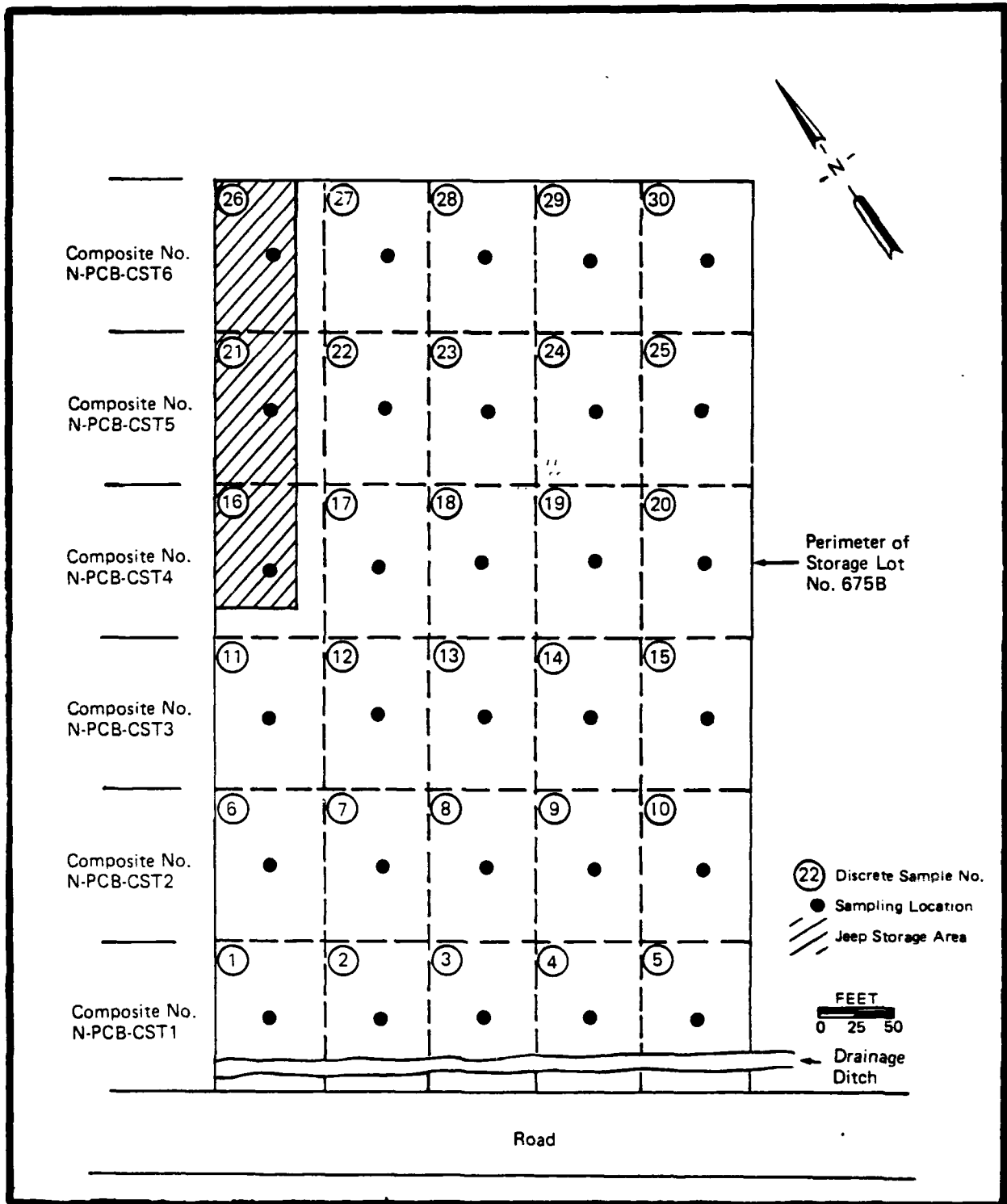


Figure 8-6. Sketch of N-TEAD Former Transformer Open Storage Lot No. 675B Showing Sampling Locations.

TABLE 8-6 ANALYTICAL RESULTS FOR COMPOSITE SOIL SAMPLES COLLECTED AT THE FORMER
TRANSFORMER OPEN STORAGE LOT NO. 675B, N-TEAD, 23 FEBRUARY 1987

<u>Parameter (µg/g)</u>	<u>CST1</u>	<u>CST2</u>	<u>CST3</u>	<u>CST4</u>	<u>CTS5</u>	<u>CST6</u>
Arclor 1016	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Arclor 1254	ND	ND	0.0191	ND	ND	ND
Arclor 1260	<0.07	<0.07	<0.07	<0.07	0.108	0.10
EA Sample Number	1329	1330	1331	1332	1333	1334

NOTE: ND indicates a compound not assigned a certified reporting limit (CRL)
and not found above the analytic detection limit.
CRLs are provided in Appendix I-G.
The parameters listed were determined according to methods not
certified by USATHAMA.

Based on the analytical results, the highest possible PCB concentration of any one discrete sample would be approximately 0.50 ppm, which is well below the maximum allowable concentration of 50 ppm PCB. The results indicate that the soils remaining at the former Transformer Open Storage site do not present a significant threat to the environment or to public health.

8.3 PCB SPILL SITE

8.3.1 Site Location, History, and Characteristics

In October 1980, a transformer oil spill occurred at the south corner of Open Storage Lot No. 665D in the N-TEAD Maintenance and Supply Area (Figure 6-5). Approximately 1,000 gallons of PCB-contaminated oil was released from two transformers punctured with a fork-lift blade during removal operations, according to Depot personnel. The spill reportedly covered an area approximately 1/2 acre in size. Clean-up of the spill involved excavation and removal of oil-contaminated soil, which was drummed and properly disposed of. Reportedly, about 440 drums (55-gallon) of contaminated soil and 18 drums (55-gallon) of contaminated oil were removed from the site. The depth of soil excavation is not known, but is reported to have been as deep as 8 feet at some locations. Removal of soil was apparently conducted where oil-contaminated soils were observed, however, there are no records available to confirm that the remaining soils were not contaminated. During the sampling effort at this site, a disturbed area was easily distinguishable from the surrounding soils.

8.3.2 Site Contamination Investigation

Due to the lack of available data confirming that the soil remaining at the spill site was not contaminated with PCBs, sampling and analysis of surficial soils (0-6 in.) for determination of PCBs was conducted during this installation PA/SI. Development and design of the sampling/analysis program was based on the same rationale as that presented for the former Transformer Open Storage Lot sampling program. Discrete samples were collected and composited to provide adequate coverage of the site, while minimizing analytical costs.

Prior to conducting soil sampling, the site was gridded into 20 quadrants (Figure 8-7). The total sampling area covered approximately 2250 feet² (45 feet X 50 feet). Each quadrant was approximately 9 feet X 10 feet in size. Soil samples were collected at the center of each quadrant. A total of 17 discrete samples were collected using a stainless steel hand trowel and placed in separate labeled sample bottles. Soil samples could not be collected from three of the quadrants due to the presence of stored equipment covering these areas (Figure 8-7).

Five composite samples, each consisting of an equal portion of sample removed from four discrete sample bottles (except for those rows where only three discrete samples were obtained), were submitted to the

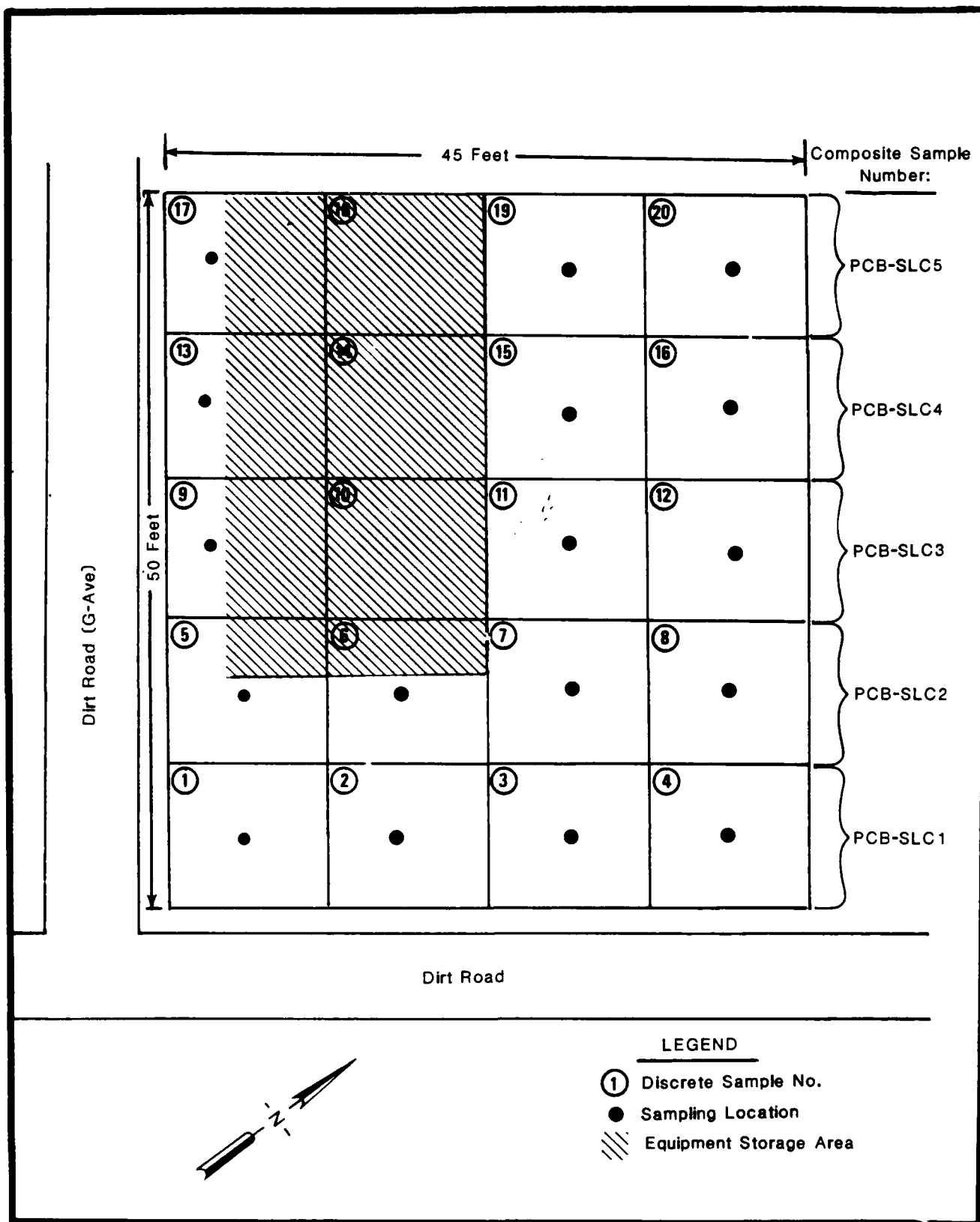


Figure 8-7. Sketch of PCB Spill Site, N-TEAD, Showing Sampling Locations.

laboratory for PCB Aroclors 1016, 1254, and 1260 determination. Discrete samples were saved in the event that the PCB concentration of the composite exceeded 10 ppm.

It was proposed in the Field Sampling Design Plan that a maximum of two soil borings, 9 feet in depth, be conducted at the location(s) where deep soil excavation and removal was reportedly conducted, if the excavation locations could be identified. There were no available records indicating where the soil excavation had been conducted and Depot personnel could not pin-point the exact location of the excavation. Therefore, the deep borings were not conducted at this site.

The results of sample analysis are summarized in Table 8-7. PCB Aroclors 1016 was not detected in any of the composite soil samples. Aroclor 1260 was detected in all five of the composites at concentrations ranging from 0.0764 to 0.2140 ppm. Based on these results, the highest possible PCB concentration of any one discrete sample comprising a composite would be approximately 0.32 ppm. This is well below the maximum allowable concentration of 50 ppm. These results indicate that the soils remaining at the PCB spill site do not present a significant threat to the environment or to public health. No further environmental evaluation is considered to be required at this site.

8.4 OB/OD AREA

8.4.1 Site Location and History

The OB/OD area is located in an isolated area in the southwest corner of N-TEAD (Figure 6-1). This area consists of four separate sites: (1) open detonation pits, (2) cluster bomb demolition area, (3) propellant burn pad, and (4) trash burn pits. Demolition of explosives has been conducted in this area since 1942. At the open demolition pits and the cluster bomb demolition area, explosives are placed in dug pits that are 40-50 feet deep, the pits are closed with earth, then detonated. Up to 15,000 lbs of explosives are detonated at one time. Also located in the same area are the trash burn pits and the propellant burn pad.

From an inspection of the EPIC aerial photos (U.S. EPA 1982), it was observed that a number of demolition pits and burial trenches have been used and closed at this site over the years. The trenches were possibly used for burial of demilitarized munitions, however, there are no available records of their use.

8.4.2 Site Characteristics

The OB/OD Area is located in a groundwater recharge area. Box Elder Wash, an intermittent stream, is located south of the site and extends to the north. Groundwater recharge occurs at peak precipitation periods and during spring thaw. The groundwater surface below this site is greater than 700 feet deep (Ertec 1982). Based on data from the boring logs of Well N-6 (located approximately 4,500 feet to the east), the unconsolidated alluvial materials below the site are comprised of sand and gravel, silty sand, and sandy-clayey silt deposits.

TABLE 8-7 ANALYTICAL RESULTS FOR COMPOSITE SOIL SAMPLES COLLECTED AT THE PCB SPILL SITE, N-TEAD, 20 FEBRUARY 1987

<u>Parameter (µg/g)</u>	<u>SLC1</u>	<u>SLC2</u>	<u>SLC3</u>	<u>SLC4</u>	<u>SLC5</u>
Arclor 1016	<0.05	<0.05	<0.05	<0.05	<0.05
Arclor 1254	ND	ND	ND	ND	ND
Arclor 1260	0.0804	0.1150	0.2140	0.1740	0.0764

EA Sample Number	1272	1273	1274	1275	1276
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NOTE: ND indicates a compound not assigned a certified reporting limit (CRL) and not found above the analytical detection limit.
CRLs are provided in Appendix I-G.
The parameters listed were determined according to methods not certified by USATHAMA.

Based simply upon infiltration of precipitation and intermittent stream flow, it is highly unlikely that significant levels of contaminants from the pits would have migrated to below 700 feet in the soil to reach groundwater. However, this site has been used for over 40 years, thus increasing the potential for percolation and, therefore, creating a potential for groundwater contamination. The direction of groundwater flow in the vicinity of the site occurs in a general northeasterly direction (Chapter 3).

8.4.3 Site Contamination Investigation

In 1981, AEHA (1983) conducted an investigation to evaluate the potential for contaminant migration from this site to groundwater and surface water. Sets of six surficial soil samples were collected from each of four demolition pits and determinations for heavy metals and explosives conducted. Low levels of barium and cadmium were detected in all of the pit soils, and low levels of mercury were present in two of the pits. Both HMX and RDX were found in every pit at concentrations ranging from 1.0 to 13.0 µg/g and 2.0 to 14.9 µg/g, respectively.

Based on the long-term and continued use of this site, and on the results of the AEHA (1983) study, this site was considered to present a potential risk to groundwater contamination. Due to the health and safety risks associated with working in an area potentially containing UXO, and to the great depth to ground water (>700 feet), well installation was not conducted at the site as part of the PA/SI Field Program. The nearest drinking water wells downgradient of the site are N-TEAD supply Well Nos. 4 and 5, located approximately 1.12 and 3.12 miles north, respectively (Figure 3-6). Though there was no apparent immediate risk of contamination to these supply wells, sampling and analysis of the water supplies was conducted during the sampling program to determine if water quality has been adversely impacted.

Water samples were collected for determination of explosives, metals, PCBs, pesticides, volatile and semi-volatile organics, cyanide, and NO_2 + NO_3 Nitrogen. The analytical results are summarized in Table 8-8. No organic parameters (explosives, PCBs, pesticides, volatiles, and semi-volatiles) were detected in either well. The only inorganic parameters detected above their CRL's in N-TEAD supply wells 4 and 5 were barium (85 ppb and 133 ppb), sodium (18,000 ppb and 36,000 ppb), zinc (100 ppb and 300 ppb), chromium (18 ppb and <10.8 ppb), and NO_3 + NO_2 Nitrogen (520 ppb and 17,500 ppb). Primary drinking water standards for zinc, chromium, and nitrate-nitrogen are 500 ppb, 50 ppb, and 10,000 ppb, respectively. There are presently no drinking water standards for barium and sodium. The concentrations were much less than the available standards except for NO_3 + NO_2 Nitrogen concentrations in Well No. 4. As discussed in previous sections, nitrate is a common contaminant because it has many sources both as a result of natural processes and as a direct or indirect effect of man's activities. The problem is that it has been documented as causing nitrate poisoning of infants when it consumes formula or breast milk high in dissolved nitrates, however, it is not a problem for older children or adults unless nitrate is present in very high concentrations. The source of NO_3 + NO_2 Nitrogen in the

TABLE 8-8 ANALYTICAL RESULTS FOR N-TEAD WATER SUPPLY WELL NOS. 4 AND 5,
28 FEBRUARY 1987

Parameter (µg/L)	N-SW-4	N-SW-5	Utah Drinking Water Standards	U.S. EPA Water Quality Criteria*
PCBs				
Aroclor 1016	<1.3	<1.3	---	7.9×10^{-5}
Aroclor 1260	<2.6	<2.6	---	7.9×10^{-5}
PESTICIDES				
Aldrin	<0.15	<0.15	---	7.4×10^{-5}
α-BHC	<0.17	<0.17	---	---
γ-BHC	<0.13	<0.13	---	---
4,4'-DDD	<0.27	<0.27	---	---
4,4'-DDE	<0.23	<0.23	---	---
4,4'-DDT	<0.27	<0.27	---	2.4×10^{-5}
Dieldrin	<0.26	<0.26	---	7.1×10^{-5}
Endrin	<0.6	<0.6	0.2	0.2
Heptachlor	<0.16	<0.16	---	4.5×10^{-4}
Malathion	ND	ND	---	---
Bromacil	ND	ND	---	---
Chlordane	ND	ND	---	4.6×10^{-4}
VOLATILES				
Trichloroethene	<2	<2	---	---
Chloroform	ND	ND	---	100
Toluene	ND	ND	---	15,000
SEMIVOLATILES				
Benyl alcohol	ND	ND	---	---
Butyl benzyl phthlate	ND	ND	---	---
Bis(2-ethylhexyl) phthalate	ND	ND	---	---
Phenol	ND	ND	---	3,500
EXPLOSIVES				
HMX	<5.07	<5.07	---	---
RDX	<4.19	<4.19	---	---
Nitrobenzene	ND	ND	---	---
1,3-Dinitrobenzene	<9.08	<9.08	---	---
1,3,5-Trinitrobenzene	<5.84	<5.84	---	---
2,4-DNT	<2.22	<2.22	---	---
2,6-DNT	<5.7	<5.7	---	---
2,4,6-TNT	<6.25	<6.25	---	---
Teryl	<4.39	<4.39	---	---

TABLE 8-8 (Cont.)

Parameter (µg/L)	N-SW-4	N-SW-5	Utah Drinking Water Standards	U.S. EPA Water Quality Criteria*
METALS				
Antimony	<7.0	<7.0	---	146
Arsenic	<2.45	<2.45	50	50
Barium	85	133	1,000	1,000
Beryllium	<0.83	<0.83	---	---
Cadmium	<11.9	<11.9	10	10
Chromium	18	<10.8	50	50
Copper	<21.0	<21.0	1,000**	1,000
Lead	<1.5	<1.5	50	50
Mercury	<1.1	<1.1	2.0	2.0
Nickel	<65.0	<65.0	---	15.4
Selenium	<2.53	<2.53	10	10
Silver	<0.14	<0.14	50	50
Sodium	36,000	18,000	---	---
Thallium	<1.7	<1.7	---	---
Zinc	300	100	500**	500
INORGANICS				
Cyanide, total	<29.5	<29.5	---	200
Nitrite+Nitrate - Nitrogen	17,500	520	10,000***	10,000***

* Ground water was evaluated using Safe Drinking Water Act - Maximum Contaminant Levels (MCLs). If MCLs were not available, Clean Water Act, Water Quality Criteria for Human Health are provided (U.S. EPA 1985).

** Secondary standards.

*** For Nitrate (As N).

NOTE: ND indicates a compound not assigned a certified reporting limit (CRL) and not found above the analytical detection limit.

Dashes (---) indicate not available.

CRLs are provided in Appendix I-G.

The parameters listed were determined according to methods not certified by USATHAMA.

well sample cannot be determined based on available data. The level of $\text{NO}_3 + \text{NO}_2$ Nitrogen detected in Well No. 4 is not considered to pose a significant threat to human health and is not inconsistent with levels found in wells throughout N-TEAD in the past.

8.4.4 Environmental and Public Health Impacts

This field program did not assess the potential contamination of groundwater in the immediate vicinity of the site. However, the environmental and public health impact of contaminants potentially reaching the groundwater is considered to be low based on (1) the site's remote and inaccessible location, (2) the great depth to groundwater, (3) concentrations of contaminants potentially reaching the groundwater table would most likely be significantly lower than those observed in the pit soils analyzed by AEHA (1983), (4) further dilution of contaminants would occur once contaminants reached the groundwater table, and (5) the nearest drinking water supply potentially impacted is located 1.12 miles downgradient.

The results of the PA/SI Sampling Program indicated that the water quality of Supply Well Nos. 4 and 5 has not been adversely impacted as a result of activities conducted at the Open Detonation Pits.

9. CONCLUSIONS

The major findings and conclusions of the installation PA/SI conducted at N-TEAD are outlined below.

9.1 PRELIMINARY SITE ASSESSMENTS

- . The following sites, assessed by records review, personnel interviews, and an onsite visit, were considered to present a low potential for environmental contamination: (1) the Transformer Boxing Site, (2) Radiological Storage Facility, (3) Pesticide/Herbicide Storage Facility, (4) PCB Storage Facility, (5) Domestic Wastewater Spreading Grounds, and (6) Staging Area Near Surveillance Test Site.
- . The following sites assessed by records review and personnel interviews only, were also considered to have a low potential for environmental contamination: (1) AEO Demilitarization Facility, (2) AEO Furnace Site, (3) AEO Maintenance Facility, (4) Rifle Range, (5) DPDO Yard, (6) Radiological Waste Storage Area, (7) Open Storage Area Within Igloo Storage Area, (8) Buildup Area.
- . Activities performed at the following sites have a high potential to have resulted in the release of contaminants to soils and ground water: (1) Sanitary Landfill, (2) Barrel Storage Area, (3) Chemical Range, (4) Surveillance Test Site, (5) Sewage Lagoon, (6) X-Ray Lagoon, and (7) Munition Saving Site.
- . Soil and groundwater in the Industrial Waste Lagoon/Old Spreading Grounds Area are contaminated with various solvent compounds and metals. The U.S. Army Corps of Engineers is evaluating the extent of contamination and alternative means for abating the contamination in this area of N-TEAD.
- . The Hercules Blackhawk and the Bauer sites, located south of N-TEAD, are not considered to present a significant threat to the groundwater quality of N-TEAD. Based on investigations conducted at these sites, it appears that the shallow aquifer at the site flows to the south and away from N-TEAD. Though a potential may exist for contaminants to migrate from the shallow water table to the deeper regional aquifer, this risk is not considered to be immediate.
- . The Anaconda Carr Fork Mine site located east and upgradient of N-TEAD may present a potential for groundwater contamination. The major contaminants of concern are heavy metals. Contaminant migration would most likely reach the supply wells located in the City of Tooele before reaching the N-TEAD.

9.2 PRELIMINARY SITE INVESTIGATIONS

9.2.1 TNT Washout Facility Area

- . Bottom sediments in the Old (closed) Washout ponds were found to be contaminated with a variety of explosive compounds. TNT levels exceeded 20,000 $\mu\text{g/g}$. The extent of contamination was found to be greatest within the area formerly encompassed by Pond Nos. 1 and 2 (combined area of <0.5 acre). However, the future potential for environmental contamination from the ponds has been significantly reduced and is considered to be low as: (1) the ponds no longer receive rinsewater, (2) they have been filled in and capped with 2-3 feet of soil and an impermeable membrane, and (3) the ponds are underlain by silt and clay units having a low rate of permeability (3.22×10^{-6} to 2.24×10^{-7} cm/sec).
- . Explosives were not found in the bottom sediment of the existing (new) TNT Washout Collection Basin. This basin does not appear to be a significant source of contamination in the Washout Facility Area.
- . Surface soils in the TNT Washout Facility area were not found to be contaminated by explosives.
- . Highly localized perched groundwater exists below, and in the immediate vicinity of, the Laundry Effluent Pond. This perched groundwater does not appear to extend completely beneath the TNT Washout Pond area.
- . The perched groundwater was found to be contaminated by a variety of explosive compounds, sodium, nitrate+nitrite nitrogen, and arsenic in excess of Federal and State drinking water standards. Sodium was also detected in elevated concentrations.
- . Groundwater in the regional aquifer beneath the TNT Washout Facility area is contaminated by explosive compounds and groundwater nitrate+nitrite nitrogen levels were found to be as much as six times the U.S. EPA and Utah drinking water standards for nitrate-nitrogen (10 mg/L). The Laundry Effluent Pond appears to be the major source of nitrate+nitrite nitrogen contamination.
- . Seepage of laundry effluent through soils is a continuing mechanism by which nitrate+nitrite nitrogen contaminants may be carried to the deep regional aquifer, which is used as a water supply source by the Depot and surrounding communities. Laundry effluent seepage also appears to be mobilizing (flushing/ leaching) explosive compounds which are present in area subsoils.

- . A potential exists for the continued migration of explosives from the perched groundwater zone to the deeper regional aquifer, as the perched groundwater zone is in direct communication with the deep regional aquifer.

9.2.2 Former Transformer Storage Area and PCB Spill Site

- . Sampling and analysis of surficial soils at the former transformer storage site and PCB spill site revealed low levels of PCB Aroclor 1254 and 1260.
- . No composite soil sample contained PCB concentrations greater than 0.19 ug/g, thus no soil samples could exceed the Federal standard of 50 ppm for PCB contaminated soils (40 CFR 761D).
- . Results of the investigation indicate that the former transformer storage site and the PCB spill site do not present a significant risk to the environment or to public health and welfare.

9.2.3 OB/OD Area

- . A boring drilled in the vicinity of the OB/OD Area to a depth of 709 feet, during a previous investigation (Ertec 1982) did not encounter groundwater.
- . This field program did not assess the potential contamination of groundwater in the immediate vicinity of the site. However, the environmental and public health impact of contaminants potentially reaching the groundwater is considered to be low based on (1) the site's remote and inaccessible location, (2) the great depth to groundwater, (3) the minimized potential for vertical flushing (mobilization) of contaminants presented by the large negative water balance for the region, (4) concentrations of contaminants potentially reaching the groundwater table would most likely be significantly lower than those observed in the pit soils analyzed by AEHA (1983), (5) further dilution of contaminants would occur once contaminants reached the groundwater table, and (6) the nearest drinking water supply potentially impacted is located 1.12 miles downgradient.
- . Sampling/analysis of Supply Well Nos. 4 and 5, which are located downgradient of the OB/OD Area, did not reveal any contamination. The water quality of these supply wells has not been adversely impacted as a result of activities conducted at the OB/OD Area.

10. RECOMMENDATIONS

The following recommendations are offered based on the findings of the N-TEAD PA/SI effort.

10.1 RECOMMENDATIONS FOR PRELIMINARY ASSESSMENT SITES

- . Sites not inspected during the PA/SI effort for N-TEAD, and considered to have a low potential of environmental contamination, should be inspected for signs of potential contamination. These sites include:

- . AEO Demilitarization Facility
- . AEO Furnace Site
- . AEO Maintenance Facility
- . Rifle Range
- . DPDO Yard
- . Radiological Waste Storage Area
- . Open Storage Area on igloo Storage Area
- . Burial Area in Industrial Area.

If potential contamination is observed, perform environmental sampling, otherwise no further work is recommended.

- . Conduct sampling/analysis of soils/sediment at the Chemical Range, Munition Sawing Site, and Surveillance Test site for explosives determination and evaluate the potential for contamination of subsurface soils and migration of contaminants to groundwater. If the soils are found to be contaminated with explosives, installation of monitoring wells to determine if groundwater is also contaminated may be necessary depending on the potential for these contaminants to migrate through the soils to the aquifer.
- . Conduct sampling/analysis of soils/sediments in the Barrel Storage Area and Sewage Lagoon to determine the presence/absence of contamination. If the soils are found to be contaminated, install groundwater monitoring wells around the perimeter of the site to determine if groundwater contamination has occurred. Analysis of organic and inorganic priority pollutants and nitrate+nitrite nitrogen (sewage lagoon) recommended.
- . Conduct periodic visual inspections (annually at a minimum) of the plastic bottom liner in the X-ray Lagoon for tears, punctures, and deterioration. Conduct sampling/analysis of the waste water to determine if the waste is hazardous. Install groundwater monitoring wells around the perimeter of the site to determine if groundwater contamination has occurred.

- . Install a minimum of six (6) groundwater monitoring wells around the perimeter of the Sanitary Landfill to evaluate the existence of contamination. Sampling/analysis of groundwater for determination of organic and inorganic priority pollutants and explosives is recommended.

10.2 RECOMMENDATIONS FOR PRELIMINARY INVESTIGATION SITES

10.2.1 TNT Washout Facility Area

Based on the findings of the site investigation activities performed in the TNT Washout Facility Area, the following recommendations are offered:

- . Install a minimum of two additional deep aquifer monitoring wells at the site, one upgradient and one downgradient along the flow path, to further define the source and extent of explosives and nitrate/nitrite contamination. Accurately determine the gradient and direction of groundwater flow and perform aquifer testing to determine rate of flow.
- . Perform soil borings to further determine: (1) the depth, magnitude, and extent of subsurface explosives contamination, (2) the horizontal extent of the perched groundwater zone in the proximity of the Laundry Effluent Pond, and (3) the horizontal extent of the silt/clay unit beneath the site.
- . Install additional shallow monitoring wells to determine the magnitude and extent of explosives contamination in the perched groundwater zone and define the relationship between the perched aquifer the deeper regional aquifer.
- . For shallow monitoring well installation and soil boring performance, it is recommended that auger drilling methods be used to: (1) define the depth and aerial extent of the perched groundwater zone; (2) obtain subsurface stratigraphic/lithographic information; and (3) obtain subsurface soil samples for chemical analysis. The use of hydraulic drilling methods is recommended for deep monitoring well installation.
- . Conduct an Endangerment Assessment using worst-case assumptions to determine the potential health risks the TNT Washout Facility Area poses to the public and the environment.
- . Implement one of the following activities at the Laundry Effluent Pond to minimize mobilization of explosives in subsurface soils (vertically and horizontally): (1) relocate the pond, (2) discontinue operation of the pond, or (3) install an impermeable bottom liner in the pond.
- . Fence in the Old (closed) TNT Washout Pond area to minimize exposure and the disturbance of the cap by humans, grazing cattle, and burrowing wildlife.

- . Place additional soil cover on the old TNT Washout ponds and seed the area with grass to minimize runoff and soil erosion.

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PART B - TOOELE ARMY DEPOT FACILITIES AT HILL AIR FORCE BASE

1. INTRODUCTION

1.1 BACKGROUND

1.1.1 Facility Location, Size, and Mission

TEAD's Non-Tactical Generator and Rail Shop Division of the Maintenance Directorate is housed and operated on leased property at Hill Air Force Base (HAFB), which is located approximately 25 miles north of Salt Lake City, Utah (Figure 1-1).

TEAD's Non-Tactical Generator and Rail Shop Division plans, directs, and coordinates the receipt, storage, issue, shipment, repair, overhaul, modification, and testing of rail transportation and non-tactical generator equipment and associated items.

TEAD occupies 10 buildings at HAFB on a permit basis. The location of the buildings are shown in Figure 1-2. HAFB is reimbursed for utilities and waste disposal services; all wastes generated by the shops are handled by HAFB. The facilities assigned to TEAD include:

<u>Building No.</u>	<u>Building Area (feet²)</u>
882	15,000
1700	48
1701	32,103
1705	311
1707	240
1711	472
1721	5,191
1722	6,880
1723	2,959
1919	7,888

The TEAD Rail Shop Maintenance Facility (Area A on Figure 1-2) consists of one large permanent structure (Building 1701) and several temporary structures (Figure 1-3). Building 1701 contains eight rail bays, a large machine shop, paint shop, and administrative/personnel support services. Building 1721 provides additional space for repair and testing facilities.

Other facilities located immediately outside of Building 1701 include:

- . An open area consisting of rinse tanks and an engine parts steam cleaning area.
- . An enclosed area for sand blasting.
- . Waste and new chemical storage area.

Supply support facilities for the Rail Shop consist of Building S-882 (Area B on Figure 1-2) which is used for storage, and a "bone yard" for storing non-serviceable rail stock (Area C on Figure 1-2).

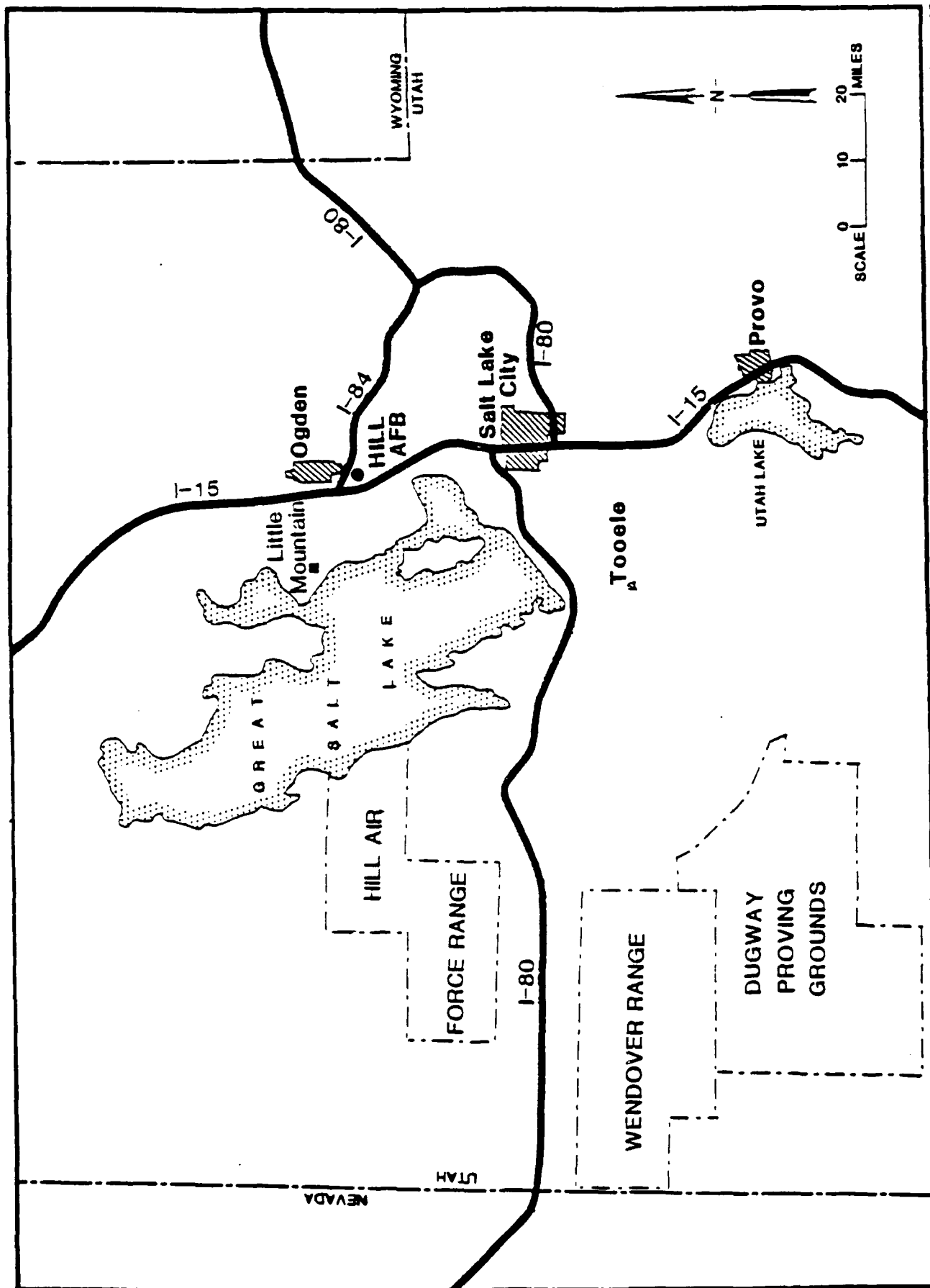


Figure 1-1. Area location map of Hill Air Force Base.

Source: Engineering Science 1982

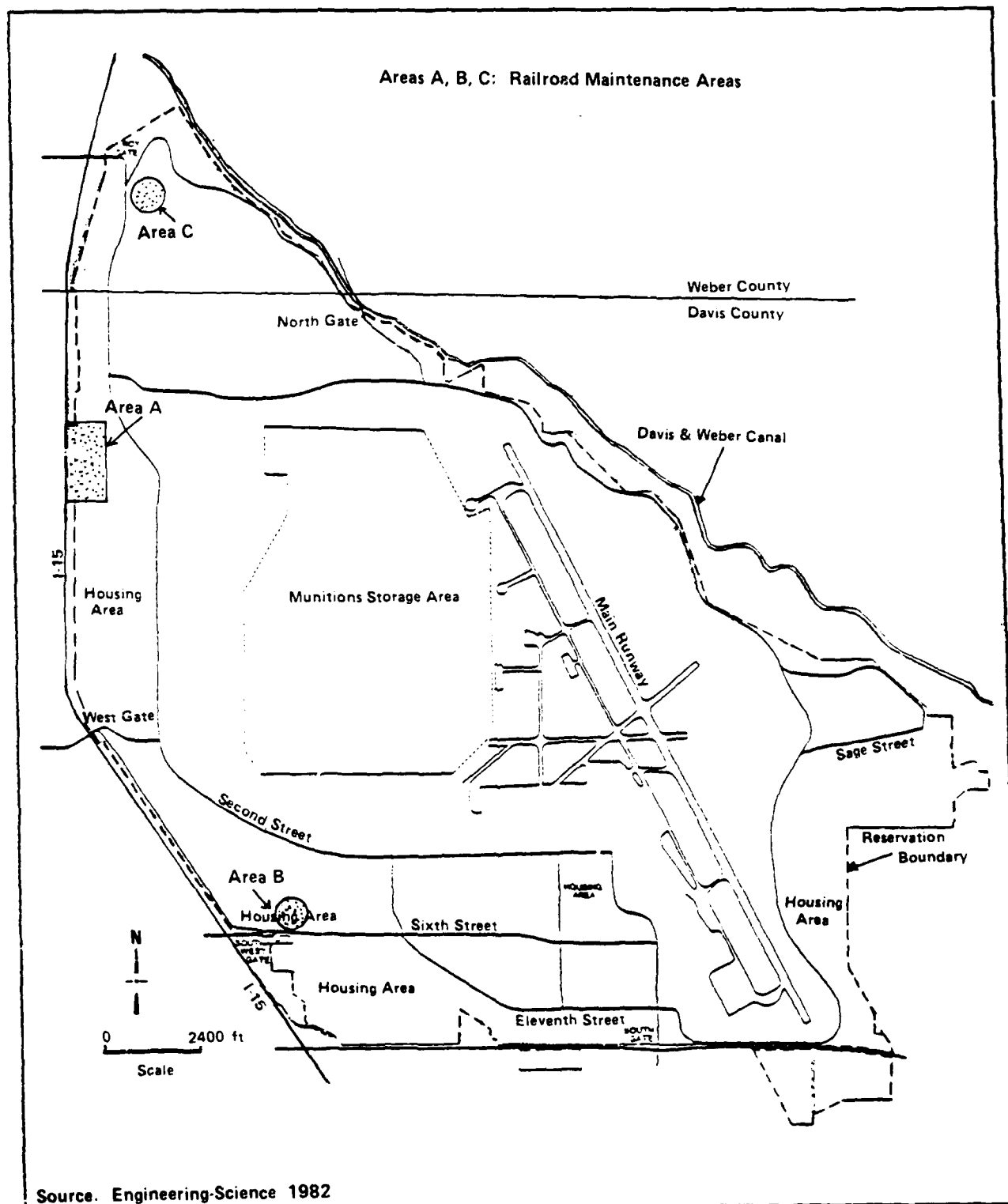


Figure 1-2. Location of Tooele Army Depot facilities at Hill Air Force Base.

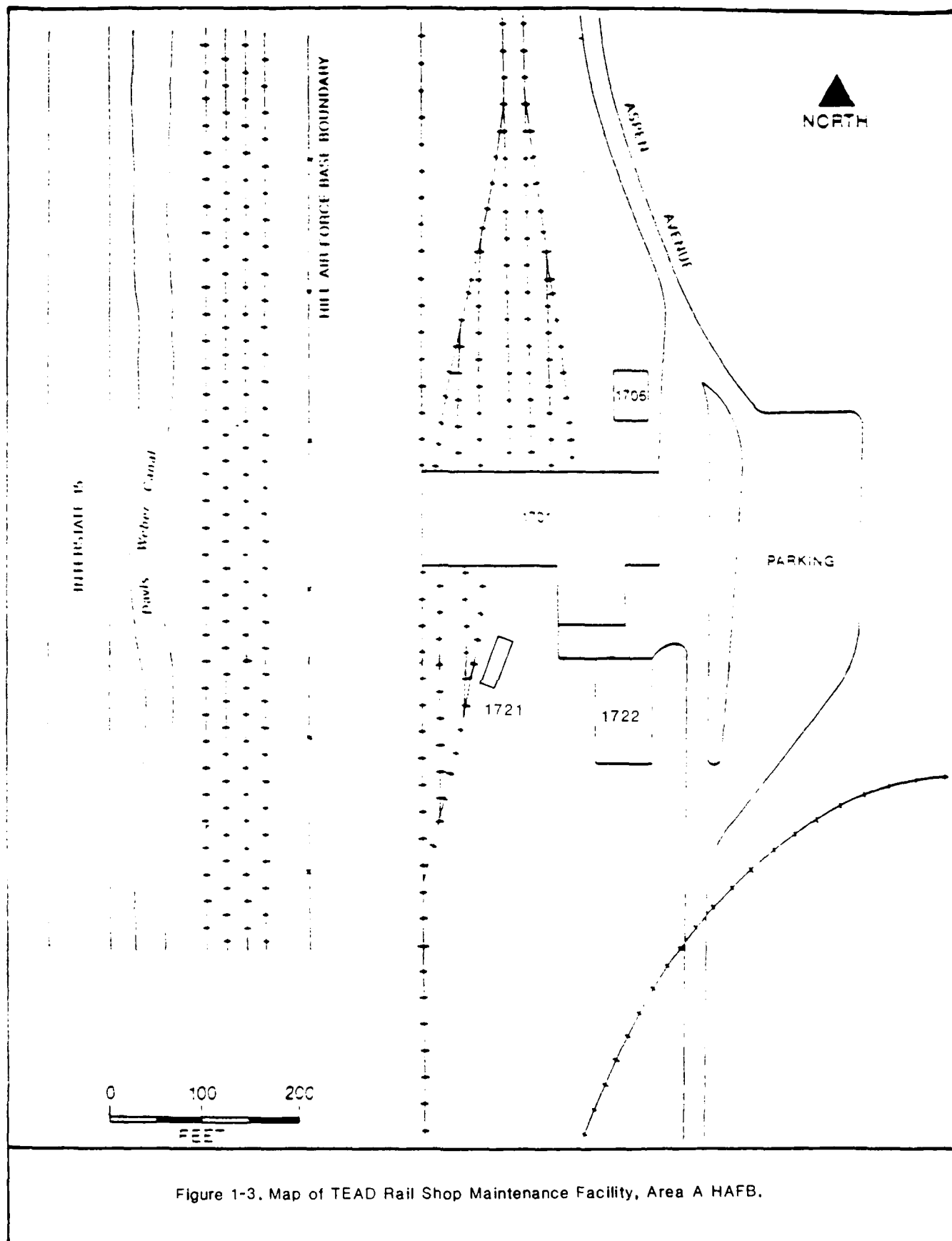


Figure 1-3. Map of TEAD Rail Shop Maintenance Facility, Area A HAFB.

Source: Hill Air Force Base 1986

1.1.2 History

The TEAD Rail Shop Maintenance Facility has been in operation since World War II. The mission of the Rail Shop has been limited by the capacity of the facility; a great deal of work is currently being reassigned to commercial facilities. The use of Building 1919 (located in Area C in Figure 1-2), formerly used by the Rail Shop personnel for a strut repair mission, has been phased out. TEAD has proposed, and is currently considering, terminating Rail Shop maintenance operations at HAFB by September 1988; however, a final determination and a definitive schedule have not yet been established. TEAD's lease agreement/permit expires in November 1989.

1.2 PA/SI OBJECTIVES

The objectives of this study, with respect to the TEAD-HAFB facilities, were to (1) update the Phase I report (USATHAMA 1979) through retrieval and review of all available documents, interviews with TEAD and HAFB employees, and inspection of the Rail Shop facilities; (2) identify potential sources of environmental contamination resulting from TEAD-HAFB past industrial/maintenance activities and operations; and (3) evaluate the potential impact of contaminant sources at TEAD-HAFB on the environment and public health.

Documents, provided by USATHAMA during pre-onsite project tasks, were reviewed. During the onsite visit conducted at the TEAD North and South Areas 9-13 December 1985, TEAD files were reviewed for any information on TEAD-HAFB operations.

On 23 May 1986, a representative from EA and USATHAMA performed a site investigation of TEAD-HAFB Rail Shop Maintenance Facility which included the following:

- . Interviews with personnel associated with the Rail Shop's operation to obtain information on: present and past operations; types, uses, generation, or storage of any hazardous wastes; and any known past environmental problems.
- . Performance of a site reconnaissance to observe: current operating practices; any evidence of spills, leaks, or contamination; and obtain photographs.
- . Visit various HAFB offices to collect available documents on: TEAD's lease agreement with HAFB; HAFB environmental investigation; and sampling plan for the Rail Shop.

1.3 OVERVIEW OF REPORT

The remaining chapters of this report (Volume I, Part B) address the following topics: site features, local and regional physiography, waste sources and disposal/treatment methods, findings of other environmental investigations, development and implementation of the PA/SI field program, and description and contaminant problems at specific sites.

Chapter 2, Site Features, provides a summary of the cultural resources (demography, land use, historical and archaeological sites) and physical resources (meteorology, geography, geology, hydrogeology) of the area in and around TEAD-HAFB. Chapter 3, Hazardous Substances Characterization, describes the waste sources and the waste disposal/treatment methods used at the site. Information presented in Chapters 2 and 3 was obtained through use of the existing database, from employee interviews, and from the onsite inspection.

Chapter 4, Summary and Findings of Other Environmental Investigations, summarizes the findings, conclusions, and recommendations of other environmental studies conducted at HAFB which included the Rail/Shop Maintenance Facility. This chapter addresses only those investigations which have involved extensive record searches and/or sampling and analysis events.

Conclusions and Recommendations based on the findings of this and previous investigations are presented in Chapter 5. A list of references immediately follows Chapter 5.

2. SITE FEATURES

The cultural and environmental settings pertinent to HAFB and this study have been characterized by Engineering Science (1982) and are highlighted in the following sections.

2.1 CULTURAL RESOURCES

2.1.1 Demography

HAFB encompasses an area of approximately 6,666 acres. The northwest portion of HAFB, comprising approximately 8 percent of the total base, lies in the southern portion of Weber County, while the remaining portion of the Base is contained in the northern part of Davis County.

As of December 1981, the Base employed a total of 19,804 people (14,407 being civilian with the remainder military). The 1980 census noted that 291,156 people resided in the Davis and Weber County area which equates to 20 percent of the total State's population. The two-county land area comprising 1,308 mi², however, represents less than 1.5 percent of the total State land area.

The City of Ogden, which is just north of HAFB, has a current population of over 73,000 people, which makes Ogden the second largest city in the State. The city in its early development was structured around the railroads. Ogden was the turnaround point for the eastern end of the Southern Pacific Railroad and the western transfer point for the Union Pacific Railroad. While the railroads are still functioning at the present time, they are not major contributors to the economy or land use.

2.1.2 Land Use

At present, the major use of land in Davis and Weber counties is largely devoted to agriculture or is vacant. Approximately 39 percent of the land falls into these two categories. It is estimated that approximately 12 percent of this agriculture/vacant land is non-developable due to steep mountains or marshy conditions which exist along the Great Salt Lake. Water of the highly saline Great Salt Lake inundates 40 percent of the two counties. Public lands, mostly forest, occupy under 14 percent of the total area. Residential, commercial, industrial, and public improvements are sited on the remaining 7 percent. The general trend has been to develop a large private economic industrial base.

Industrial parks have been established in both Davis and Weber counties. Continued residential growth is projected in support of new industries and also to support continued expansion of existing industries. Residential development in areas immediately adjacent to the Base boundaries is nearing saturation and future growth should take place outwards in areas accessible to both rail and interstate highway systems.

2.1.3 Historical and Archaeological Resources

The TEAD Rail Shop Maintenance Facility (Building 1701) at HAFB, as well as some of the older equipment within the site is of historical interest as they are considered to be old enough, are of historical value and are one of the few remaining facilities that remain which represent rail shop activities performed in the past.

The site is not officially identified as a national historical site, but potentially could be, and any remedial activities should be addressed to the historical value of the site.

There are no identified archaeological sites at the Rail Shop Facility, however, the site potentially could be of historical archaeological interest (Christiansen 1988).

2.2 PHYSICAL RESOURCES

2.2.1 Meteorology

The mean annual precipitation and the mean annual snowfall for a 30-year period of record at HAFB is 18.9 inches and 79 inches, respectively (Engineering Science 1982). According to the Climactic Atlas of the United States, the estimated lake evaporation for the Ogden area averages 40 in./year.

2.2.2 Geography

The Ogden, Utah area is located in the Great Basin, a subdivision of the Basin and Range Physiographic Province (Engineering Science 1982). This area is primarily characterized by isolated ranges of dissected fault block mountains, separated over varying distances by aggraded desert plains.

HAFB is situated within the Weber Delta district of the Great Basin, which is characterized by broad plains and terraces extending from the shore of the Great Salt Lake eastward to the base of the Wasatch Range.

2.2.2.1 Topography

The Weber Delta, located immediately west of the Wasatch Range, slopes in a westerly direction towards the Great Salt Lake. Raised areas, such as the terrace on which HAFB is located, are generally level and exhibit slight to moderate relief, especially where dissected by erosional activity. Surface elevations at HAFB vary from a low of approximately 4,600 feet mean sea level (MSL) along the west installation boundary (in the Railroad Workshop Area) to 5,045 feet MSL between the east installation boundary and Building 720. In contrast, the Wasatch Range to the east rises abruptly from the Delta floor to elevations on the order of 9,572 feet MSL at Mount Ogden.

2.2.2.2 Drainage

The HAFB area is drained by three systems: Kays Creek, Fife Ditch, and a man-made feature, the Davis & Weber Canal. Drainage of installation land areas is accomplished by overland flow to dry swales terminating at the previously cited systems, or simply by infiltration to surface soils. Flooding is not a problem typical of the HAFB area, although flooding may occur for brief periods where surface drainage is restricted within erosional features. Installation surface drainage and infiltration are depicted on Figure 2-1.

2.2.2.3 Surface Water

The Utah State Department of Health (Division of Environmental Health) has regulatory responsibility for the maintenance of water quality in the HAFB area. Wastewater Disposal Regulations (Part II) sets forth the authority for the assignment of stream classifications for all state waters. The standards are summarized as follows: Kays Creek - Class 3C - protected for non-game fish and other aquatic life, including necessary aquatic organisms in their food chain.

HAFB has a National Pollutant Discharge Elimination System (NPDES) permit which was revised in the Spring of 1981. The permit was issued for the discharge of stormwater to Kays Creek and requires a spill and contingency plan, best management practices on base, and secondary containment for outside chemical storage for volumes greater than four 55-gal drums. There are no numeric limits regarding the quality of the stormwater discharged.

To comply with Air Force Regulation 19-7 (Environmental Pollution Monitoring), the Base Bioenvironmental Engineer obtains monthly grab samples from all detention ponds on-base which discharge to streams off-base.

2.2.2.4 Surface Soils

Surface soils at HAFB are predominantly silts, clays, sand, and gravels typical of the Weber Delta district. Surface soils are well drained with deep water levels, have a slight to moderate erosion susceptibility, and possess good soil bearing values.

2.2.3 Geology

The surficial geology at the TEAD Rail Shop Maintenance Facility areas at HAFB is shown in Figure 2-2. Table 2-1 serves as the legend for the Geologic Map. Generally, the geology of HAFB is dominated by unconsolidated deposits. The unconsolidated deposits at HAFB consist of silts, clays, gravels, and sands, which were deposited in a complex basin system formed by the block faulting of older consolidated units. The development and eventual disappearance of Glacial Lake Bonneville during pleistocene time created many area geomorphologic features such as the Weber Delta and is responsible for the deposition of major Quaternary geologic units.

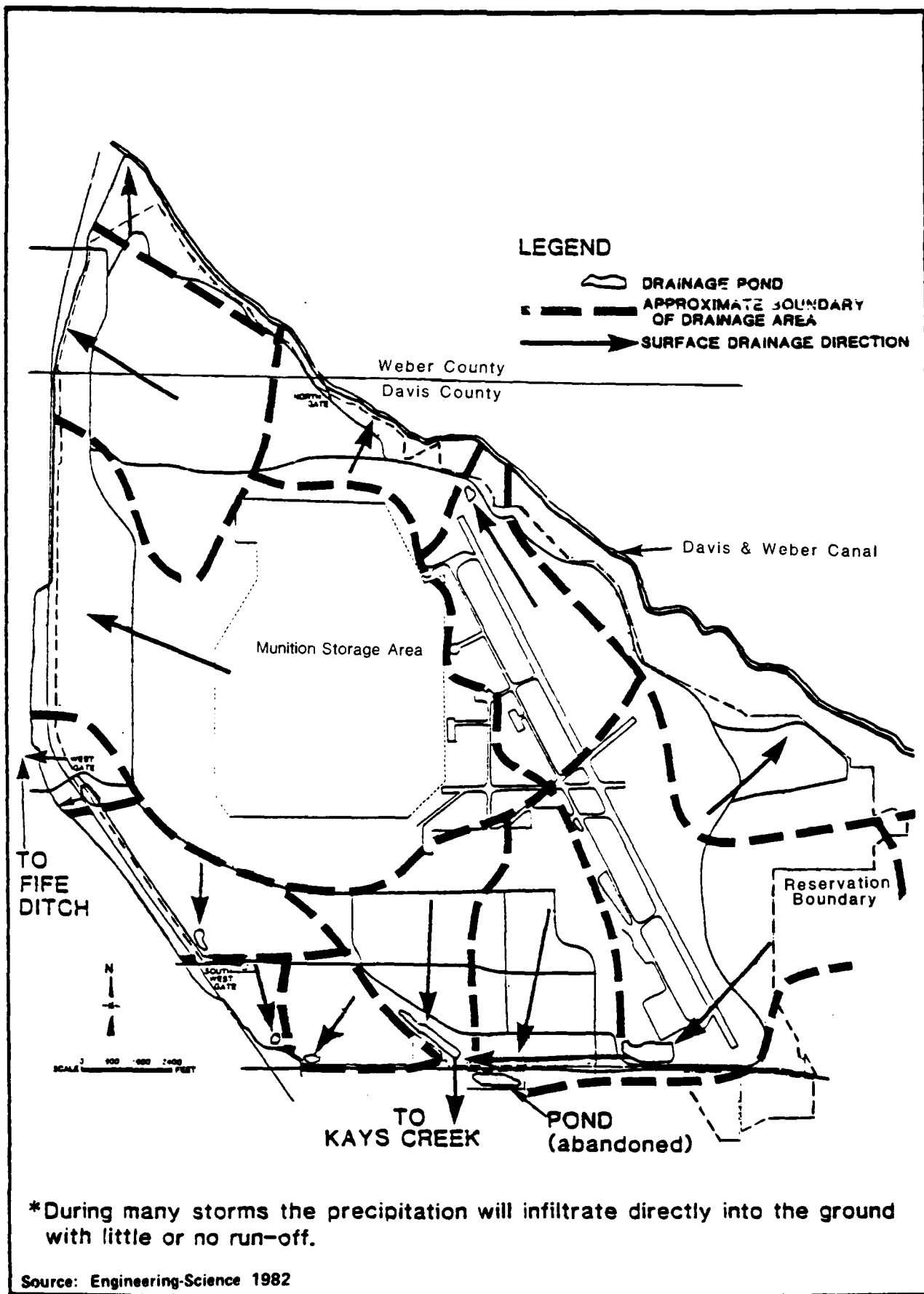
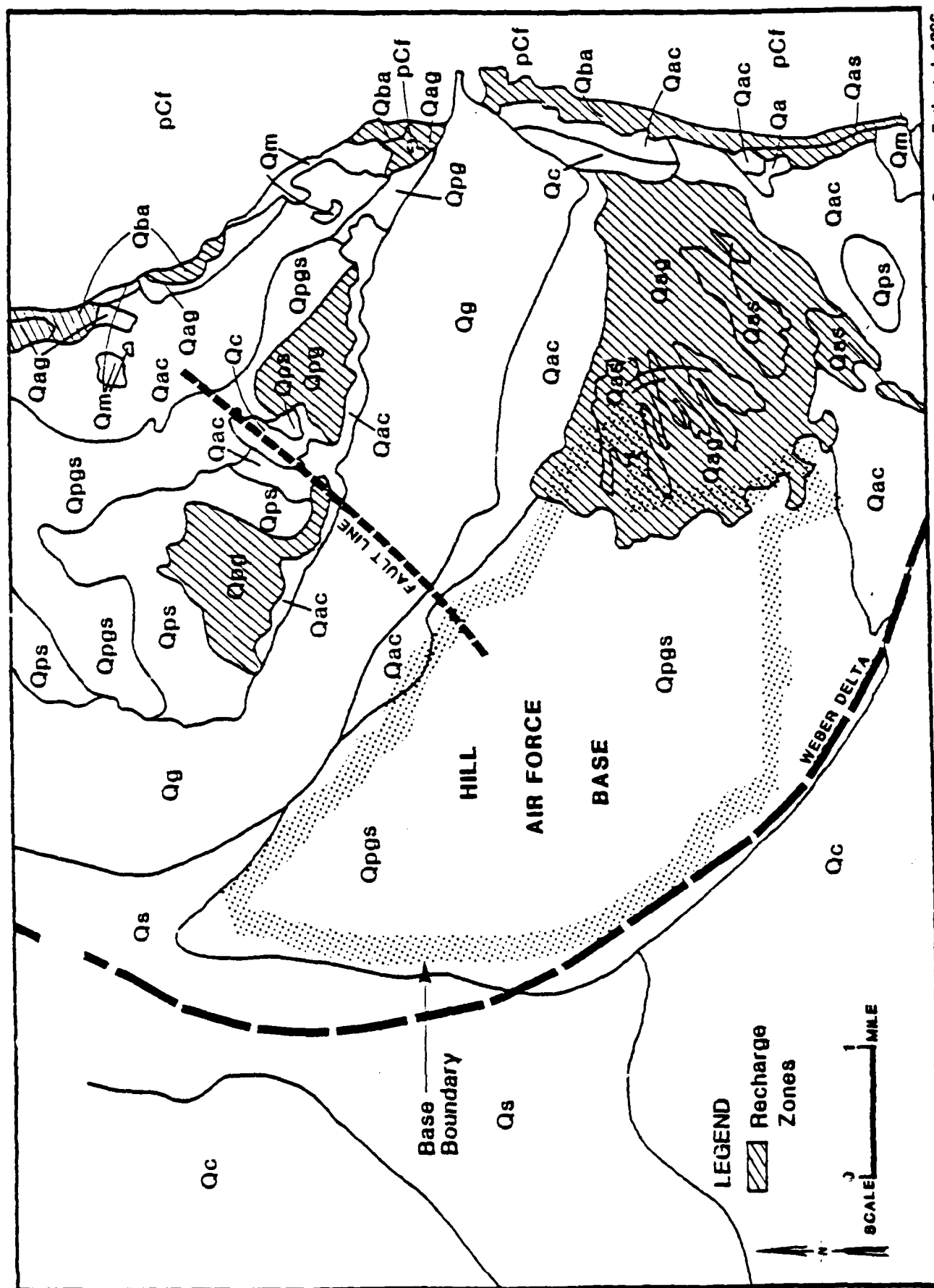


Figure 2-1. Surface drainage and infiltration at Hill Air Force base.



Sources: Feth et al. 1966

Figure 2-2. Surface geology of Hill Air Force Base.

TABLE 2-1 GENERAL STRATIGRAPHY OF HILL AIR FORCE BASE

Symbol	System	Series	Formation and Lithology	Thickness in feet
Qa	Quaternary	Recent	Alluvium: Permeable river sand and gravel; includes windflows near mountains which are impermeable locally.	200
Qg			Gravel; Permeable floodplain sands and gravel.	Unknown
Qs			Sand: Permeable fine sands underlying lowlands.	10-20
Qc			Clay: Impermeable plastic to non-plastic clay overlying artesian aquifer.	15+
UNCONFORMITY				
Qpg Qpgs Qps	Quaternary	Pleistocene	(Lake, Bonneville Group) Proud Formation: gravel, permeable gravel and sand, permeable sand, permeable.	5-20 10-50 10-20
Qba			Bonneville and Alpine Formation sand and gravel over bedrock, very permeable.	5-50
Qag Qas Qac			Alpine Formation: gravel, permeable sand; permeable. clay, silt, fine sand, usually impermeable.	<25 100 200
Qm	Quaternary	Pleistocene	Mudflow deposits: particle size varies from clay to boulders. Usually impermeable.	varies
ANGULAR UNCONFORMITY				
Pcf		Precambrian	Farmington Canyon Complex: metasedimentary and meta-volcanic rocks. Permeable where jointed or fractured.	10,000

HAFB test borings and water well logs indicate that Weber Delta sediments have been deposited in an almost systematic manner that has formed discrete layers of materials according to particulate grain size. This layering has a significant impact on the occurrence and movement of local groundwater and is discussed in greater detail in the Section 2.2.4.

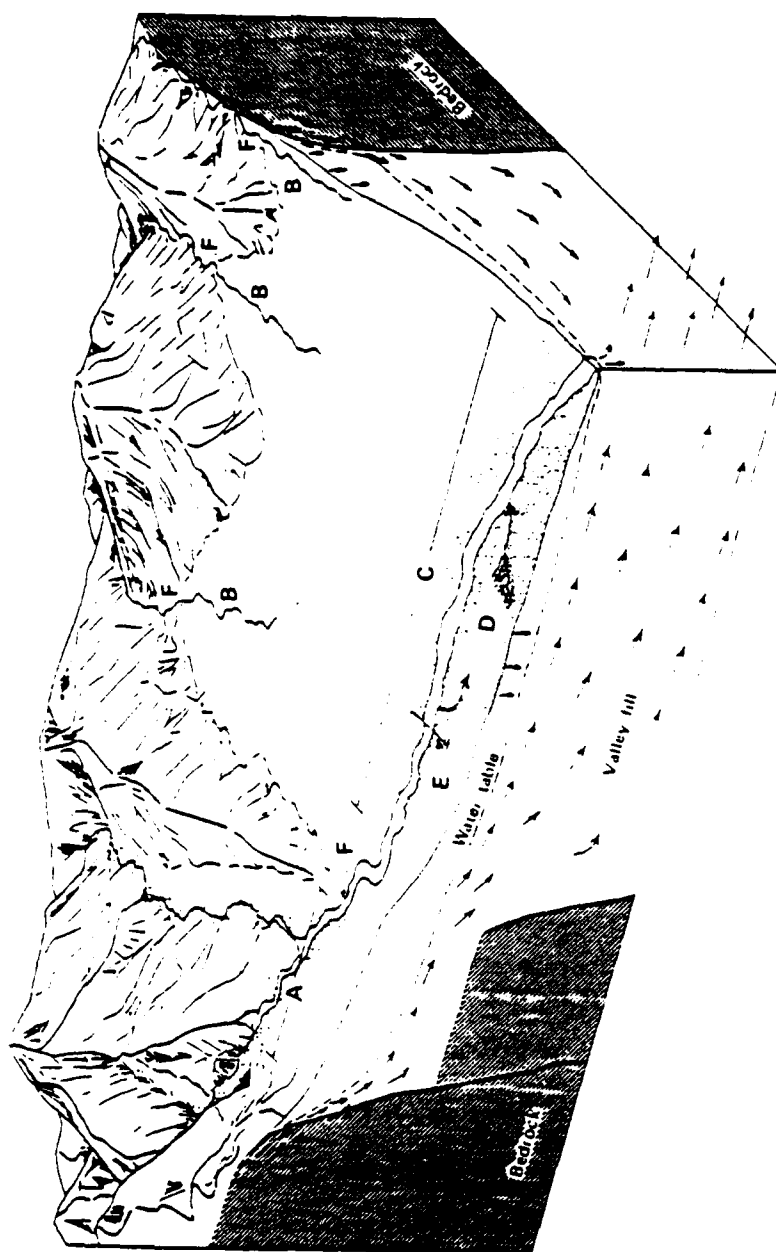
As discussed previously, unconsolidated units of the study area have been deposited in a basin. Geophysical data indicate that the thickness of unconsolidated materials deposited within the deepest areas of the basin have a maximum total thickness on the order of 6,000 feet (Feth et al. 1966). The younger Weber Delta deposits occur to depths of approximately 800 feet along their eastern margin, near the Wasatch Range. The Weber Canyon as a fan deposit, dips westward slightly and becomes significantly thinner along the line presently thought to define its western limit.

Few significant geologic discontinuities are known to exist in the study area. The major discontinuities in geologic units are the Wasatch Fault, east of the base, and an inferred fault extending from the main instrument runway northeast, and a few folds in Pleistocene unconsolidated deposits (Feth et al. 1966). Numerous lineaments interpreted from remote sensing data also exists on the base. Lineaments (a simple linear structure) may indicate the presence of underlying geologic discontinuities, which may have modified the structure of overlying geologic units locally. The Wasatch Fault extends along the western margin of the Wasatch Range, forming the boundary between the Basin and Range Physiographic Province and the Rocky Mountains to the east. The Wasatch Fault is probably not a single break, but rather a mile-plus wide zone of breakage and slippage, extending over a length of some 150 miles. Vertical displacement along the fault is thought to exceed 10,000 feet (Feth et al. 1966).

Generally, the Wasatch is a normal fault or series of normal faults. Where it is exposed to observation, it is downthrown to the west and dips westward an average of 33 degrees. Thrust faults along the basin floor (postulated by Glenn et al. 1980) may serve as conduits for the horizontal movement of the ground water. The fault zone is significant to groundwater movement as warm, mineralized waters may occur along its length locally. Near HAFB, the fracture alignment is marked by multiple fault facets. Erosion of the fault facets has created several coarse-grained unconsolidated geologic units that receive and transmit recharge to deeper aquifers of the Weber area (Map units Qag, Qas, Qpg, and Qba depicted on Figure 2-2).

2.2.4 Hydrogeology

HAFB lies within the limits of the Weber Delta groundwater district of Utah. The area hydrology functions as a complex system whose major components and their relationships are depicted in Figure 2-3. Ground water is contained in the unconsolidated alluvial materials that have been deposited in the down-faulted basins of the region. The major sources of recharge to the groundwater reservoir consist of subsurface



- A. Ground water reservoir supports stream flow
- B. Minor streams lose flow to ground-water system on alluvial fans
- C. Stream loses water to water table and surface diversions
- D. Irrigated area recharges ground-water system
- E. Flood Plain
- F. Point of maximum stream flow

Not to Scale

Source: Eakin et al. 1976

Figure 2.3. Area hydrologic system.

flow from the Wasatch Range, direct infiltration from precipitation, and seepage from streams and irrigated areas. Groundwater moves through the system from the recharge areas in a generally westward direction. Geologic units, previously identified in this report as recharge zones, include map units Qag, Qas, Qba, and Qpg which are depicted in Figure 2-2. A groundwater model of the study area is presented as Figure 2-4 showing general directions of movement.

HAFB and adjacent communities derive water resources from the Delta Aquifer, the major source of groundwater for the region. The Delta Aquifer consists of thick and extensive deposit of interlayered gravel, sand, silt, and clay arranged in a fan-shaped body that extends west from the area of Weber Canyon. The upper surface of the Delta Aquifer is thought to be 500-700 feet below ground surface and is shown in Figure 2-5. The aquifer typically functions under artesian (confined) conditions due to the existence of thick clay sequences overlying it. Such clay sequences may be identified on the logs of HAFB water wells (Figure 2-6). The principal water-bearing zone of the Delta Aquifer is estimated to be 50-150 feet thick, however, according to Feth et al. (1966), greater thicknesses have been encountered without determination of a lower boundary.

Groundwater within the Delta Aquifer radiates outward (generally westward) from Weber Canyon and is recharged by the Weber River. The Delta Aquifer is known to be a very productive aquifer, from which large quantities of water may be obtained. The general quality of ground water recovered from this unit may be described as acceptable, however, it tends to be hard, containing dissolved calcium, sodium, and magnesium.

Perched water tables are known to develop locally in the study area due to the presence of near-surface clay layers. These clay layers tend to impede the downward migration of infiltrating precipitation, which then may flow downdip along the clay surface and emanate as springs. Most spring activity tends to occur following periods of precipitation and may cease entirely during dry periods.

HAFB currently obtains approximately 85 percent of its water resources from Base wells and purchases the remainder according to need from the Weber Basin Water Conservancy District. All HAFB wells are screened in the Delta Aquifer. Locations of Base wells are shown on Figure 2-7. Base wells now in service range in depth from 627 to 900 feet. The relatively high yields and low drawdowns observed in Base wells indicate a very permeable and productive aquifer. Static water levels range from 418 feet below land surface at Well No. 2 to 515 feet at Well No. 4. HAFB well construction data is summarized as Table 2-2. The quality of water derived from HAFB wells is generally good, as shown in Table 2-3.

Figure 2-7 also shows the locations of known municipal wells in the vicinity of the Base perimeter. Well data on these municipal wells is presented in Table 2-4.

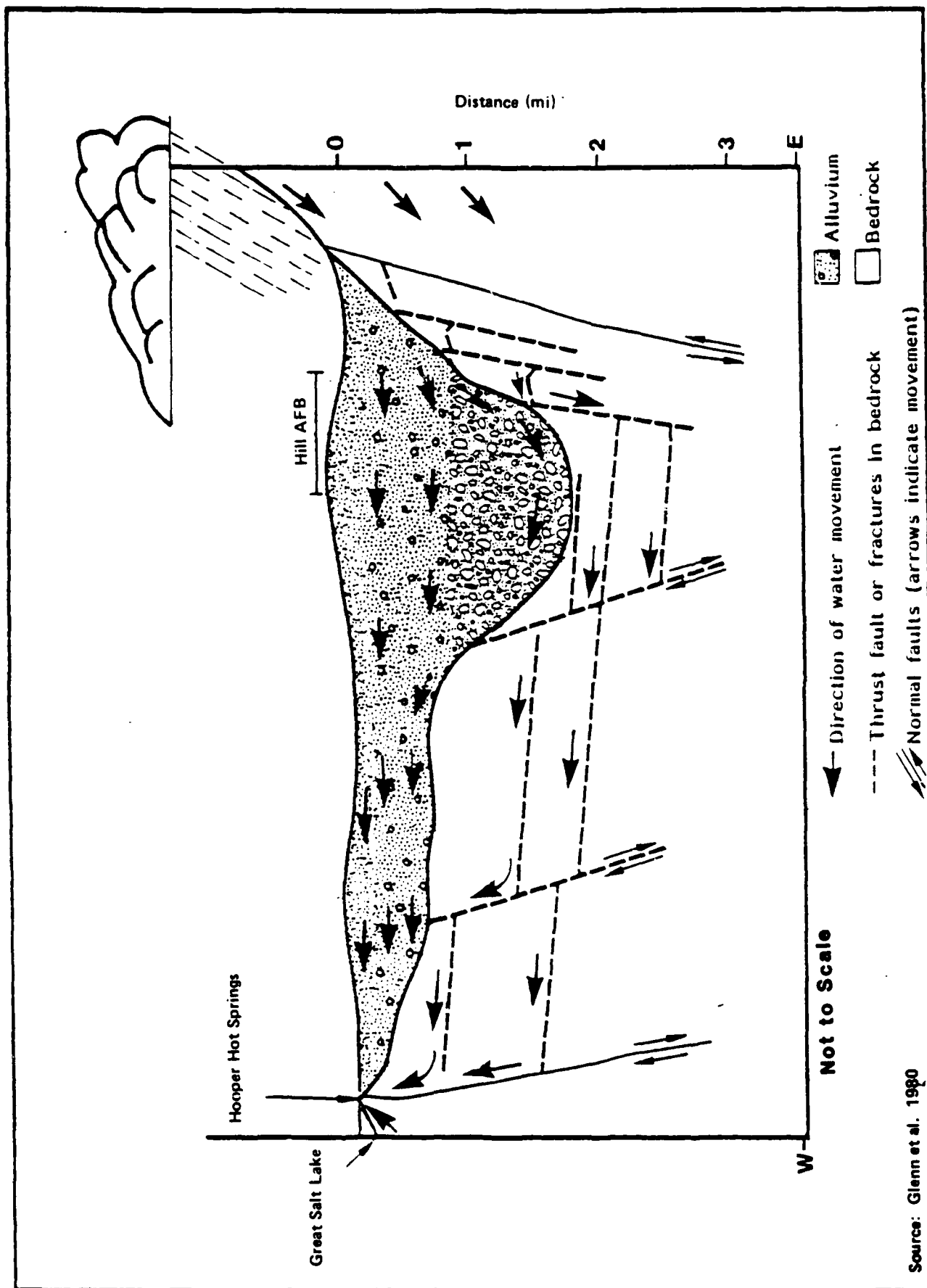
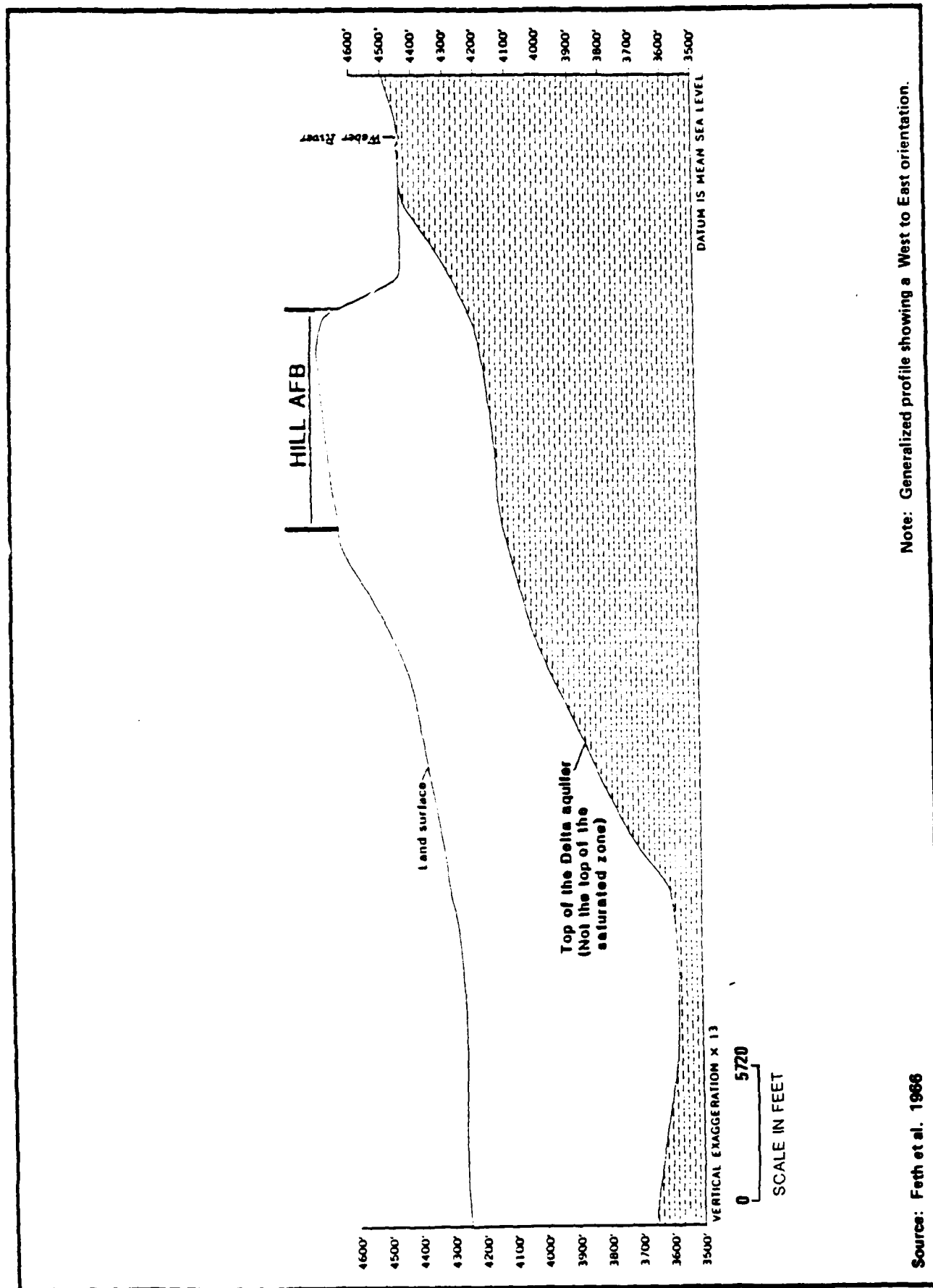


Figure 2-4. Hill Air Force Base Ground-water model study area.



Note: Generalized profile showing a West to East orientation.

Source: Feth et al. 1986

Figure 2-5. Profile of the Delta Aquifer.

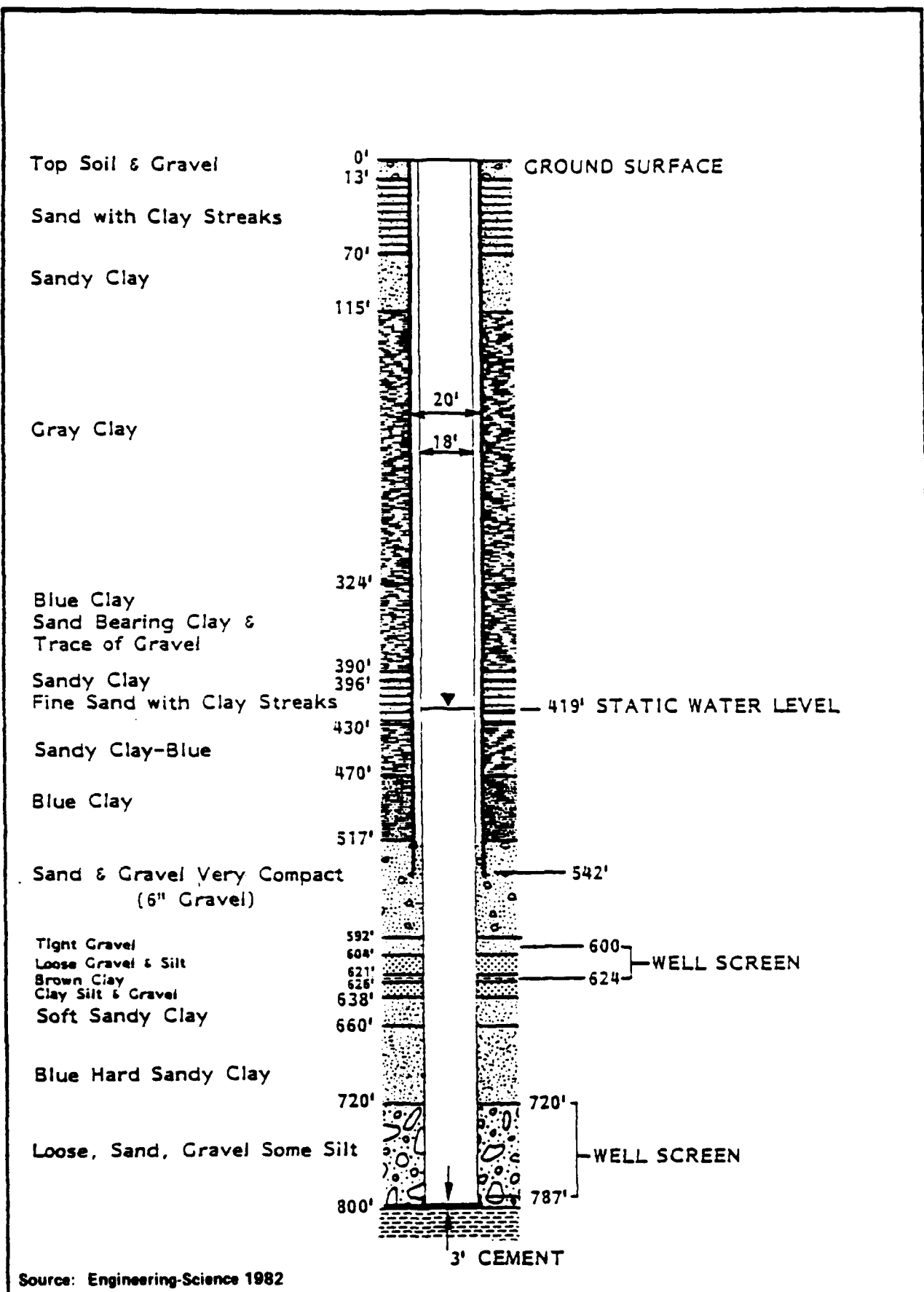


Figure 2-6. Well construction and lithology for Well No. 3, Hill Air Force Base.

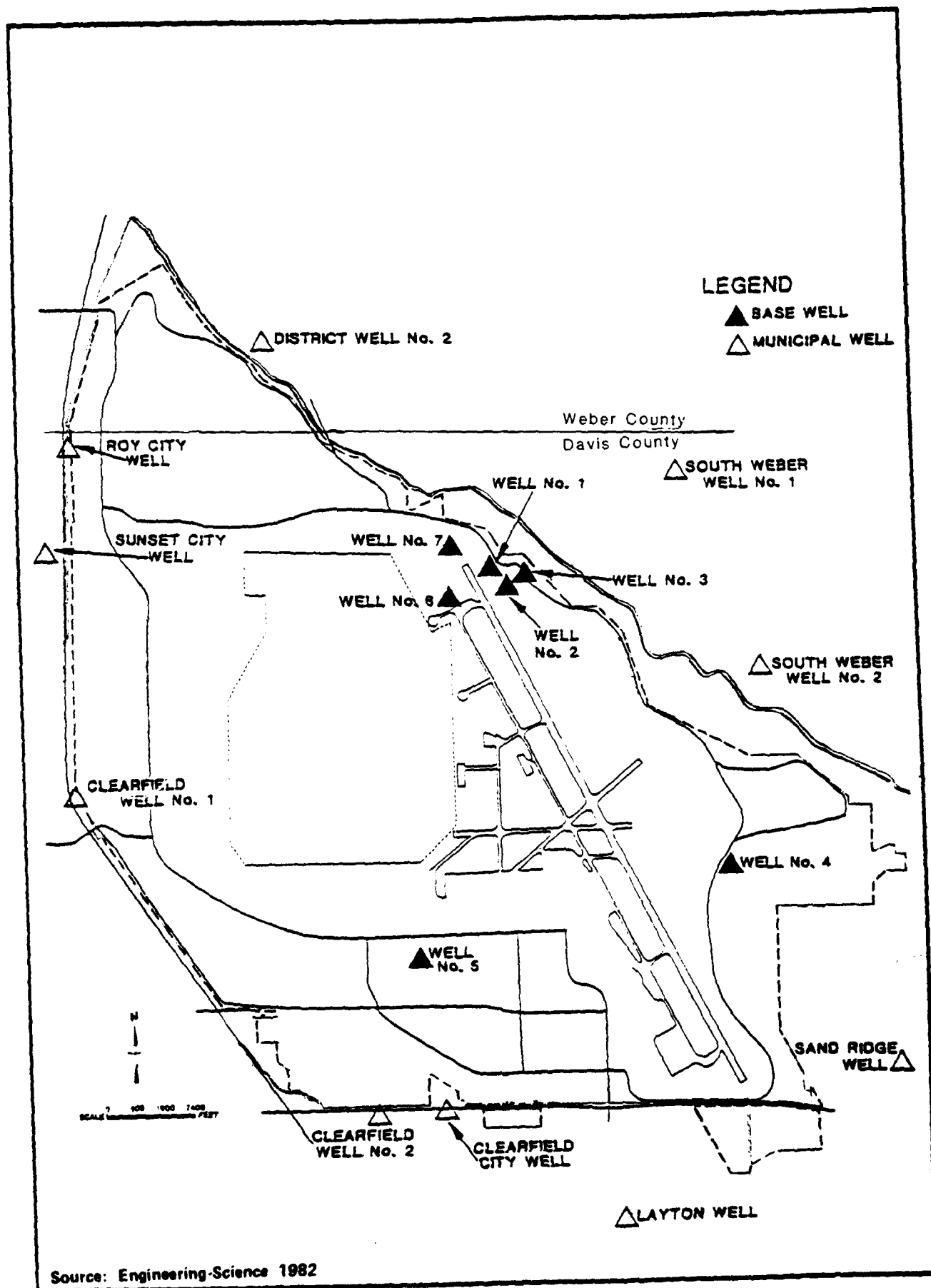


Figure 2-7. Deep well locations at Hill Air Force Base and vicinity.

TABLE 2-2 SUMMARY OF HILL AIR FORCE BASE WELL DATA

<u>Number</u>	<u>Finished Depth (feet)</u>	<u>Casing Diameter (inches)</u>	<u>Elevation (feet, MSL)</u>	<u>Water Level (feet)</u>	<u>Yield (gpm)</u>	<u>Drawdown (feet)</u>
1	Well not in service					
2	627	20	4,736	418	750	6
3	800	20	4,731	---	740	8
4	730	20	4,798	515	1,080	8
5	805	20	4,630	470	1,000	---
6	900	20	4,773	461	875	8
7	900	20	4,767	469	537	19

Source: Bolke and Waddell 1972, HAFB.

TABLE 2-3 SUMMARY OF CHEMICAL ANALYSIS RESULTS FOR GROUNDWATER SAMPLES
COLLECTED FROM HAFB WELL

<u>Parameter (mg/L)</u>	<u>Well No. 4</u>	<u>Well No. 5</u>	<u>Well No. 6</u>	<u>Well No. 7</u>
Arsenic	0.01	0.01	0.01	0.01
Cadmium	0.001	0.001	0.001	0.001
Chromium (Hexavalent)	0.01	0.01	0.01	0.01
Cyanide	0.01	0.02	0.01	0.01
Fluoride	0.45	0.33	0.57	0.55
Barium	0.20	0.13	0.20	0.14
Calcium	55.20	44.0	72.80	71.20
Magnesium	17.28	14.40	17.76	16.32
Sodium	46.20	43.70	27.30	29.40
Iron	0.42	0.36	0.11	0.08
Manganese	0.22	0.19	0.03	0.01
Chloride	22.0	20.0	18.0	18.0
Phosphate	0.77	0.43	0.09	0.06
Nitrate Nitrogen	0.65	0.70	1.05	1.20
Nitrite Nitrogen	0.10	0.05	0.08	0.10
Total Hardness	210.0	270.0	256.0	246.0
Alkalinity as CaCO ₃	282.0	242.0	254.0	250.0
Total Solids	493.0	427.0	484.0	465.0
Total Dissolved Solids	481.0	419.0	476.0	461.0
Surfactants	0.01	0.01	0.01	0.01
Ammonia	0.02	0.05	0.01	0.01
Oil and Grease	1.0	1.0	1.0	1.0

Source: R.W. Beck Associates 1975.

TABLE 2-4 SUMMARY OF MUNICIPAL WELLS LOCATED NEAR HAFB PERIMETER

Well Name	Finished Depth (Feet)	Design Cap. (CGS)	Casing Diam. (Inches)	Elevation (Ft. MSL)	Static Water Level (Ft. MSL)	Yield (gpm)	Drawdown (Feet)
<u>Weber Basin Water Conservancy District:</u>							
District Well No. 2*	915	11.5	16	4,366	4,281	6,000	26
South Weber Well No. 1	1,000	10.4	20	4,226	4,071	4,476	25
South Weber Well No. 2	1,200	10.6	20	4,533	4,266	4,500	53
Laytone Well	---	5.1	---	4,626	4,264	---	25
Clearfield Well No. 1	---	5.1	---	4,584	4,276	1,100	15
Clearfield Well No. 2	---	5.0	---	4,570	4,275	1,100	45
<u>City Wells:</u>							
Sand Ridge Well	1,000	---	12	0	530 Below Surface	900	6
Hill Field Road Well	850	---	12	---	---	2,000	15
Sunset City Well	850	---	16	---	---	1,250	---
Roy City Well No. 1	900	---	12	---	---	850	---
Clearfield City Well	1,000	---	10	---	---	2,000	---

* To be used for production in near future.

3. HAZARDOUS SUBSTANCES CHARACTERIZATION

TEAD Rail Shop Maintenance Facility generates degreasing solutions, paint wastes, and engine oil wastes (Table 3-1). The degreasing process is now a closed vapor degreasing system with a 200- and 300-gallon trichloroethylene (TCE) tank. The operation uses 150 gallons of TCE/month. Waste TCE is drummed, removed by HAFB's Civil Engineering Squadron (CES), and disposed through the Defense Property Disposal Office (DPDO) by selling to contractors. This practice has been in effect since 1974. The TCE waste was sent to the Army Depot in Ogden, Utah from approximately 1949 to 1964. Between 1964 and 1974, the TCE waste was disposed of in a pit (Pit No. 3) at HAFB. This pit, located on the eastern portion of HAFB (Figure 3-1), was used by HAFB as a TCE disposal area since the 1940s to dispose of hazardous wastes (Engineering Science 1982).

An open area outside of Building 1701 is used for cleaning large train parts. Prior to 1979, an open air dip tank and concrete pad was used to rinse and steam clean engine parts. The runoff from steam cleaning was collected in an underground oil-water separator. The rinse was a sodium cyanide solution used for alkaline stripping. In 1979, the cleaning process was modernized with the addition of a new concrete pad, rinse tanks, pump, and drainage system. Runoff from steam cleaning now collects in a new oil-water separator, then drains to a sanitary sewer. Prior to 1979, it was discharged to the ground surface. Waste oils are collected in the oil separator, then moved to a large holding tank (approximately 500 gallons). When full, the waste oil is analyzed and removed by HAFB to the DPDO and sold to contractors. This practice has been in effect since 1949. The alkaline degreasing solutions have been pumped out of the degreasing tank by CES then sold to contractors through DPDO since 1959 (Engineering Science 1982).

The paint shop (located in Building 1701) uses a waterfall system to recover residual paint. Wastewaters generated during shop operation are reportedly channeled to a base sanitary wastewater treatment facility.

Approximately five years ago, a capacitor, situated on a truck trailer bed, reportedly leaked, causing transformer oil (containing PCB) to spill on the ground in the TEAD Rail Shop Facility Area. The contaminated soils were reportedly excavated and removed by the U.S. Army under the supervision of the U.S. EPA.

The Tooele Rail Shop has been included in the U.S. Air Forces IRP Phase II investigation of sites at HAFB because of the potential for soil contamination. The activities being performed as part of this investigation are presented in the following section.

TABLE 3-1 HISTORICAL SUMMARY OF ACTIVITIES INVOLVING USE OF HAZARDOUS MATERIALS AT TEAD RAIL SHOP MAINTENANCE FACILITY, HAFB

<u>Building No.</u>	<u>Activities</u>	<u>Hazardous Materials</u>
1701	Vapor-degreasing, welding	Trichloroethylene, trichloroethane, metal dust
	Spray painting	Paint pigments
1711	Spray painting	Paint pigments
1723	Metal stripping, cleaning, anodizing and electroplating	Paint pigments, petroleum products
1919	Spray painting, repairing and reconditioning landing gear	paint pigments, petroleum products

Source: USATHAMA 1979.

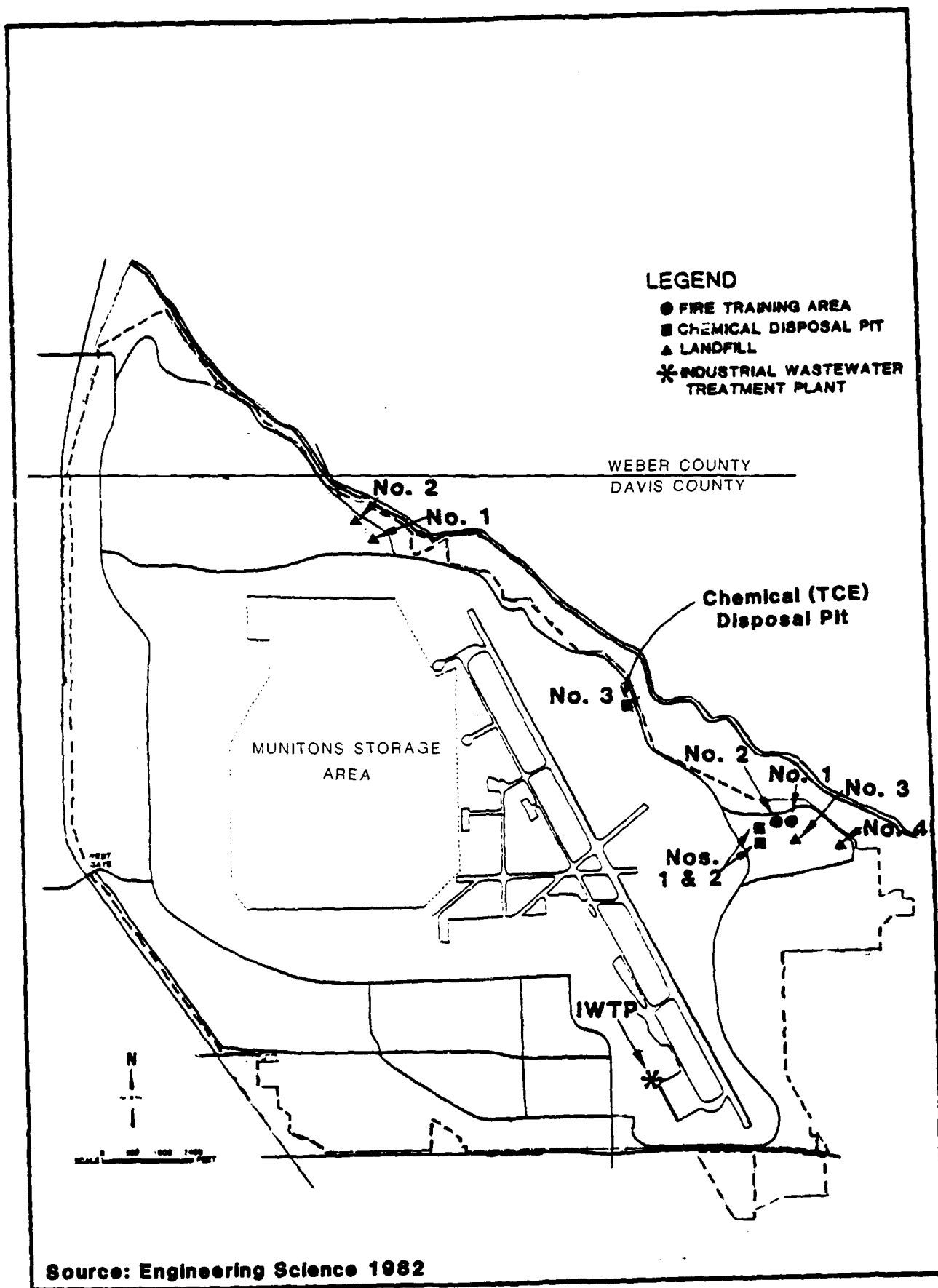


Figure 3-1. Hazardous waste disposal locations at Hill Air Force Base.

4. SUMMARY OF OTHER ENVIRONMENTAL INVESTIGATIONS

4.1 INSTALLATION ASSESSMENT OF TOOELE ARMY DEPOT, REPORT NO. 141

This report was prepared for USATHAMA to assess the potential sources of environmental contamination at the TEAD complex (North Area, South Area, and HAFB) with respect to the use, storage, treatment, and disposal of toxic and hazardous materials and to define any site conditions which may adversely affect the environmental or public health and welfare. The investigation involved conducting an extensive records search and was performed from October to December 1978.

The focus of the investigation was on the North Area and South Area of the TEAD complex. Very little information was presented on TEAD's facilities at HAFB. TEAD's Rail Equipment Division, located at HAFB, was identified as an industrial area generating cleaning and plating wastes, which are then handled by HAFB.

4.2 INSTALLATION RESTORATION PROGRAM, PHASE I - RECORD SEARCH

Engineering Science was retained by the Air Force Engineering and Services Center on 15 July 1981 to conduct the HAFB Phase I Records Search under Contract No. F08637-80-G0009, Call No. 0011, using funding provided by the Air Force Logistics Command (Engineering Science 1982). The onsite portion of Phase I was performed at HAFB on 3 and 4 September, and 21-25 September 1981. During this period, formal interviews were conducted with base personnel familiar with past waste disposal practices, and file searches were performed for identified facilities which have generated, handled, transported, and disposed of waste materials.

TEAD's Rail Shop Maintenance Facility was identified as an industrial operation that generates degreasing solution and engine oil wastes, as well as TCE wastes. A PCB spill was also reported to have occurred at TEAD's Rail Shop which was reportedly cleaned up by the U.S. Army under the supervision of the U.S. EPA.

4.3 ANALYSIS OF EXISTING FACILITIES/ENVIRONMENTAL ASSESSMENT REPORT

This report was prepared by the Tooele Army Depot as an informational report (Tooele Army Depot 1985). The findings of this report with respect to the TEAD Rail Shop were as follows:

- . The Rail Shop Mission is limited primarily by the capacity of the facility. A decision will have to be made in the near future to either initiate a major renovation of Building 1721, in combination with an expansion of at least 50 percent additional floorspace, or to abandon the facility completely and build a new facility at TEAD.

- . Maintenance facilities outside of Building 1701, including temporary buildings, outside solvent cleaning, sand blasting, test stands, outside storage, and personnel support facilities, have been a source of almost constant conflict with HAFB with respect to the eyesore appearance of the facility, environmental contamination, and use of space and facilities. This situation will probably continue until the temporary facilities are demolished and replaced by appropriate new construction.
- . The appearance of the materials storage yard probably helps increase the conflict with the Air Force. Fences, paving, and additional storage racks and increased indoor storage would increase efficiency and reduce losses, as well as improve the appearance of the complex.
- . All outlying buildings around Building 1701 should be demolished as soon as possible and replaced with adequate facilities.

4.4 IRP, PHASE II - CONFIRMATION/QUANTIFICATION

The Tooele Rail Shop has been included in the U.S. Air Force's IRP Phase II investigation of sites at HAFB because of the age of the facility and the potential for soils in the vicinity of the site to be contaminated. The purpose of the Phase II site investigation is to define and quantify the presence or absence of contamination resulting from past activities at a site that may have an adverse impact on public health or the environment. Phase II investigative activities at HAFB are presently ongoing and involves the performance of the following activities in the TEAD Rail Shop Facility Area:

- . Review available records and interview personnel knowledgeable of the operations and history of the area.
- . Collect hand augered soil samples to a depth of 3 feet and analyze for total halogenated organics (TOX), total organic carbon (TOC), oil and grease (O&G), sodium, potassium, hydroxide (alkalinity), and cyanide (Figure 4-1).
- . Install one corehole (20 linear feet). Collect four soil samples and analyze for sodium, potassium, hydroxide (alkalinity), cyanide, TOC, TOX, and O&G (Figure 4-1).
- . If groundwater is encountered, complete the corehole as a shallow test well (20 linear feet) and collect two rounds of groundwater samples, and analyze for sodium, potassium, hydroxide (alkalinity), cyanide, TOC, TOX, PCB, and O&G.

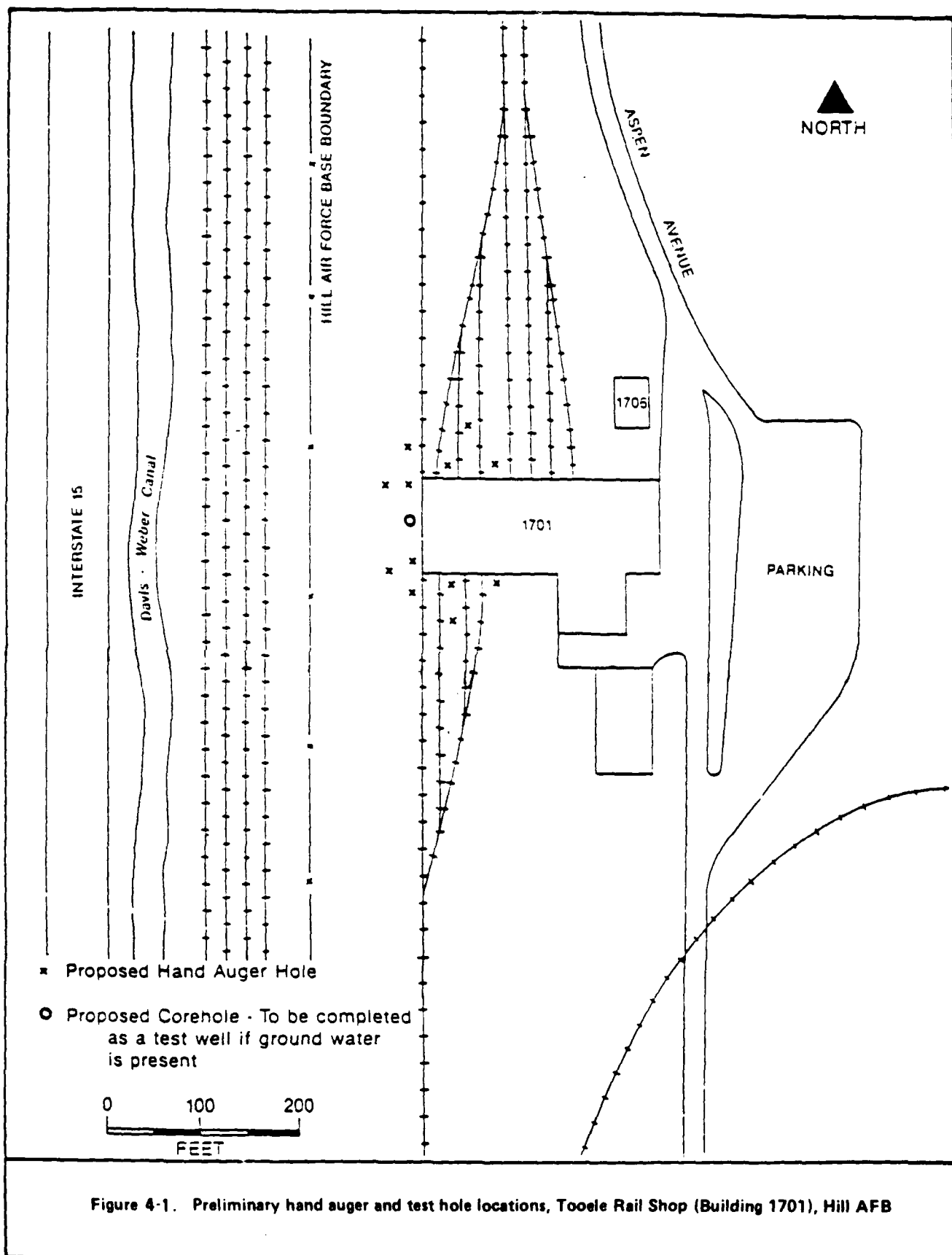


Figure 4-1. Preliminary hand auger and test hole locations, Tooele Rail Shop (Building 1701), Hill AFB

Source: Hill Air Force Base 1986

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

Due to the nature of current and past operations and practices at the TEAD Railroad Shop facility at HAFB, and to the extensive period of time that the facility has been operated, a potential for environmental contamination exists. The degree and extent of environmental contamination, if any, cannot be evaluated based on the limited available database. HAFB has developed a limited sampling plan (Phase II study) for the TEAD facilities to evaluate if contamination of soils or ground water in the area has occurred. Until the results of the Phase II study are available, no conclusions can be made regarding the existence of contamination at the TEAD-HAFB facilities.

5.2 RECOMMENDATIONS

The U.S. Air Force has included, and is currently investigating, this site as part of its IRP, Phase II investigation of HAFB. It is recommended that future activities for this site be based on the findings of the Phase II Sampling and Analytical Program.

PART B - REFERENCES

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