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DRAFT FINAL RCRA FACILITY INVESTIGATION OF LANDFILLS WORK PLANS NAS FORT
WORTH TX
6/1/1997
HYDROGEOLOGIC

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**NAVAL AIR STATION
FORT WORTH JRB
CARSWELL FIELD
TEXAS**

**ADMINISTRATIVE RECORD
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**Draft Final
Work Plans**

**RCRA Facility Investigation of Landfills
NAS Fort Worth JRB, Texas**

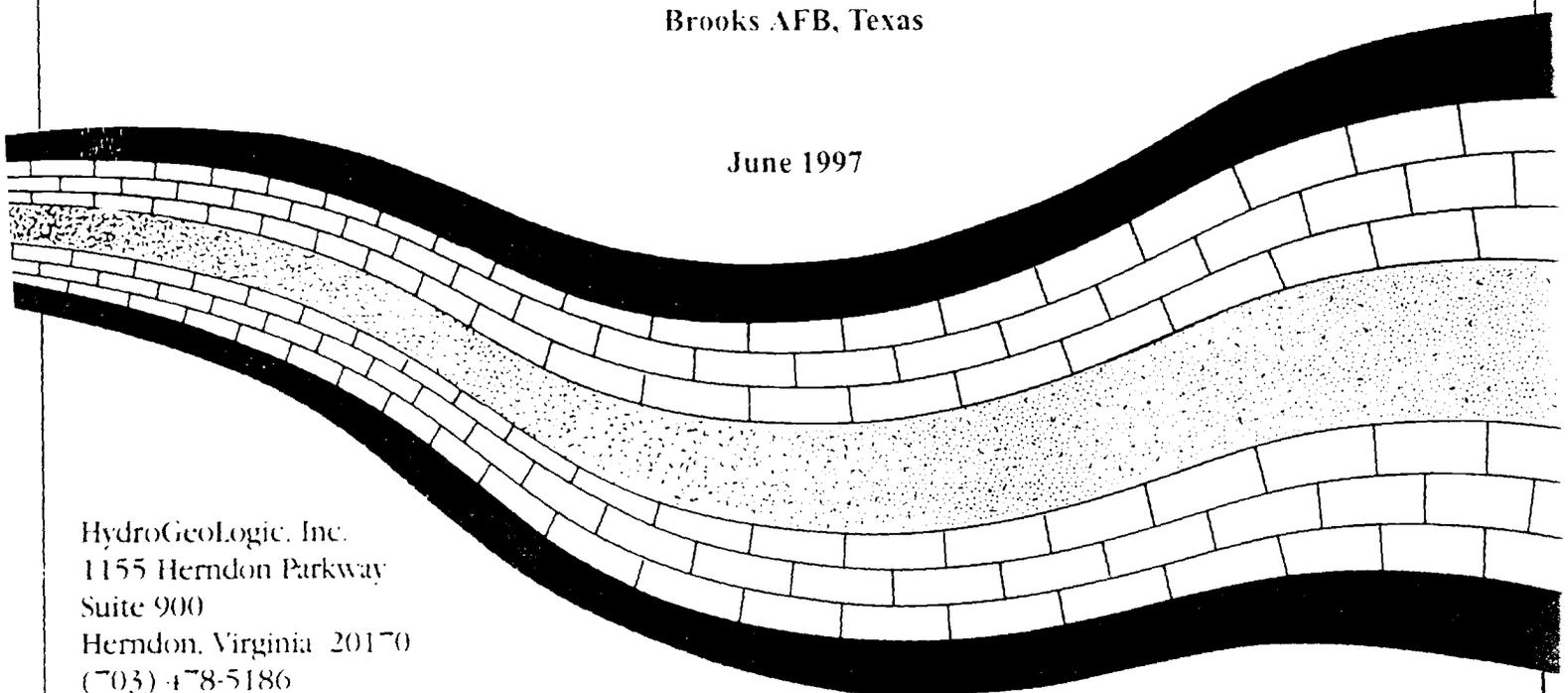


Contract No. F41624-95-D-8005

Prepared for
U.S. Air Force Center for Environmental Excellence
Brooks AFB, Texas

June 1997

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DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
BROOKS AIR FORCE BASE TEXAS

330 2

17 June 1997

MEMORANDUM FOR MARK WEEGAR (TNRCC)

FROM: HQ AFCEE/ERD
3207 North Road
Brooks AFB, TX 78235

SUBJECT: Naval Air Station Joint Reserve Base
Formerly Carswell AFB
TNRCC Solid Waste Registration No. 65004
EPA ID No. TX0571924042
Landfill Work Plans

Dear Mr. Weegar,

One copy of the work plans for investigation of several landfills at NAS Ft. Worth JRB is submitted for your review and comment.

Should you have any questions regarding this letter, please contact me at (210) 536-5290.

Sincerely,

Joseph R. Dunkle
Remedial Program Manager
NAS Ft. Worth JRB



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This document presents the Work Plans for the RCRA Facility Investigation at Landfills at NAS Fort Worth JRB.				
The Work Plans present detailed procedures for additional investigation required to evaluate the potential threat to human health and the environment posed by wastes handled at the subject sites.				
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PREFACE

HydroGeoLogic, Inc. (HydroGeoLogic) was contracted on February 14, 1997 to perform Resource Conservation Recovery Act (RCRA) Facility Investigations (RFIs) at several Solid Waste Management Units (SWMUs) that require further investigation at the Naval Air Station (NAS) Fort Worth Joint Reserve Base (JRB), Texas. Work will be conducted under Contract Number F41624-95-D-8005, Delivery Order Number 0005. SWMUs to be investigated during this project include: SWMU 17 (Landfill No. 7 or LF-07), SWMU 27 (Landfill No. 10 or LF-10), SWMU 29 (Landfill No. 2 or LF-02), SWMU 30 (Landfill No. 9 or LF-09), and SWMU 62 (Landfill No. 6 or LF-06).

Responsible key HydroGeoLogic personnel are as follow:

John (Jack) B. Robertson, P.G.	Program Manager
James P. Costello, P.G.	Project Manager
Michael J. Rodtang, P.G.	Task Manager/Project Geologist
Christopher G. Spill	Corporate Health and Safety Officer
Gary M. Mayer	Corporate QA/QC Officer

HydroGeoLogic has also subcontracted with Law Environmental and Engineering Services, Inc. (Law) to provide support in specific areas that include Health and Safety (CIH) and toxicology (Risk Assessment Leader).

The period of performance for this D.O. is from February 14, 1997 to April 30, 1998. This contract will be administered by DCMAO Baltimore, located at 200 Towsontown Blvd., West, Towson, Maryland 21204-5299. The Contracting Officer will be Ms. Diane C. Sharpe. The Contracting Officer's Representative (COR) will be Mr. Joseph Dunkle (210/536-5290) located at AFCEE/ERD, 3207 North Road Brooks AFB, Texas 78235-5363.

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**DRAFT FINAL
WORK PLAN**

**RCRA FACILITY INVESTIGATION OF LANDFILLS
NAS FORT WORTH JRB, TEXAS**

Contract Number F41624-95-D-8005

Prepared for:

U.S. Air Force Center for Environmental Excellence
Brooks AFB, Texas

Prepared by:

HydroGeoLogic, Inc.
1155 Herndon Parkway, Suite 900
Herndon, VA 20170

June 1997

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LIST OF ACRONYMS AND ABBREVIATIONS

1,2-DCE	1,2-Dichloroethene
1,1,1-TCA	1,1,1-Trichloroethane
ACC	Air Combat Command
AFB	Air Force Base
AFBCA	U.S. Air Force Base Realignment and Closure Agency
AFCEE	U.S. Air Force Center for Environmental Excellence
AFP-4	Air Force Plant 4
ARARs	Applicable or Relevant and Appropriate Requirements
BDAT	Best Demonstrated Achievable Technology
BLRA	Baseline Risk Assessment
BRAC	Base Realignment and Closure Commission
BTEX	Benzene, toluene, ethylbenzene, and xylenes
CAFB	Carswell Air Force Base
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cis-1,2,-DCE	cis-1,2,-Dichloroethene
CFR	Code of Federal Regulation
CLP	Contract laboratory program
CMS	Corrective measures study
COPC	Chemical of potential concern
DCE	Dichloroethene
DEQPPM	Defense Environmental Quality Program Policy Memorandum
DoD	Department of Defense
DQO	Data quality objectives
DRMO	Defense Reutilization and Marketing Office
DTIC	Defense Technical Information Center
EPA	U.S. Environmental Protection Agency
ERA	Ecological Risk Assessment
ESE	Environmental Science and Engineering Incorporated
FAR	Federal Acquisition Regulation
°F	Fahrenheit
FSP	Field Sampling Plan
FT-08	Fire Training Area 1
FT-09	Fire Training Area 2
HSP	Health and Safety Plan
ILS	Instrument Landing System

LIST OF ACRONYMS AND ABBREVIATIONS

Inc.	Incorporated
IRP	Installation Restoration Program
IRPIMS	Installation Restoration Program Information Management System
ISM	Interim/Stabilization Measures
IT	International Technology Corporation
JP-4	Jet propulsion (grade 4)
JRB	Joint Reserve Base
L	Liter
LAW	Law Environmental Incorporated
LF-02	Landfill No. 2 (a.k.a. SWMU 29)
LF-04	Landfill No. 4 (a.k.a. SWMU 22)
LF-05	Landfill No. 5 (a.k.a. SWMU 23)
LF-06	Landfill No. 6 (a.k.a. SWMU 62)
LF-07	Landfill No. 7 (a.k.a. SWMU 17)
LF-09	Landfill No. 9 (a.k.a. SWMU 30)
LF-10	Landfill No. 10 (a.k.a. SWMU 27)
$\mu\text{g/L}$	microgram per Liter
mg/L	milligram per Liter
MS	matrix spike
MSD	matrix spike duplicate
MSCs	Media Specific Concentrations
NAS	Naval Air Station
NCP	National Contingency Plan
NFA	No Further Action
NIOSH	National Institute of Occupational Safety and Health
NGVD	National Geodetic Vertical Datum
OSHA	Occupational Safety and Health Administration
PA	Preliminary Assessment
PCB	Poly chlorinated biphenol
PD-680	Petroleum naphtha
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RI/FS	Remedial Investigation/Feasibility Study
RRS	risk reduction standards

LIST OF ACRONYMS AND ABBREVIATIONS

S	spike
SAC	Strategic Air Command
SAP	Sampling and Analysis Plan
SARA	1986 Superfund Amendments and Reauthorization Act
SD	spike duplicate
SI	Site Investigation
SOW	Statement of Work
SVOCs	Semi-Volatile Organic Compounds
SW-846	Solid Waste EPA Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, 3rd edition, 1986
SWMU 17	Solid Waste Management Unit No. 17 (a.k.a. LF-07)
SWMU 22	Solid Waste Management Unit No. 22 (a.k.a. LF-04)
SWMU 23	Solid Waste Management Unit No. 23 (a.k.a. LF-05)
SWMU 27	Solid Waste Management Unit No. 27 (a.k.a. LF-10)
SWMU 29	Solid Waste Management Unit No. 29 (a.k.a. LF-02)
SWMU 30	Solid Waste Management Unit No. 30 (a.k.a. LF-09)
SWMU 62	Solid Waste Management Unit No. 62 (a.k.a. LF-06)
TCE	Trichloroethene
TNRCC	Texas Natural Resource Conservation Commission
trans-1,2,-DCE	trans-1,2,-Dichloroethene
TRPH	Total Recoverable Petroleum Hydrocarbon
TSWQS	Texas Surface Water Quality Standards
US	United States
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USCG	United States Coast Guard
VOC	Volatile Organic Compound
WP	Work Plan
WP-07	Waste Burial Area No. 7 (a.k.a. SWMU 24)

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1.0 INTRODUCTION

The following sections briefly describe the objective of the U.S. Air Force Installation Restoration Program and the rationale for implementing this program.

1.1 THE U.S. AIR FORCE INSTALLATION RESTORATION PROGRAM

The objective of the U.S. Air Force Installation Restoration Program (IRP) is to assess past hazardous waste disposal and spill sites at U.S. Air Force installations and to develop remedial actions consistent with the National Contingency Plan (NCP) for sites that pose a threat to human health and welfare or the environment. This section presents information on the program origins, objectives, and organization.

The 1976 Resource Conservation and Recovery Act (RCRA) is one of the primary Federal laws governing the disposal of hazardous wastes. Sections 6001 and 6003 of RCRA require Federal agencies to comply with local and state environmental regulations and provide information to the U.S. Environmental Protection Agency (EPA) concerning past disposal practices at Federal sites. The Resource Conservation Recovery Act (RCRA) Section 3012 requires state agencies to inventory past hazardous waste disposal sites and provide information to the EPA concerning those sites.

In 1980, Congress enacted the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (i.e., Superfund). CERCLA outlines the responsibility for identifying and remediating contaminated sites in the United States and its territories. The CERCLA legislation identifies the EPA as the primary policy and enforcement agency regarding contaminated sites.

The 1986 Superfund Amendments and Reauthorization Act (SARA) extends the requirements of CERCLA and modifies CERCLA with respect to goals for remediation and the steps that lead to the selection of a remedial process. Under SARA, technologies that provide permanent removal or destruction of a contaminant are preferable to actions that only contain or isolate the contaminant. SARA also provides for greater interaction with public and state agencies and extends the EPA's role in evaluating health risks associated with contamination. Under SARA, early determination of Applicable or Relevant and Appropriate Requirements (ARARs) is required, and the consideration of potential remediation alternatives is recommended at the initiation of a Remedial Investigation/Feasibility Study (RI/FS). SARA is the primary legislation governing remedial action at past hazardous waste disposal sites.

Executive Order 12580, adopted in 1987, gave various Federal agencies, including the Department of Defense (DoD), the responsibility to act as lead agencies for conducting investigations and implementing remediation efforts when they are the sole or co-contributor to contamination on or off their properties.

To ensure compliance with CERCLA, its regulations, and Executive Order 12580, the DoD developed the IRP, under the Defense Environmental Restoration Program, to identify potentially contaminated sites, investigate these sites, and evaluate and select remedial actions for potentially

contaminated facilities. The DoD issued the Defense Environmental Quality Program Policy Memorandum (DEQPPM) 80-6 regarding the IRP program in June 1980, and implemented the policies outlined in this memorandum in December 1980. The NCP was issued by EPA in 1980 to provide guidance on a process by which (1) contaminant release could be reported, (2) contamination could be identified and quantified, and (3) remedial actions could be selected. The NCP describes the responsibility of Federal and state governments and those responsible for contaminant releases.

The DoD formally revised and expanded the existing IRP directives and amplified all previous directives and memoranda concerning the IRP through DEQPPM 81-5, dated 11 December 1981. The memorandum was implemented by a U.S. Air Force message dated 21 January 1982.

The IRP is the DoD's primary mechanism for response actions on U.S. Air Force installations affected by the provisions of SARA. In November 1986, in response to SARA and other EPA interim guidance, the U.S. Air Force modified the IRP to provide for a RI/FS program. The IRP was modified so that RI/FS studies could be conducted as parallel activities rather than serial activities. The program now includes ARAR determinations, identification and screening of technologies, and development of alternatives. The IRP may include multiple field activities and pilot studies prior to a detailed final analysis of alternatives. Over the years, requirements of the IRP have been developed and modified to ensure that DoD compliance with Federal laws, such as RCRA, NCP, CERCLA, and SARA, can be met.

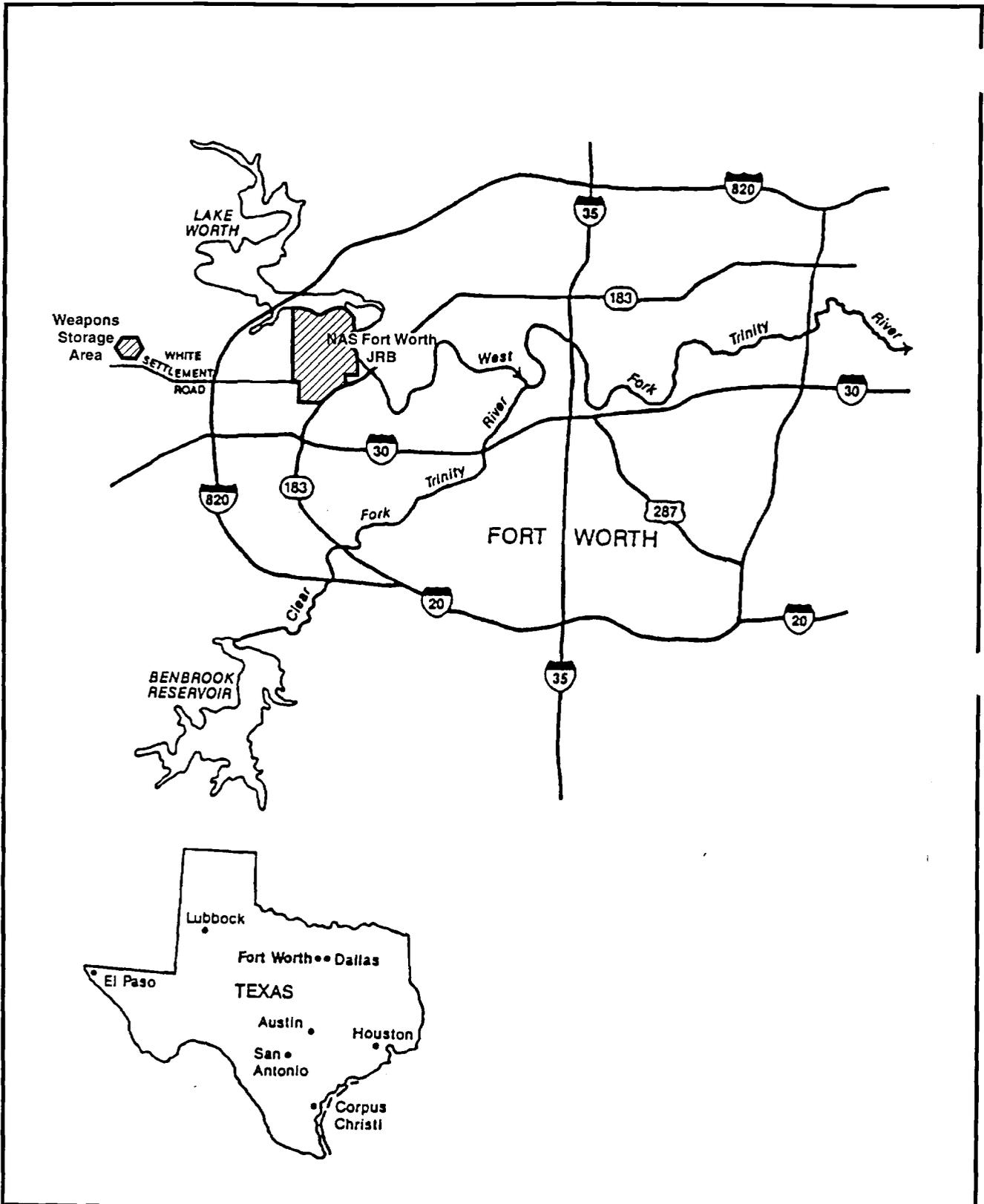
The TNRCC is the lead regulatory agency for the activities to be conducted at the subject sites. TNRCC's Risk Reduction Standards Program (RRS) program is the primary regulatory program that governs the closure of these sites. The IRP, TNRCC's RRS and RCRA, however, rely heavily on guidance documents prepared under CERCLA. This WP has been prepared using guidance documents from all four programs (i.e., TNRCC RRS, RCRA, IRP, CERCLA) in an effort to address as many of the concerned parties as possible. The WP for this project consist of the following documents:

The Work Plan, which describes the work to be performed, explains project objectives, and presents the rationale for conducting specific project activities. The WP describes the site history and setting along with a summary of environmental investigations on the Base. Each site is described, along with data needs and the proposed sampling program for each site. Technical reports and presentation formats are also discussed in the WP.

The Sampling and Analysis Plan, consisting of a Field Sampling Plan (FSP) and a Quality Assurance Project Plan (QAPP).

The Field Sampling Plan describes the planned field sampling procedures. Each method to be used is described in detail, including mobilization activities, environmental sampling procedures record keeping, and a field quality control program.

The Quality Assurance Project Plan describes the field and analytical procedures which will be used to provide quality control for the project. The QAPP provides the project organization responsibility and defines quality assurance objectives on a project wide basis. Laboratory



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 Site

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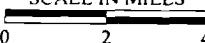
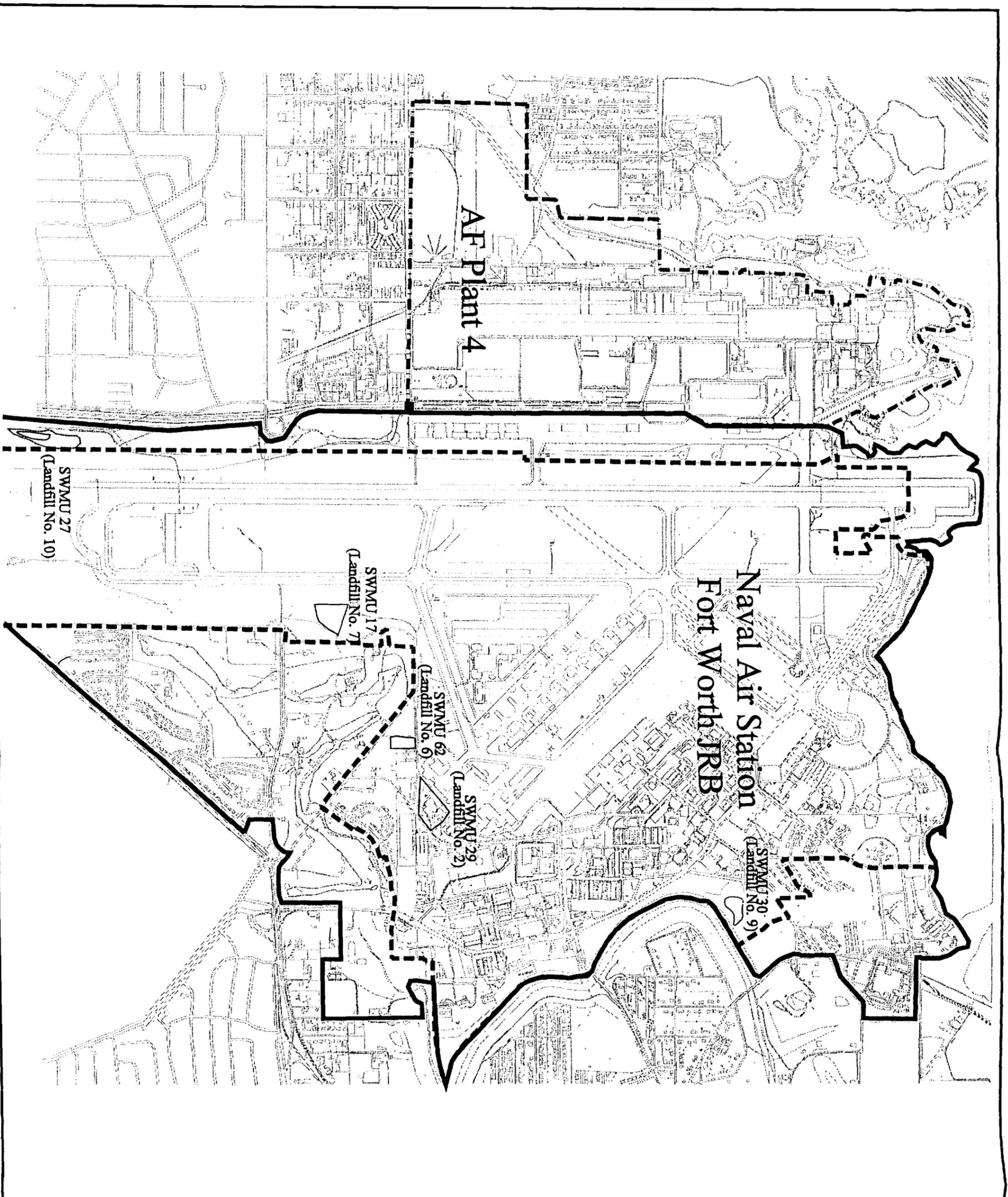


Figure 1.1
Site Location Map
NAS Fort Worth JRB, Texas

[From Radian, 1989]



*HydroGeologic, Inc. — Draft Final RST Work Plan
NAS Fort Worth JRB, Texas*

Figure 1.2

**NAS Fort Worth JRB
Base Boundaries**

**Air Force Center
For Environmental Excellence
Brooks AFB, Texas**

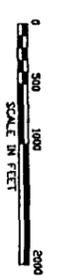
LEGEND

——
Former Property Boundary
of Carswell AFB

- - - -
Approximate NAS
Fort Worth JRB
Site Boundary

- · - · -
Property Boundary
of AF Plant 4

☞
SWMU's Locations



Drawn By: M. LAWLOR Date: 6/12/97

Checked By: K. HURLEY Date: 6/12/97

Title/Name: FIG1-2.DWG

Map Source:
JACOBS 1996

responsibility for much of the facility and its name was changed from CAFB to NAS Fort Worth JRB. The NAS Dallas and elements of Glenview and Memphis NASs were combined into the NAS Fort Worth JRB to streamline naval operations into one central area. The principal activities on the Base have been maintaining and servicing bombers, fuel tankers, and fighter jet aircraft. (A.T. Kearney, 1989).

1.2.3 Site Operational History

A summary of past and current industrial activities and waste disposal operations conducted at the NAS Fort Worth JRB is presented in the following sections.

1.2.3.1 Industrial Activities

Major industrial operations at the NAS Fort Worth JRB include: maintenance of jet engines, aerospace ground equipment, fuel systems, weapon systems, and pneudraulic systems; maintenance of general and special purpose vehicles; aircraft corrosion control; and non-destructive inspection activities. Most of the liquid wastes that have been generated by industrial operations can be characterized as waste oils, recoverable fuels, spent solvents, and spent cleaners (CH2M HILL, 1996a).

Waste oils generally refer to lubricating fluids/oils and to a lesser extent hydraulic fluids. Recoverable fuels refer to fuels drained from aircraft tanks and other Base vehicles, such as Jet Propulsion grade 4 (JP-4) and unleaded gasoline. Spent solvents and cleaners refer to stripping liquids used for degreasing and cleaning of aircraft, aircraft systems and parts, electronic components, and vehicles. Included in this category are PD-680 (petroleum naphtha) and various chlorinated organic compounds. Specific types of degreasing solvents used by the U.S. Air Force have changed over the years. In the 1950s, carbon tetrachloride was commonly used until it was replaced by trichloroethylene (TCE) in about 1960. Since then, TCE and 1,1,1-trichloroethane (1,1,1-TCA) have been used though TCE usage has decreased in favor of 1,1,1-TCA. Today, PD-680 Type II, 1,1,1-TCA and, to a limited extent, TCE are used. Waste paint solvents and strippers are also generated onsite from corrosion control activities. Typical paint solvents include compounds like isobutyl acetate, toluene, methyl ethyl ketone, isopropanol, naphtha, and xylene. Paint strippers generally contain such compounds as methylene chloride, toluene, ammonium hydroxide, and phenolics. Servicing and maintenance of the engines and equipment of the B-52 and KC-135 aircraft generated the majority of waste liquids at NAS Fort Worth JRB (CH2M HILL, 1996a).

1.2.3.2 Waste Disposal Operations

Wastes have been generated and disposed of at the NAS Fort Worth JRB since the beginning of industrial operations in 1942. Historical waste management practices at the NAS Fort Worth JRB were presented in the Phase I Initial Assessment Report (CH2M HILL, 1984), the Phase I Remedial Investigation Report (Radian, 1989), and the Site Characterization Summary Informal Technical Information Report (CH2M HILL, 1996b) and are summarized in the following paragraphs:

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- 1942-1970: The majority of waste oils, recovered fuels, spent solvents, and cleaners were burned at the fire department training areas during practice exercises. Some waste oils and spent solvents were disposed of through contractor removal, while some waste paints (contaminated with thinners and solvents), waste oils, and PD-680 are suspected of having been disposed of in the Base landfills. Some waste oils, recovered fuels, spent solvents, and cleaners were also discharged to sanitary and storm sewers. These discharges occurred primarily at the washracks. In 1955, an oil/water separator (Facility 1190) was installed to recover waste materials discharged from the washracks. Non-aqueous materials from oil/water separators were pumped out and disposed of through contractor removal. Aqueous discharge from oil/water separators was, and still is, pumped into the sanitary sewers.
- 1971-1975: During this period, most waste oils, spent solvents, and cleaners were disposed of by contractor removal. A private contractor would pump the materials from oil/water separators, 55-gallon drums, and bowsers. Recovered JP-4 was still stored at the fire training area and burned in practice exercises. Recovered JP-4 was also reused in aerospace ground equipment operations. Some waste paints (contaminated with thinners and solvents), waste oils, and PD-680 are suspected of having been disposed of in the Base landfills. Some waste oils, solvents, and cleaners were discharged into sanitary sewer drains, primarily at the washracks that discharge to the Facility 1190 oil/water separator. This oil/water separator was routinely pumped out by a private contractor and the recovered materials were removed from the Base by the contractor.
- 1976-1982: The majority of waste oils, spent solvents, and cleaners were disposed of by service contract either directly or through the Defense Reutilization and Marketing Office (DRMO). Recovered JP-4 was stored at the fire department training area and burned during practice exercises. Recovered JP-4 was also used in aerospace ground equipment operations. PD-680 used at the washracks was discharged to the Facility 1190 oil/water separator which discharged to the sanitary sewers.
- 1983-Present: Waste oils, solvents, and cleaners are collected in 55-gallon drums and temporarily (less than 90 days) stored at 12 hazardous waste accumulation points located throughout the Flightline Area of the Base. They are subsequently disposed of by contractor removal through DRMO. Recovered JP-4 and other fuels (Mogas - unleaded gasoline) are stored at the fire department training area for subsequent burning in practice exercises or is reused in aerospace ground equipment operations. Waste paint solvents or thinners and strippers such as toluene, isobutyl acetate, methyl ethyl ketone (MEK), isopropanol, naphtha, and xylene are also temporarily stored prior to removal. Removal of waste oils and PD-680 (Type II) from oil/water separators is also handled by off-base contractor through DRMO.

1.3 SWMU IDENTIFICATION AND DESCRIPTION

330 27

The areas of interest for this RFI are five landfills located throughout the NAS Fort Worth JRB Installation. These landfills are identified as SWMU 17 (Landfill No. 7 or LF-07), SWMU 27 (Landfill No. 10 or LF-10), SWMU 29 (Landfill No. 2 or LF-02), SWMU 30 (Landfill No. 9 or LF-09), and SWMU 62 (Landfill No. 6 or LF-06). The locations of the SWMUs in relation to the Base are presented on Figure 1.3. Table 1.1 provides a summary description of each SWMU and lists the current status of each site.

SWMU 17 is approximately 3.4 acres and is located in the Flightline Area, east of Taxiway 197, and adjacent to the south side of building 4146. The period of official operation of this SWMU was from 1978 to 1983. Unauthorized dumping may have continued for several years following 1983. This area reportedly received construction debris in the form of concrete, asphalt, wood, trees, and potentially small amounts of undocumented hazardous materials.

SWMU 27 is approximately 4.5 acres and is located in the southwestern portion of NAS Fort Worth JRB, east of the perimeter road and west of Overrun 51. Based on aerial photographic interpretation, the period of operation for this SWMU started around 1988 and continues to the present day. The SWMU currently receives concrete rubble, tree limbs, and street sweepings.

SWMU 29 originated as a borrow pit located in the center portion of NAS Fort Worth JRB between Haile Drive and the perimeter road. This 4.4 acres and was converted to a landfill in 1952 and accepted construction debris and moderate quantities of unspecified hazardous wastes. In 1956, the landfill was no longer needed and was covered.

SWMU 30 is located approximately 300 feet southeast of Building 2570 and occupies approximately 1.7 acres. The SWMU received construction debris in the form of concrete, asphalt, and wood from 1978 through 1983. The site is currently covered by vegetation.

SWMU 62 is approximately 1.5 acres and is located southwest of SWMU 29 between Roaring Springs Road, Haile Drive and the perimeter road. This area served as an active landfill from 1975 through 1978. It was documented that in addition to construction debris, the landfill also received three drums of hydraulic fluid, (USACE, 1993) and moderate quantities of unspecified hazardous wastes.

1.4 SITE INVESTIGATION HISTORY

This RCRA Facility Investigation (RFI) is being conducted at the NAS Fort Worth JRB as part of the ongoing IRP. The IRP effort at the NAS Fort Worth JRB was initiated in 1984 and has continued to the present. Previous IRP investigations have resulted in analytical data associated with two of the SWMUs. Investigations conducted at other sites near SWMU 17 have resulted in groundwater data that is relevant to characterizing this site. A preliminary site investigation was conducted at SWMU 62. Previous investigations have not been conducted at SWMUs 27, 29 and 30.

SWMU 27
(Landfill No. 10)

Overrun
51

Flightline
Area

SWMU 17
(Landfill No. 7)

10X1WGY 197

Naval Air Station Fort Worth JRB

SWMU 62
(Landfill No. 6)

SWMU 29
(Landfill No. 2)

SWMU 30
(Landfill No. 9)

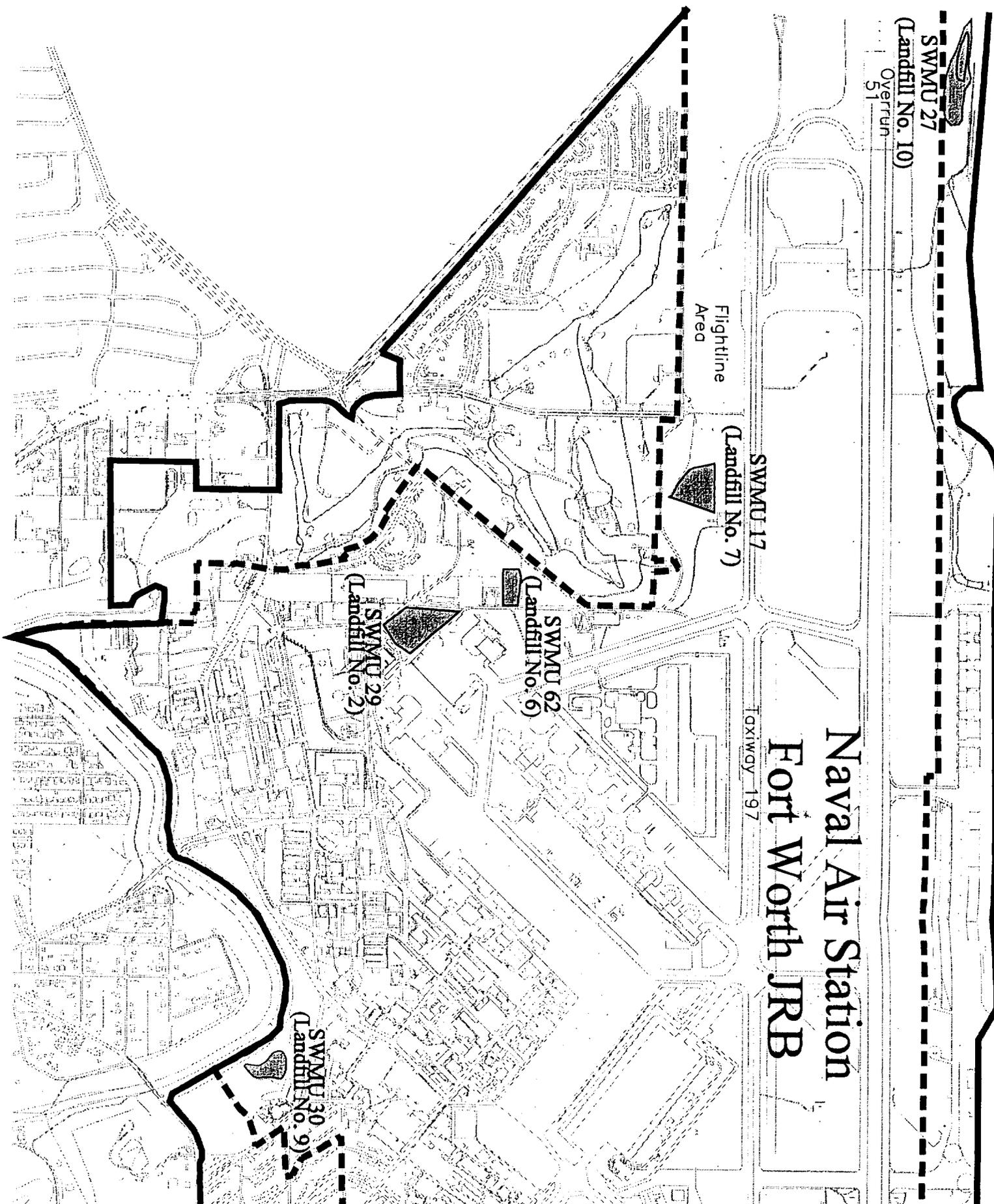


Table 1.1
Current SWMU Summary Table
NAS Fort Worth JRB, Texas

IRP Site ID	SWMU No.	Description	Materials Received	Operation Dates	Status
LF02	29	Landfill 2	Construction rubble and materials, moderate quantities of unspecified hazardous wastes	1952-1956	RCRA Facility Investigation
LF06	62	Landfill 6	Construction rubble, drums of hydraulic fluid, and small quantities of hazardous materials	1975-1978	RCRA Facility Investigation
LF07	17	Landfill 7	Construction waste and rubble; possibly small amounts of hazardous wastes	1978-1983	RCRA Facility Investigation
LF09	30	Landfill 9	Construction rubble and trees; possibly small amounts of hazardous materials	1978-1983	RCRA Facility Investigation
LF10	27	Landfill 10	Concrete rubble, tree limbs, and street sweeping debris	Origination unknown; currently operational	RCRA Facility Investigation

Source(s): Management Action Plan, Carswell AFB (October 28, 1993)
RCRA Facility Investigation Statement of Work, Annex A (January 21, 1997).

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The following IRP investigations have been performed at the NAS Fort Worth JRB: **330 31**

- CH2M HILL, 1984, Installation Records Program for Carswell Air Force Base.
- Radian Corporation, 1986, Installation Restoration Program Phase II - Confirmation/Quantification, Stage 1, Final Report
- Radian Corporation, 1989, Installation Restoration Program RI/FS, Stage 2 Draft Final Technical Report, Carswell Air Force Base, Volumes 1&2
- Radian Corporation, 1991, Installation Restoration Program RI, Stage 2 Final Report, Carswell Air Force Base.
- International Technology Corporation, 1994, Draft Phase III Summary Report of Field Sampling, Analysis, and Testing at Carswell Air Force Base.
- U.S. Army Corps of Engineers, Fort Worth District, 1993, Preliminary Assessment/Site Investigation for Site LF-06 Landfill Number 6, SWMU No. 62.
- CH2M HILL, 1997, Draft RCRA Facility Investigation Work Plan for Area of Concern 2, (TCE Groundwater Plume).
- HydroGeoLogic, Inc, 1997, RCRA Facility Investigation/Corrective Measures Study Draft Work Plans for WP-07, Landfills 4,5, and 8, Carswell AFB, Texas.

Each of the following sections will summarize the results of previous investigation results from the subject sites. Remedial Actions have not been initiated at any of the sites included in this Work Plan.

1.4.1 SWMU 17

Although SWMU 17 is located within the Flightline Area, it has never been directly investigated. Previous investigations of the Flightline Area have centered around SWMUs 22, 23, 24, and 25 as well as several other areas of interest. The following paragraphs provide an overview of previous investigations that have been conducted in the vicinity of SWMU 17.

Sampling of the alluvial terrace groundwater beneath the Flightline Area began during the SI (Radian, 1986) and has continued periodically until the most recent sampling conducted by CH2M Hill in April, 1997. The results of this most recent investigations are not yet available, so the most current analytical data used in preparing this Work Plan is from the Law Environmental, Inc. January 1996 sampling (LAW, 1996). The following list is a summary of the investigations conducted in the Flightline Area:

- **Site Investigation (Phase II, Stage I), February/March 1985 (Radian, 1986).** This investigation involved the initial installation and sampling of monitoring wells in the Flightline Area. The results of this investigation showed that TCE

contamination was present in the groundwater beneath the site and that the center of the portion of the plume associated with the Flightline Area paralleled White Settlement Road between Landfill No. 4 (LF-04) and Waste Burial Area No. 7 (WP-07). Chemicals other than TCE and its associated daughter products were detected, but not at significant levels.

- **Phase I RI/FS (Phase II, Stage II), February and April 1988 (Radian, 1989).** The Phase I RI/FS included two rounds of groundwater sampling in the Flightline Area. The results of these sample analyses show the Flightline Area portion of the chlorinated organic compound plume remained centered around WP-07. The concentrations of the Flightline Area portion of the plume did not change appreciably between the SI and Phase I RI/FS sampling. Several inorganic compounds including antimony, arsenic, lead, and selenium exceeded comparison criteria by greater than an order of magnitude. Subsequent sampling events, however, did not confirm these elevated concentrations suggesting these results may be anomalous readings.
- **Phase II RI/FS (Phase II, Stage II), April/May 1990 (Radian, 1991).** The Phase II RI/FS was initiated to further investigate the TCE plume in the Flightline Area. The results showed the Flightline Area portion of the TCE plume centered at monitoring well LF04-4G, further east than previous sampling events (groundwater flow is in an easterly direction). Additional downgradient wells were installed which showed the plume extending farther north than previous investigations. The installation and sampling of additional wells to the east also showed the plume to extend farther east, perpendicular to groundwater flow. Only TCE and cis-1,2,-Dichloroethene (DCE) exceeded comparison criteria by greater than one order of magnitude. The elevated inorganic results present in the earlier Phase I RI/FS study were not confirmed during this sampling event.
- **Recovery Well Sampling, April 1993 (IT, 1993), July 1994 (IT, 1994).** IT Corporation conducted sampling of the groundwater recovered during testing of extraction wells installed for the groundwater remediation system in the Flightline Area. The results of these analyses showed the maximum TCE concentration at recovery well CAR-RW7, just east of the WP-07. It should be noted that IT collected dynamic samples for remediation system design. Dynamic samples collected from recovery wells are generally obtained at much higher flow rates than samples collected from monitoring wells. Therefore, the results of the recovery well sampling may not correlate well with samples collected during other sampling events.
- **Quarterly Groundwater Sampling, CAFB (LAW, 1996a, 1996b).** LAW Environmental, Inc. conducted quarterly groundwater sampling in April 1995, July 1995, October 1995, and January 1996 in the Flightline Area. The results of these four sampling events showed that the magnitude and extent of the TCE plume changed little between the first and fourth quarter. The center of the

Flightline Area portion of the plume continued to be along White Settlement Road between LF-04 and WP-07. Several inorganic chemicals exceeded comparison criteria during the four quarterly sampling events, but the concentrations were either within an order of magnitude of the comparison criteria or appeared to be isolated anomalous results.

- **Quarterly Groundwater Sampling, AFP-4 (Jacobs, 1996).** Jacobs Engineering Group has been conducting quarterly groundwater sampling at AFP-4 and NAS Fort Worth JRB to monitor the nature and extent of the TCE plume that originates in the East Parking Lot Area at AFP-4. The downgradient portion of this plume is commingled with the TCE plume originating in the Flightline Area. Jacobs Engineering samples several Flightline Area wells on a quarterly basis to monitor this plume. Figure A.1 of Appendix A illustrates the AFP-4 TCE plume.

The Flightline Area portion of the TCE plume is defined in the upgradient (southwestern) direction based on the consistently low reading obtained in groundwater samples collected from LF04-4A, LF04-4B, and FT09-12A. The western extent of the TCE plume cannot be accurately delineated since the AFP-4 TCE plume originates in this direction and it is commingled with the Flightline Area TCE plume. The eastern (downgradient) extent of the TCE plume is not well defined based on the results from LF04-04 and LF05-18 during the October 1995 Jacobs Engineering sampling. These same wells, however, sampled by Law in January 1996 were below detection limits. The alluvial terrace deposits thin out and are exposed along stretches of Farmers Branch Creek. Therefore, Farmers Branch Creek can be considered the northern extent of the Flightline Area portion of the TCE plume. A more detailed presentation of the Flightline Area portion of the TCE plume during the January 1996 sampling is presented in Figure A.2 of Appendix A. The extent of the Flightline Area portions of the cis-1,2-DCE and the trans-1,2-DCE plumes during this same period are presented on Figures A.3 and A.4 of Appendix A, respectively.

1.4.2 SWMU 62

During the Preliminary Assessment (PA) conducted in 1993 (USACE, 1993), the soil and groundwater were sampled and analyzed for lead, benzene, toluene, ethyl benzene, and xylenes (BTEX), and total recoverable petroleum hydrocarbons (TRPH). Figure 1.4 shows the location of the five soil borings (LF06-1 through LF06-5) that were drilled and sampled. Of those five, only three borings were sampled for groundwater due to caving conditions caused by gravel in two boreholes. Hydrocarbon contamination in the soils was found in three of the soil borings at depths consistent with debris identified during drilling operations. Table 1.2 is a list of the laboratory analyses performed on the samples collected during this investigation. Analytical results for soil samples collected during the PA/SI are presented in Table 1.3, and groundwater analytical results from soil borings are presented in Table 1.4. The PA reported soil concentrations of toluene, xylene, and TRPH at concentrations up to 0.006 mg/kg, 0.0042 mg/kg, and 5,160 mg/kg, respectively. Groundwater concentrations of lead and TRPH were also reported at concentrations up to 0.361 mg/L and 0.3 mg/L, respectively. These contaminants were identified from LF06-1. No evidence of buried debris in this boring was noted during the investigation.

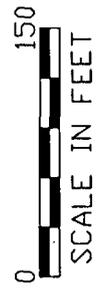
Figure 1.4

Previously Installed
 Soil Borings at
 SWMU 62

Air Force Center
 For Environmental Excellence
 Brooks AFB, Texas

LEGEND

-  SWMU Area
-  Building
-  Fence
-  Road
-  Soil Boring Location (Soil Samples)
-  Soil Boring Location (Soil and Groundwater Samples)



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Filename: FIG1-8.DWG	
Map Source: USACE, 1993	

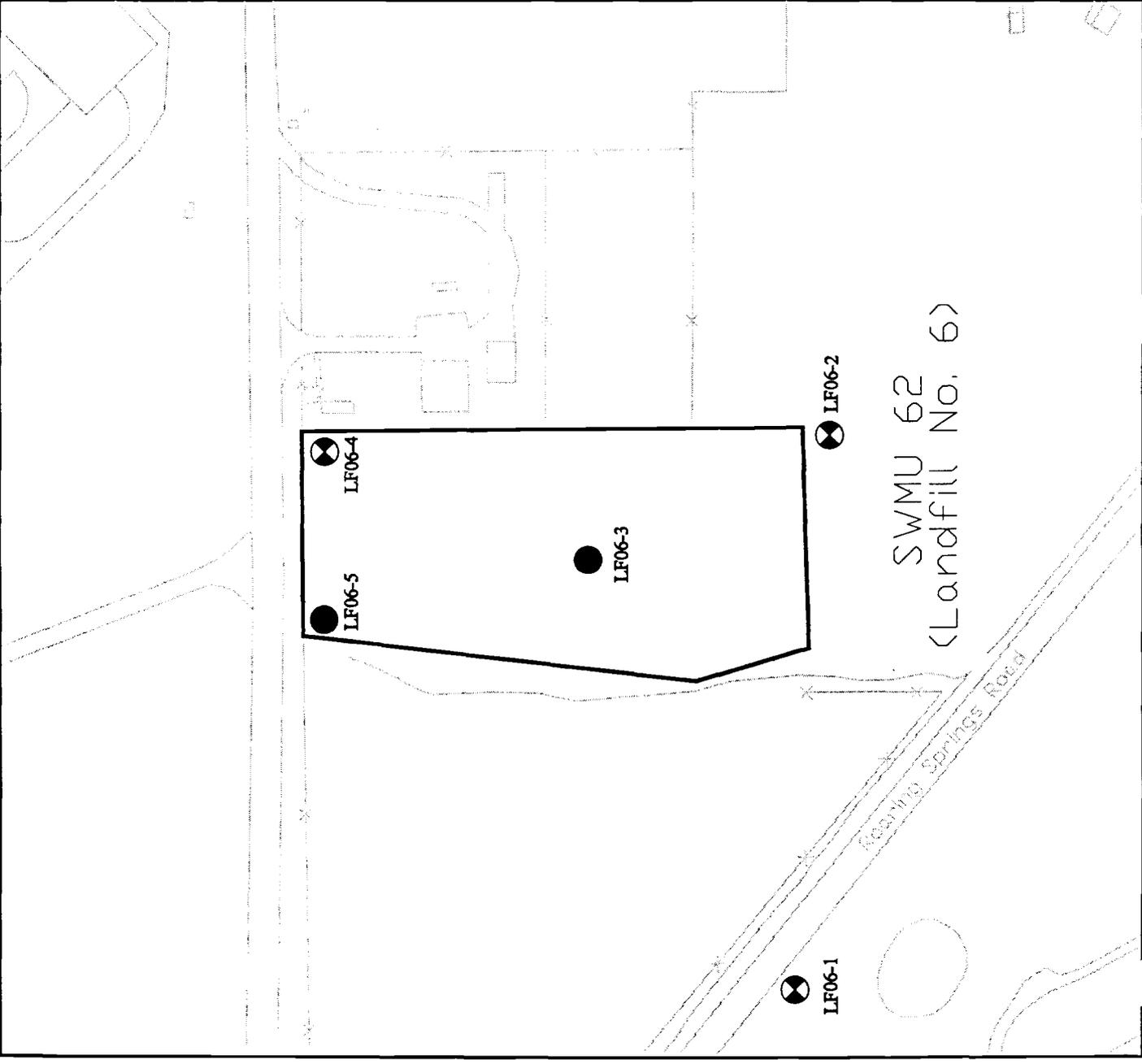


Table 1.2
Sampling Analysis From Previous Investigations
SWMU 62
NAS Fort Worth JRB, Texas

Well Name	TDS ¹	BTEX ²	TRPH ³	TOX ⁴	TCLP Lead ⁵	TCLP Benzene ⁶	Lead ⁷
Soil							
LF06-1	NA	X	X	X	X	X	NA
LF06-2	NA	X	X	X	X	X	NA
LF06-3	NA	X	X	X	X	X	NA
LF06-4	NA	X	X	X	X	X	NA
LF06-5	NA	X	X	X	X	X	NA
Groundwater							
LF06-1	X	X	X	NA	NA	NA	X
LF06-2	X	X	X	NA	NA	NA	X
LF06-3	X	X	X	NA	NA	NA	X
LF06-4	X	X	X	NA	NA	NA	X
LF06-5	X	X	X	NA	NA	NA	X

Notes:

NA - Not Analyzed

¹ TDS - Total Dissolved Solids analyzed using EPA Method 160.3² BTEX - Benzene, Toluene, Ethylbenzene and Xylenes measured using EPA Method 8020.³ TRPH - Total Recoverable Petroleum Hydrocarbons analyzed using EPA Method 418.1.⁴ TOX - Total Halogenated Organics analyzed using EPA Method 9020.⁵ TCLP Lead - Toxicity Characteristic Leaching Parameter for Lead using EPA Method 6010.⁶ TCLP Benzene - Toxicity Characteristic Leaching Parameter for Benzene using EPA Method 1311/8020.⁷ Lead analyzed using EPA Method 6010.

Source:PA/SI Landfill No. 6, SWMU No. 62 (USACE, 1993)

Table 1.3
Analytical Results of Soil Samples - SWMU 62
January 28, 1993 to February 4, 1993
NAS Fort Worth JRB, Texas

Parameter (mg/Kg)	TNRCC Risk Reduction Standard #2 ¹	Sample Location and Depth											
		LF06-1					LF06-3			LF06-4			
		1.0-1.5 ft	7.0-7.5 ft	9.0-9.5 ft	1.0-2.5 ft	7.5-8.0 ft	15.0-15.5 ft	1.0-1.5 ft	4.0-4.5 ft	6.0-6.5 ft	14.5-15.0 ft		
Toluene	100	ND	ND	ND	ND	ND	0.0023	ND	0.006	ND	ND	ND	ND
Xylenes	1,000	ND	ND	ND	ND	ND	0.0042	ND	0.002	ND	ND	ND	ND
TRPH	NA	23	30	40	23	5,160	34	401	ND	86	225		

Notes:

Soil samples were analyzed for benzene, toluene, ethyl benzene, xylenes (BTEX), TPRH, and TOX; one soil sample was arbitrarily selected at a suspected burial depth in each boring for TCLP lead and benzene analyses. Unless otherwise noted, all parameters were ND.

ND = Not Detected above the detection limit of 0.002 mg/Kg (benzene, toluene, ethyl benzene, and xylenes), 10 mg/Kg (TRPH and TOX), 0.2 mg/L (TCLP lead), or 0.005 mg/L (TCLP benzene).

TCLP = Toxic Characteristic Leach Procedure

TOX = Total Halogenated Organics.

TRPH = Total Recoverable Petroleum Hydrocarbons.

¹Maximum Concentration of Groundwater Protection Standard for Industrial Use Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II) Texas Administrative Code. Title 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission

Source: PA/SI for Landfill No. 6, SWMU No. 62 (USACE, 1993)

Table 1.4
Groundwater Analytical Results from Soil Borings - SWMU 62
January 28, 1993 to February 4, 1993
NAS Fort Worth JRB, Texas

Parameter (mg/L)	TNRCC Risk Reduction Standard #2 ¹	Background UTLs Groundwater ²	Sample Location		
			LF06-1	LF06-2	LF06-4
TRPH	NA	NA	0.3	ND (0.2)	ND (0.2)
TDS	NA	NA	356	474	736
Lead	0.015	ND (0.0016)	0.361	0.068	NA

Notes:

Groundwater samples were analyzed for benzene, toluene, ethyl benzene, xylenes (BTEX), TPRH, TDS, and lead. Unless otherwise noted, all parameters were ND.

Borings LF06-3 and LF06-5 were not sampled due to borings caving.

ND = Not Detected above the detection limit of 0.001 mg/L (benzene, toluene, ethyl benzene, and xylenes).

TDS = Total Dissolved Solids

TRPH = Total Recoverable Petroleum Hydrocarbons.

¹Maximum Concentration of Groundwater Protection Standard for Industrial Use Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II) Texas Administrative Code. Title 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission

²Basewide Background Study, Volume 1 (Jacobs, 1997).

Source: PA/SI for Landfill No. 6, SWMU No. 62 (USACE, 1993)

1.4.3 SWMUs 27, 29, and 30

330 38

Previous investigations have not been conducted at SWMUs 27, 29 and 30. Therefore, no data exists as to whether media at these SWMUs are contaminated as a direct result of past activities during their respective periods of operation.

1.5 DESCRIPTION OF CURRENT STUDY

An investigation will be conducted at five landfills at NAS Fort Worth JRB in an effort to obtain closure of the units under TNRCC Risk Reduction Standards Program. The results of previous investigations, and the results of the investigation outlined in these Work Plans, will be used to determine which RRS is appropriate for closure of each of the subject SWMUs.

Sampling results from previous investigations at SWMU 17 and 62 exceed RRS2. Additional sampling will be conducted during this RFI to further evaluate the source of this contamination, and also to delineate the extent of this contamination. If the RRS2 media specific concentrations (MSCs) are exceeded during this investigation, then, 1) “hot spot” remediation to achieve RRS2 levels will be performed, or 2) closure under RRS3, including preparation of a Baseline Risk Assessment (BLRA) and, if necessary, a Corrective Measures Study (CMS), will be initiated.

Previous investigations have not been conducted at SWMUs 27, 29 and 30. An initial assessment will be conducted at each of these sites, focusing on characterizing any potential contaminant sources and providing a preliminary evaluation of the nature and extent of any contamination detected. The results of the samples collected during these investigations will be compared to the draft background values (Jacobs, 1997) to determine if closure under RRS1 is appropriate. If background values are not available for organic chemicals, the investigation results will be compared to practical quantitation limits (PQLs) for closure under RRS1.

The results of the investigations proposed in the RFI Work Plan may not provide a complete delineation of the nature and extent of the contamination present at each of the subject SWMUs. If further delineation of contamination is required at any of the SWMUs in this study, additional monitoring wells and/or soil borings will be installed to complete characterization of the contaminants. When delineation of the contamination is complete at each of the SWMUs, the data will be compiled and presented in an RFI Report with a discussion of the RRS standard that is appropriate for closure at each of the sites.

2.0 SUMMARY OF EXISTING INFORMATION

330 39

The climate, physiography, geology, hydrology, biology, demographics for the NAS Fort Worth JRB area is described in the following sections. These data have primarily been derived from the Summary of Remediation Projects at Air Force Plant 4 and Carswell Air Force Base (ESE, 1994) and the RI/FS Reports (Radian, 1989, 1991).

2.1 INSTALLATION ENVIRONMENTAL SETTING

2.1.1 Physiographic Province

The NAS Fort Worth JRB area is located along the border zone between two physiographic provinces. The southeastern part of the Base is situated within the Grand Prairie section of the Central Lowlands Physiographic Province. Most of NAS Fort Worth JRB is located within this province. This region is characterized by broad, eastward-sloping terrace surfaces that are interrupted by westward-facing escarpments. The land surface is typically grass covered and treeless except for isolated stands of upland timber. The northwestern part of the NAS Fort Worth JRB area is situated within the Western Cross Timbers Physiographic Province. This area is characterized by rolling topography and a heavy growth of post and blackjack oaks (Radian, 1989). Surface elevations for this region range from about 850 feet above national geodetic vertical datum (NGVD), west of the Base, to approximately 550 feet above NGVD, along the eastern side of the Base. Figure 2.1 is a section of the Lake Worth, Texas U.S. Geological Survey Topographic Map showing the relief of the NAS Fort Worth JRB/AFP-4 region.

2.1.2 Regional Geology

The geologic units of interest for the region, from youngest to oldest, are as follows: (1) the Quaternary Alluvium (including fill material and terrace deposits), (2) the Cretaceous Goodland Limestone, (3) the Cretaceous Walnut Formation, (4) the Cretaceous Paluxy Formation, (5) the Cretaceous Glen Rose Formation, and (6) the Cretaceous Twin Mountains Formation. A generalized cross section of the geology beneath NAS Fort Worth JRB is presented in Figure 2.2 (Radian, 1989). The areal limits of surface exposure of these units at NAS Fort Worth JRB are shown in Figure 2.3. Cross section locations and individual cross sections at NAS Fort Worth JRB are presented in Figure 2.4 - 2.7 (CH2M HILL, 1996b). The regional dip of these stratigraphic units beneath NAS Fort Worth JRB is between 35 to 40 feet per mile in an easterly to southeasterly direction. NAS Fort Worth JRB is located on the relatively stable Texas Craton, west of the faults that lie along the Ouachita Structural Belt. No major faults or fracture zones have been mapped near the Base.

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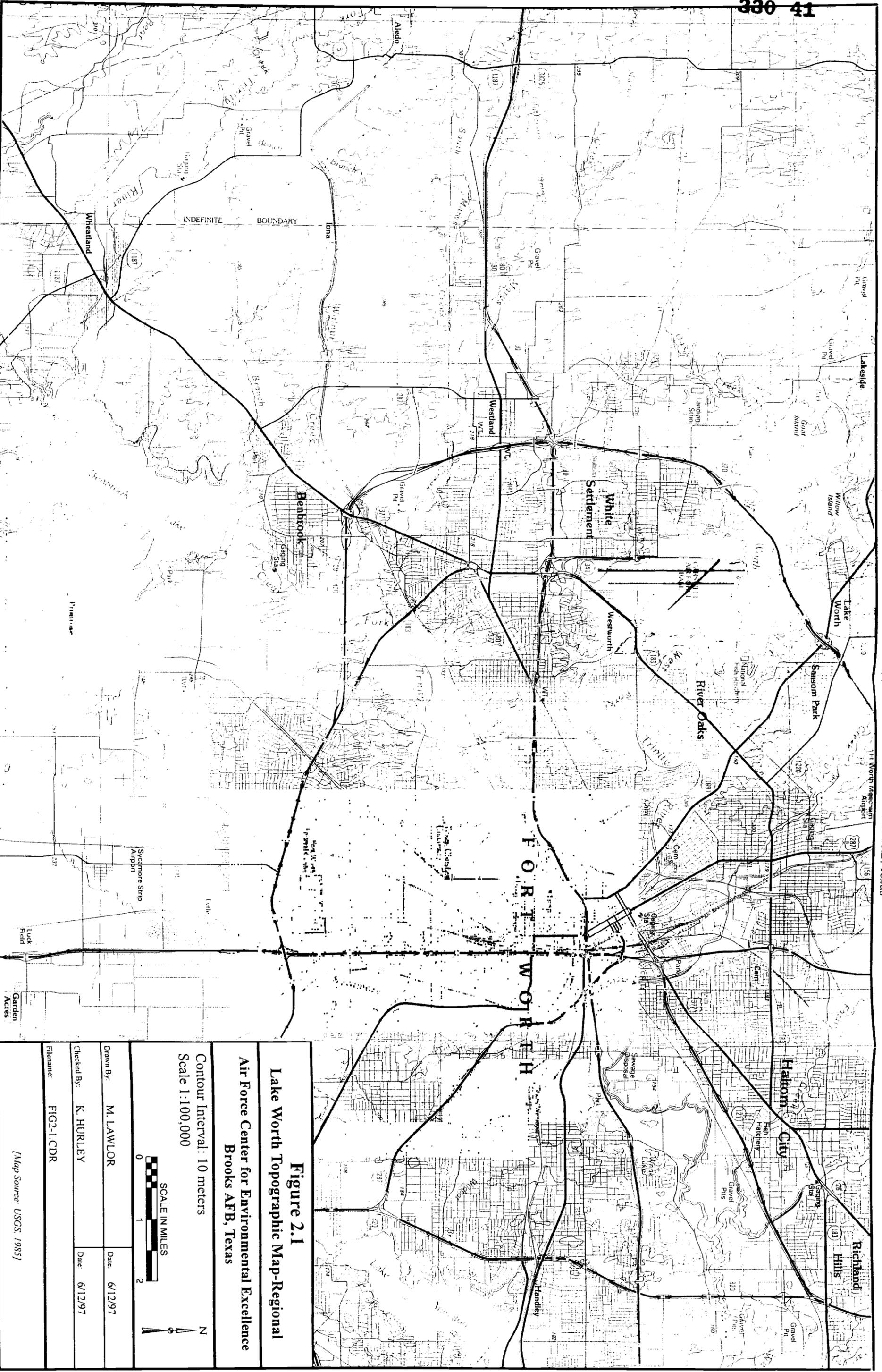


Figure 2.1

Lake Worth Topographic Map-Regional
Air Force Center for Environmental Excellence
Brooks AFB, Texas

Contour Interval: 10 meters
 Scale 1:100,000



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[Map Source: USGS, 1985]

Figure 2.2

Generalized Geologic
 Cross Section
 NAS Fort Worth JRB, Texas

Air Force Center
 For Environmental Excellence
 Brooks AFB, Texas

LEGEND

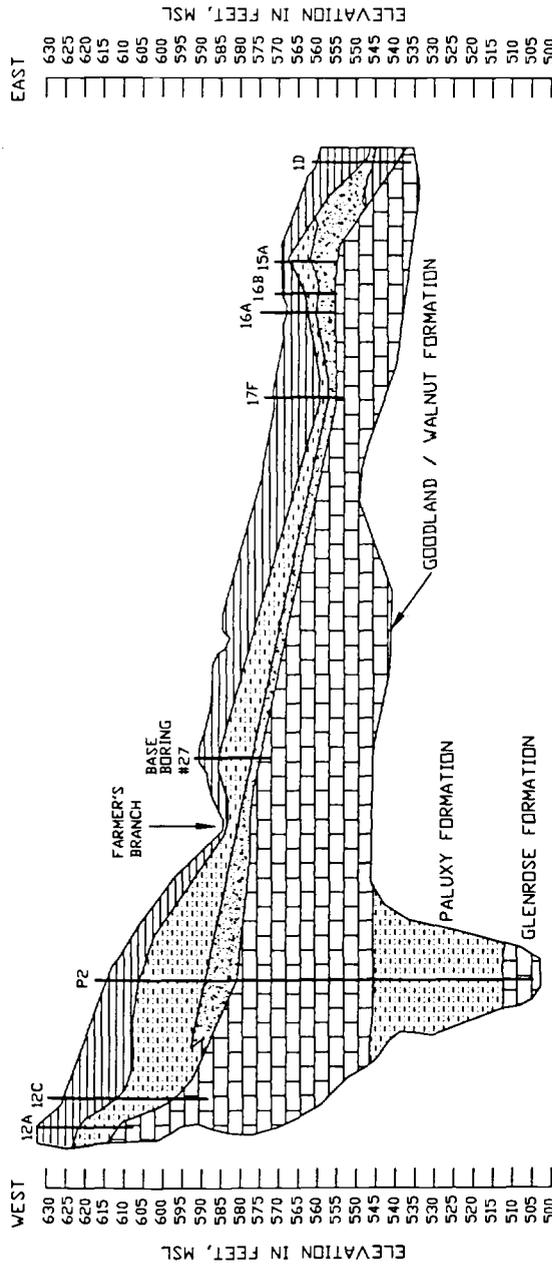
-  CLAY AND FILL MATERIAL
-  SAND
-  GRAVEL
-  LIMESTONE AND SHALE



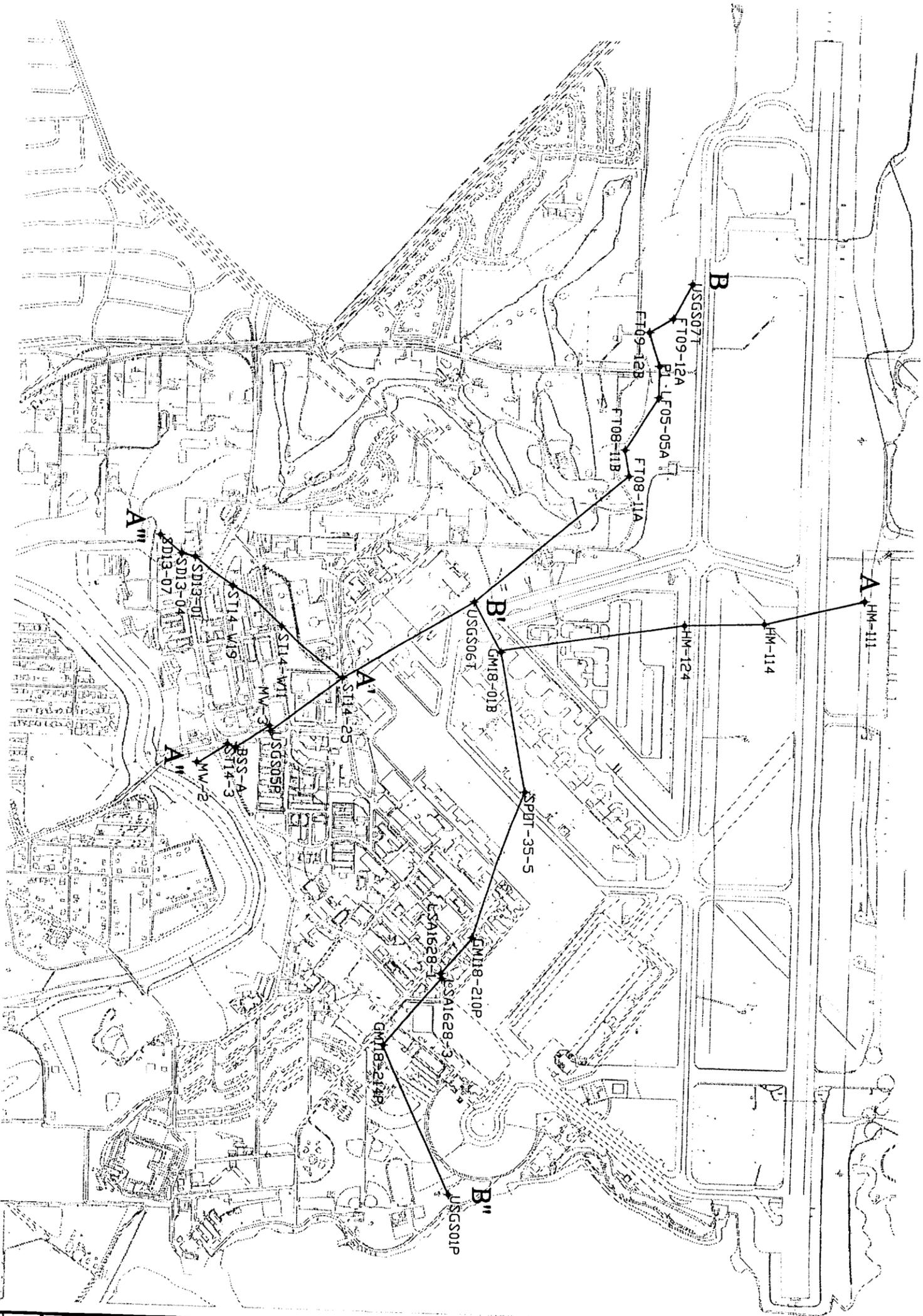
330 42

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Source: USACE, 1993



- NOTES**
1. STRATIGRAPHIC CONDITIONS ARE KNOWN ONLY AT THE MONITOR WELLS AND BORINGS; CONTACTS ARE INTERPOLATED BETWEEN CONTROL POINTS.
 2. HATCHURED ZONES ALONG MONITOR WELLS REPRESENT THE INTERVAL OF GRAVEL PACK AROUND EACH WELL SCREEN.



*HydroGeologic, Inc. — Draft Final RFI Work Plan
NAS Fort Worth JRB, Texas*

Figure 2.4

Cross Section Location Map

**Air Force Center
For Environmental Excellence
Brooks AFB, Texas**

LEGEND

- ★ USGS01P Boring Location
- A — A' Cross Section Line

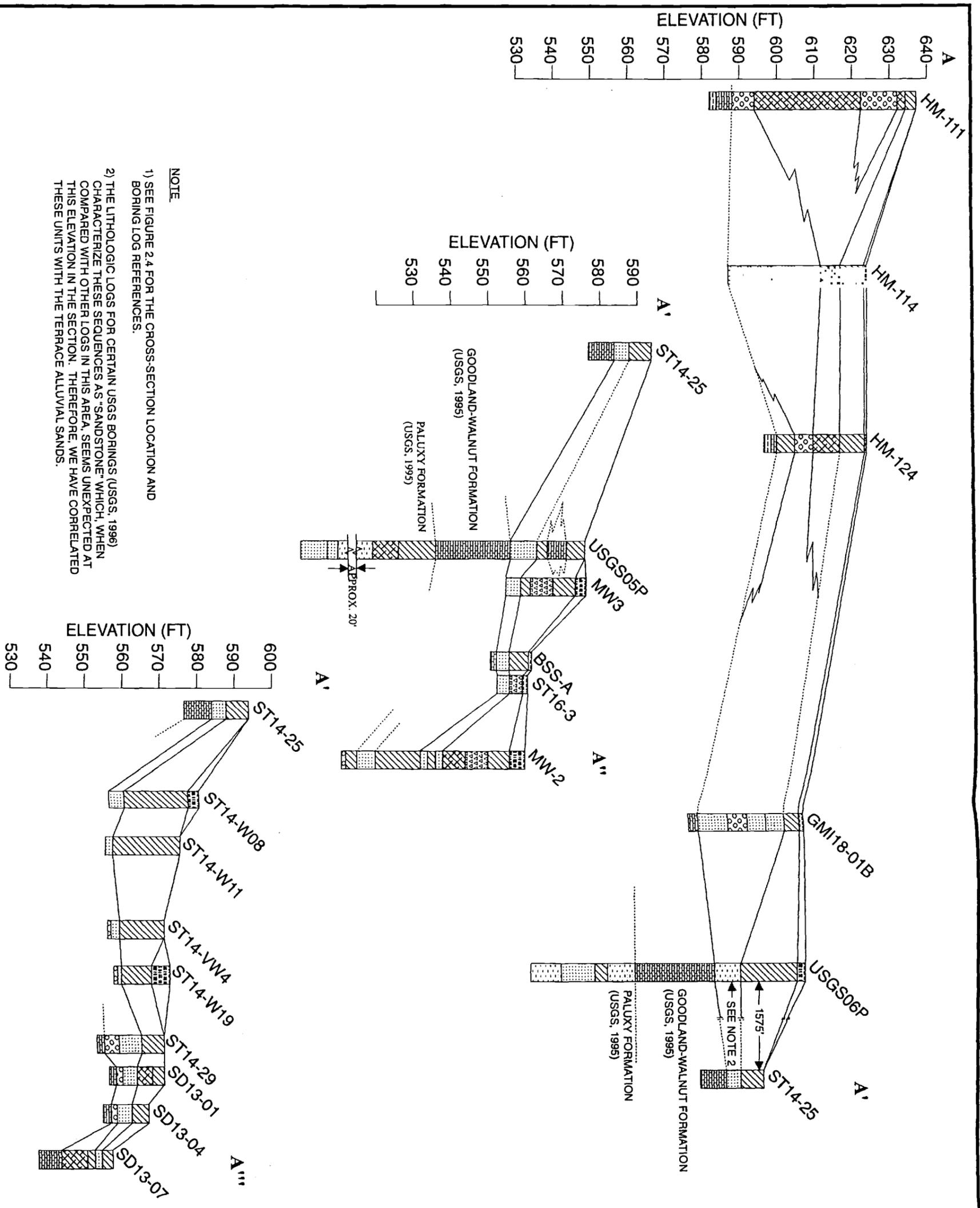


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Filename: FIG2-4.DWG

Map Source:
JACOBS, 1996



NOTE
 1) SEE FIGURE 2.4 FOR THE CROSS-SECTION LOCATION AND BORING LOG REFERENCES.
 2) THE LITHOLOGIC LOGS FOR CERTAIN USGS BORINGS (USGS, 1996) CHARACTERIZE THESE SEQUENCES AS "SANDSTONE" WHICH, WHEN COMPARED WITH OTHER LOGS IN THIS AREA, SEEMS UNEXPECTED AT THIS ELEVATION IN THE SECTION. THEREFORE, WE HAVE CORRELATED THESE UNITS WITH THE TERRACE ALLUVIAL SANDS.

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 NAS Fort Worth JRB, Texas

Figure 2.5

Cross Sections A-A', A'-A'', and A''-A'''

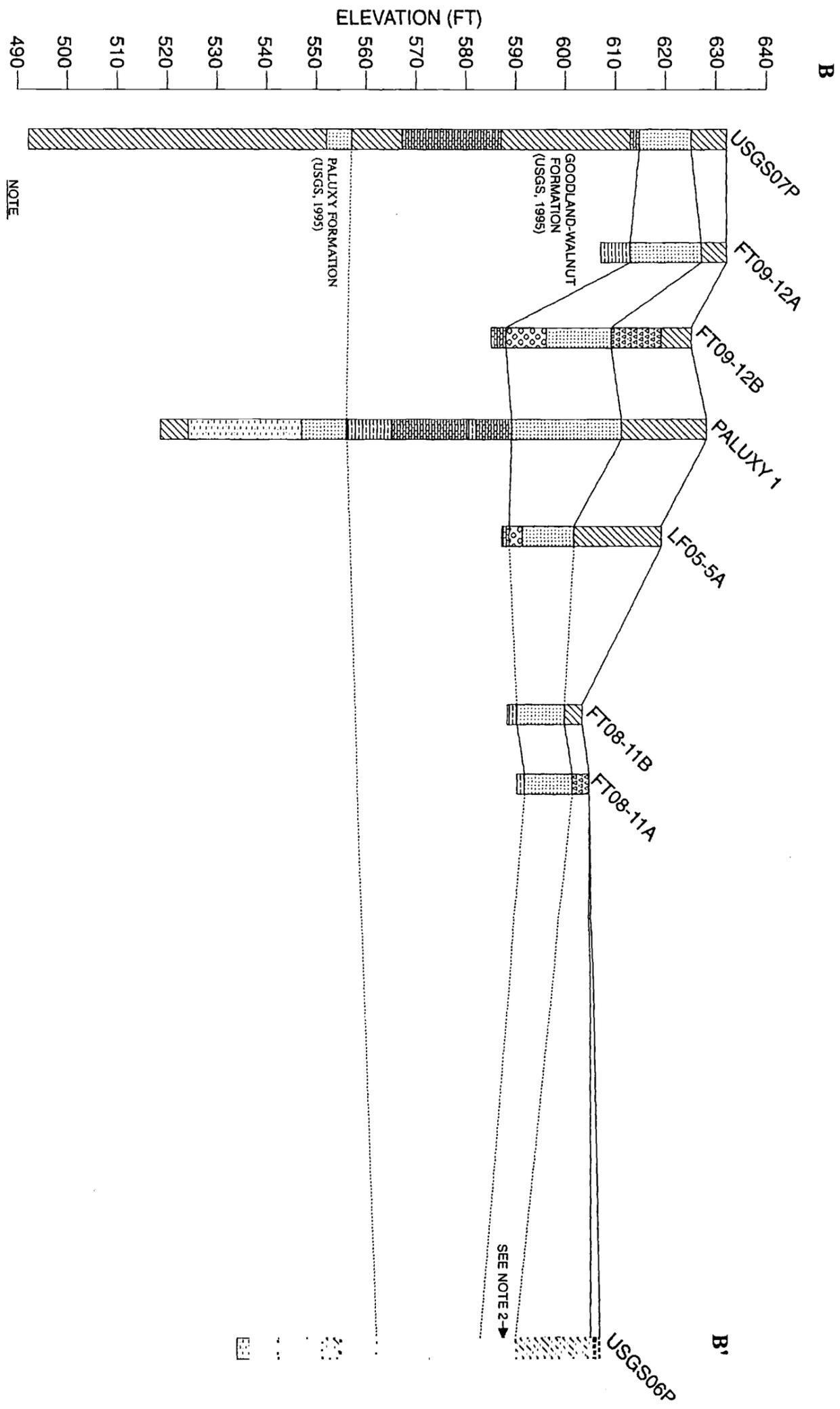
**Air Force Center
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 Brooks AFB, Texas**

Legend

- STRATIGRAPHIC CONTACT
- INFERRED STRATIGRAPHIC CONTACT
- FINE TO COARSE-GRAINED SAND, CLAYEY SAND, SILTY SAND, GRAVELLY SAND
- CLAY, SILTY CLAY, SANDY CLAY
- SILT, CLAYEY SILT, SANDY SILT
- GRAVELLY CLAY OR CLAY W/LIMESTONE FILL, SOIL, GRAVEL ROCK
- COARSE GRAVEL, SILTY GRAVEL, SANDY GRAVEL
- LIMESTONE
- CLAYSTONE/MUDSTONE/SHALE
- SANDSTONE

Horizontal Scale in Feet
 0 600 1200

Drawn By: M. LAWLOR	Date: 6/12/97
Checked By: K. HURLEY	Date: 6/12/97
Filename: X-SECT.CDR	
Source: CH2M HILL, 1996 b	



NOTE

1) SEE FIGURE 2.4 FOR THE CROSS-SECTION LOCATION AND BORING LOG REFERENCES.

2) THE LITHOLOGIC LOGS FOR CERTAIN USGS BORINGS (USGS, 1996) CHARACTERIZE THESE SEQUENCES AS 'SANDSTONE' WHICH, WHEN COMPARED WITH OTHER LOGS IN THIS AREA, SEEMS UNEXPECTED AT THIS ELEVATION IN THE SECTION. THEREFORE, WE HAVE CORRELATED THESE UNITS WITH THE TERRACE ALLUVIAL SANDS.

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Figure 2.6

Cross Sections B-B'

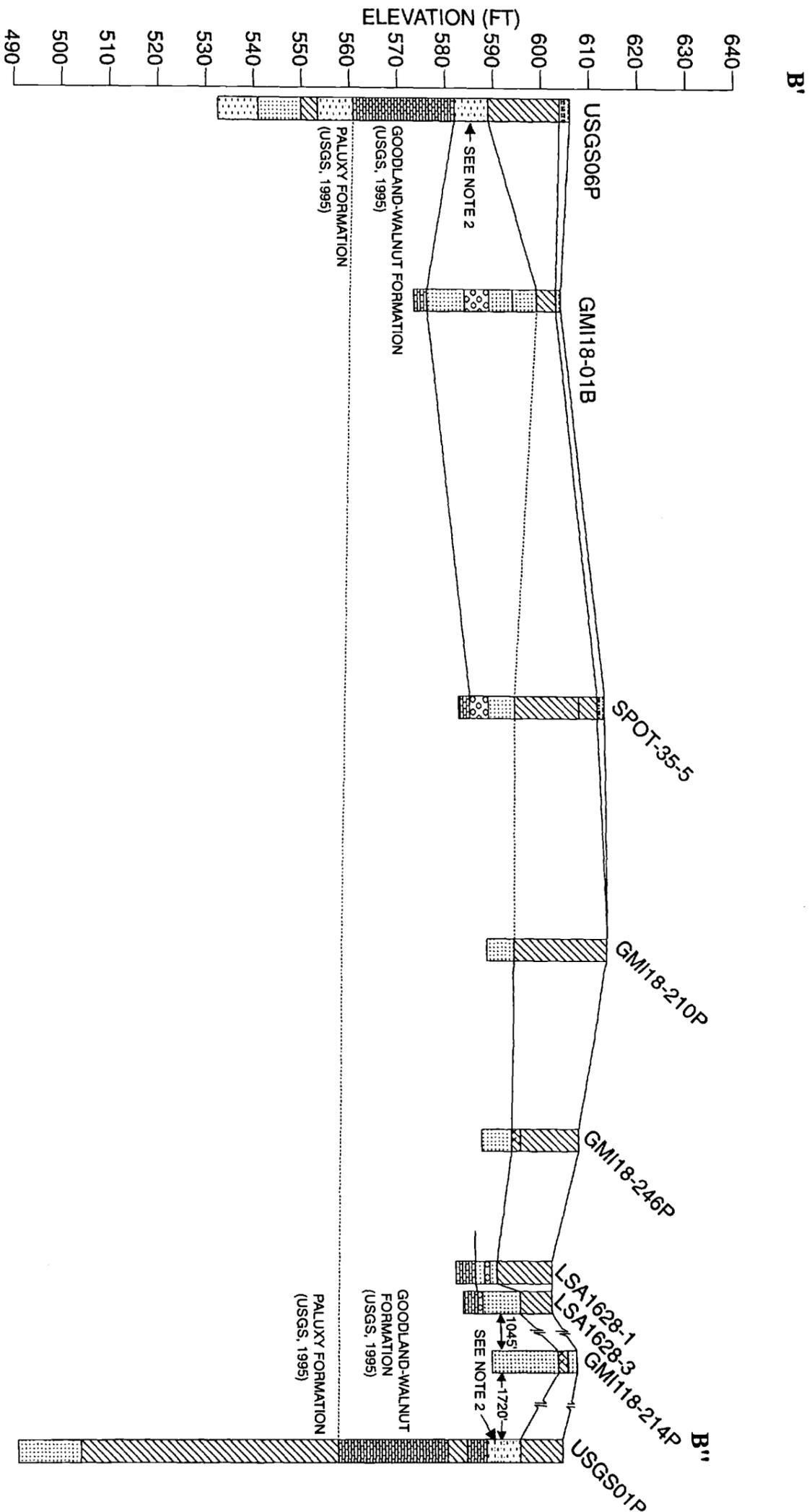
**Air Force Center
 For Environmental Excellence
 Brooks AFB, Texas**

- Legend**
- STRATIGRAPHIC CONTACT
 - INFERRED STRATIGRAPHIC CONTACT
 - FINE TO COARSE-GRAINED SAND, CLAYEY SAND, SILTY SAND, GRAVELLY SAND
 - CLAY, SILTY CLAY, SANDY CLAY
 - SILT, CLAYEY SILT, SANDY SILT
 - GRAVELLY CLAY OR CLAY W/LIMESTONE
 - FILL, SOIL, GRAVEL ROCK
 - COARSE GRAVEL, SILTY GRAVEL, SANDY GRAVEL
 - LIMESTONE
 - CLAYSTONE/MUDSTONE/SHALE
 - SANDSTONE



Drawn By:	M. LAWLOR	Date:	6/12/97
Checked By:	K. HURLEY	Date:	6/12/97
Filename:	X-SECT.CDR		

Source: CH2M HILL, 1996 b



NOTE

1) SEE FIGURE 2.4 FOR THE CROSS-SECTION LOCATION AND BORING LOG REFERENCES.

2) THE LITHOLOGIC LOGS FOR CERTAIN USGS BORINGS (USGS, 1996) CHARACTERIZE THESE SEQUENCES AS "SANDSTONE" WHICH, WHEN COMPARED WITH OTHER LOGS IN THIS AREA, SEEMS UNEXPECTED AT THIS ELEVATION IN THE SECTION. THEREFORE, WE HAVE CORRELATED THESE UNITS WITH THE TERRACE ALLUVIAL SANDS.

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 NAS Fort Worth, JRB, Texas

Figure 2.7

Cross Sections B'-B''

**Air Force Center
 For Environmental Excellence
 Brooks AFB, Texas**

- Legend**
- STRATIGRAPHIC CONTACT
 - - - INFERRED STRATIGRAPHIC CONTACT
 - PINE TO COARSE-GRAINED SAND, CLAYEY SAND, SILTY SAND, GRAVELLY SAND
 - ▨ CLAY, SILTY CLAY, SANDY CLAY
 - ▩ SILT, CLAYEY SILT, SANDY SILT
 - ▧ GRAVELLY CLAY OR CLAY W/LIMESTONE
 - ▦ FILL, SOIL, GRAVEL ROCK
 - ▥ COARSE GRAVEL, SILTY GRAVEL, SANDY GRAVEL
 - ▤ LIMESTONE
 - ▣ CLAYSTONE/MUDSTONE/SHALE
 - ▢ SANDSTONE



Drawn By: **M. LAWLOR** Date: **6/12/97**

Checked By: **K. HURLEY** Date: **6/12/97**

Filename: **X-SECT.CDR**

Source: **CH2M HILL, 1996 b**

2.1.3 Groundwater

330 48

The water-bearing geologic formations located in the NAS Fort Worth JRB area may be divided into the following five hydrogeologic units, listed from the shallowest to the deepest: 1) an upper perched-water zone occurring in the alluvial terrace deposits associated with the Trinity River; 2) an aquitard of predominantly dry limestone of the Goodland and Walnut Formations; 3) an aquifer in the Paluxy Sand; 4) an aquitard of relatively impermeable limestone in the Glen Rose Formation; and 5) a major aquifer in the sandstone of the Twin Mountains Formation. Each of these units is examined in more detail in the following paragraphs. This relationship is illustrated in Figure 2.8.

2.1.3.1 Alluvial Terrace Deposits

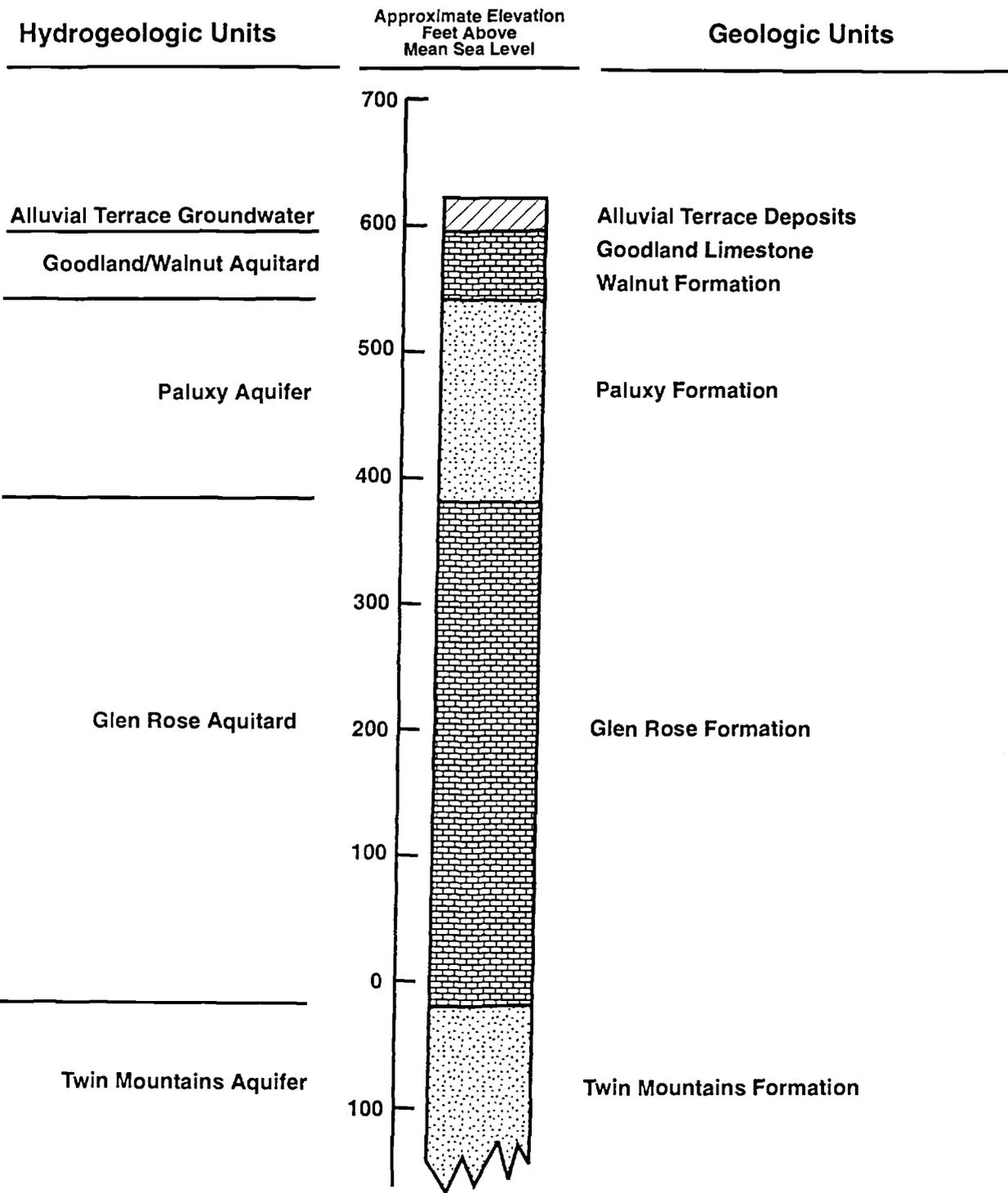
The uppermost groundwater in the area occurs within the pore space of the grains of coarse sand and gravels deposited by the Trinity River. In some parts of Tarrant County, primarily in those areas adjacent to the Trinity River, groundwater from the terrace deposits is used for irrigation and residential use. Groundwater from the terrace deposits is rarely used as a source of potable water due to its limited distribution and susceptibility to surface/stormwater pollution (CH2M HILL, 1984).

Recharge to the water-bearing deposits occurs through infiltration from precipitation and from surface water bodies. Extensive onsite pavement and construction restricts this recharge. Additional recharge, however, comes from leakage in water supply lines, sewer systems, storm drains, and cooling water systems. This leakage has been calculated to be in excess of approximately 115.5 million gallons for NAS Fort Worth JRB and AFP-4 in 1991 (GD Facility Management, 1992). This inflow of water to the shallow aquifer locally affects groundwater flow patterns and contamination transport, along with increasing hydraulic head, which acts as the force to potentially drive water into lower aquifer systems. The estimated hydraulic conductivity of the alluvial aquifer is 4.57 gpd/ft² (Radian, 1989)

This flow between aquifers is restricted by the Goodland/Walnut Formations and therefore the alluvial terrace groundwater is not hydraulically connected to the underlying aquifers at NAS Fort Worth JRB. The primary water flow in the terrace deposits is generally eastward toward the West Fork of the Trinity River, although localized variations exist across the entire site. The hydraulic gradient across the Base is variable, reflecting variations in the flow direction and localized recharge. Discharge from the aquifer occurs into surface water onsite, specifically Farmers Branch Creek.

Potentiometric maps of NAS Fort Worth JRB and AFP-4 alluvial terrace groundwater are presented in Figure 2.9 (Jacobs, 1996) and Figure 2.10 (CH2M HILL, 1997). The data is also presented in Tables 2.1 and 2.2. Both the January 1996 and January 1997 groundwater elevation data show an easterly trend in groundwater flow over the area of NAS Fort Worth JRB toward the West Fork of the Trinity River. This easterly trend varies slightly in the area of SWMU 17 where groundwater flow is towards the northeast into Farmers Branch Creek. The location of monitoring wells in the area of SWMU 17 are presented in Figure 2.11 and well construction specifications for wells which will be used in the investigation can be found in Table 2.3. Groundwater quality

330 49



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Filename: Fig2-8.cdr	

Legend

-  Alluvium
-  Limestone
-  Sandstone

Figure 2.8
Stratigraphic Column Correlating
Hydrogeologic Units and Geologic Units
at NAS Fort Worth JRB, Texas
[From Radian, 1989]



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 NAS Fort Worth JRB, Texas

Figure 2.9

NAS Fort Worth JRB/AFP-4
 Alluvial Terrace Groundwater
 Contour Map (June 1995)

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LEGEND

- Former Property Boundary of Carswell AFB
- - - Approximate NAS Fort Worth JRB Site Boundary
- . - . Property Boundary of AF Plant 4
- Groundwater Flow Direction
- ~ Water Level Contour
- 612.15 + Water Level Elevation feet (NVGD)
- SWMU Locations

Note:
 Water levels recorded by
 IT Corporation June 12-27, 1995
 Contour Interval = 5 feet

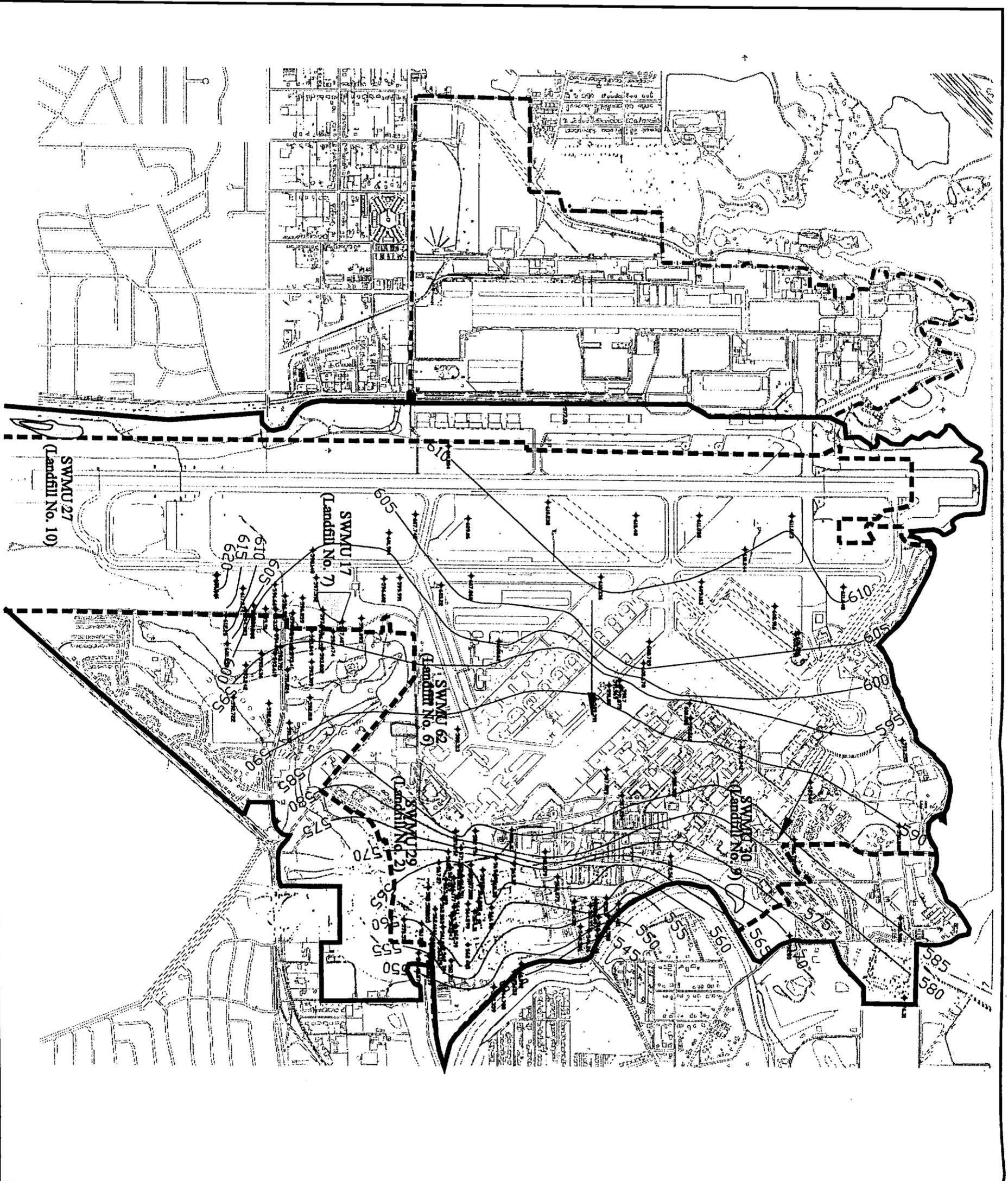


Drawn By: M. LAWLOR Date: 6/12/97

Checked By: K. HURLEY Date: 6/12/97

Filename: FIG2-9.DWG

Map Source:
 JACOBS, 1996



*HydroGeologic, Inc. — Draft Final RFI Work Plan
NAS Fort Worth JRB, Texas*

Figure 2.10

**NAS Fort Worth JRB
Alluvial Terrace Groundwater
Contour Map (January 1997)**

**Air Force Center
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Brooks AFB, Texas**

LEGEND

- Former Property Boundary of Carswell AFB
- - - - - Approximate NAS Fort Worth JRB Site Boundary
- — — — — Property Boundary of AF Plant 4

→ Groundwater Flow Direction

~ Water Level Contour

*** Water Level Elevation feet (NGVD)

○ SWMU Locations

Note:
Water levels recorded by
CH2M Hill January, 1997
Contour Interval = 5 feet



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Checked By: **K. HURLEY** Date: **6/12/97**

Filename: **FIG2-10.DWG**

Map Source: **JACOBS, 1996**

Table 2.1
Groundwater Elevation Summary - June 1995
NAS Fort Worth JRB, Texas

330 5

Well ID	Ground Surface Elevation ¹ (NGVD) ²	Top of Inner Casing Elevation (NGVD)	Depth to Water ³ (feet)	Groundwater Elevation (NGVD)
LF01-1A	566.62	570.27	17.43	552.84
LF01-1C	560.46	560.00	20.24	539.76
LF01-1D	560.46	563.93	21.46	542.47
LF01-1E	559.40	562.25	19.63	542.62
FT08-11A	604.8	608.22	13.05	595.07
FT08-11B	603.8	608.14	10.51	597.63
FT09-12A	632	635.66	18.64	617.02
FT09-12B	625.6	627.55	31.43	596.12
FT09-12C	625.5	628.05	32.45	595.70
LF04-04	609.4	612.07	19.22	592.85
LF04-10	626.9	626.54	33.42	593.12
LF04-4A	624.6	625.76	15.34	610.42
LF04-4B	618.4	619.9	21.82	598.08
LF04-4D	613.1	615.35	20.98	594.37
LF04-4E	617.5	618.54	24.25	594.29
LF04-4F	622.8	625.36	29.98	595.38
LF05-02	620	622.69	26.32	596.37
LF05-18	612.1	611.84	19.36	592.48
LF05-5C	606.8	608.68	11.85	596.83
LF05-5D	608.5	611.71	13.81	597.90
LF05-5G	612	615.39	21.38	594.01
WP07-10B	621.1	624.46	25.12	595.98
WP07-10C	615.4	617.24	19.24	596.16
SD13-01	570.30	573.24	13.07	560.17
SD13-02	570.64	573.39	15.22	558.17
SD13-03	568.60	571.54	11.96	559.58

Table 2.1 (continued)
Groundwater Elevation Summary - June 1995
NAS Fort Worth JRB, Texas

330 53

Well ID	Ground Surface Elevation¹ (NGVD)²	Top of Inner Casing Elevation (NGVD)	Depth to Water³ (feet)	Groundwater Elevation (NGVD)
SD13-05	NA	571.40	9.75	561.65
SD13-06	NA	557.66	10.78	546.88
SD13-07	NA	556.30	17.60	538.70
ST14-01	573.20	575.89	14.36	561.53
ST14-02	572.70	575.64	12.73	562.91
ST14-03	574.83	576.60	10.87	565.73
ST14-04	572.90	575.74	13.19	562.55
ST14-W05	NA	593.75	9.05	584.70
ST14-W06	NA	581.33	13.55	567.78
ST14-W07	NA	579.98	13.64	566.34
ST14-W08	NA	580.43	11.99	568.44
ST14-W09	NA	575.51	9.94	565.57
ST14-W11	NA	576.21	8.88	567.33
ST14-W13	NA	574.35	9.63	564.72
ST14-W15	NA	573.35	10.98	562.37
ST14-W16	NA	573.46	9.03	564.43
ST14-W19	NA	573.11	10.33	562.78
ST14-W20	NA	573.44	9.63	563.81
ST14-W21	NA	572.76	10.86	561.90
ST14-W22	NA	571.16	10.76	560.04
ST14-W23	NA	564.97	6.65	558.32
OT15C	NA	567.87	8.81	559.06
P3A	NA	604.77	11.94	592.83
P6A	NA	632.45	12.57	619.88
T3	NA	575.11	4.36	570.75
T4A	NA	606.49	18.63	587.86

Table 2.1 (continued)
Groundwater Elevation Summary - June 1995
NAS Fort Worth JRB, Texas

330 54

Well ID	Ground Surface Elevation ¹ (NGVD) ²	Top of Inner Casing Elevation (NGVD)	Depth to Water ³ (feet)	Groundwater Elevation (NGVD)
T7	NA	604.88	18.35	586.53
MW-5	NA	563.90	5.05	558.85
MW-7	NA	567.88	8.67	559.21
MW-8	NA	556.91	9.02	547.89
MW-9	NA	560.30	12.02	548.28
MW-10	NA	559.53	15.08	544.45
MW-11	NA	558.90	26.68	532.22
MW-12	NA	560.38	11.40	548.98
LSA1628-1	NA	601.67	10.36	591.31
LSA1628-2	NA	601.93	10.72	591.21
LSA1628-3	NA	601.71	10.25	591.46
BSSA	566.90	566.38	5.29	561.09
BSSB	567.10	569.73	9.93	559.80
GMI22-02M	NA	619.19	9.44	609.75
GMI22-03M	NA	607.99	20.77	587.22
GMI22-04M	NA	610.71	19.84	590.87
GMI22-05M	NA	584.36	11.94	572.42
GMI22-06M	NA	606.77	18.60	588.17
GMI22-07M	NA	605.63	16.00	589.63
GMI22-08M	NA	606.92	16.90	590.02

Notes:

¹Source: IRP Stage 2 RI Final Report (Radian, 1991)²NGVD - Feet above National Geodetic Vertical Datum.³Depth to Water 4th Quarter Water Level Survey conducted in January, 1996 in the three days prior to the start of Quarterly Groundwater Sampling (LAW, 1996).

Table 2.2
Groundwater Elevation Summary - January 1997
NAS Fort Worth JRB, Texas

Well ID	Top of Casing (NGVD)	Depth to Water ³ (feet)	Total Depth of Well (feet)	Groundwater Elevation (NGVD)
15B	567.59	8.45	12.47	559.14
17I	578.13	11.11	19.82	567.02
17J	579.94	11.62	21.33	568.32
17K	575.47	10.11	18.61	565.36
17L	577.32	10.81	20.94	566.51
17M	N/A	9.94	16.13	N/A
BSS-A	566.49	5.06	10.25	561.43
BSS-B	569.41	9.76	12.84	559.65
FT08-11A	608.15	12.06	17.68	596.09
FT08-11B	608.05	10.64	17.03	597.41
FT09-12A	635.38	18.01	27.8	617.37
FT09-12B	627.36	32.07	37.75	595.29
FT09-12C	627.86	32.94	39.7	594.92
FT09-12D	627.26	31.75	37.02	595.51
FT09-12E	627.34	32.35	38.67	594.99
GMI-04-01M	613.79	0	20.61	613.79
GMI-22-02M	619.13	10.34	27.86	608.79
GMI-22-03M	608.03	20.74	35.3	587.29
GMI-22-04M	610.70	20.04	25.62	590.66
GMI-22-05M	584.28	11.72	13.82	572.56
GMI-22-06M	606.84	18.52	26.63	588.32
GMI-22-07M	605.66	15.97	23.34	589.69
GMI-22-08M	606.94	16.36	25.11	590.58
HM-111	636.49	26.29	47.55	610.20
HM-114	627.95	18.89	35.67	609.06
HM-116	634.06	23.58	31.55	610.48
HM-117	633.32	22.28	39.24	611.04
HM-118	626.23	15.99	26.34	610.24
HM-119	625.04	14.02	28.86	611.02
HM-120	616.84	5.19	17.57	611.65
HM-121	627.66	18.5	30.38	609.16
HM-122	619.44	19.45	27.8	599.99
HM-123	624.85	27.46	38.47	597.39
HM-124	623.26	15.39	24.41	607.87

Table 2.2 (continued)
Groundwater Elevation Summary - January 1997
NAS Fort Worth JRB, Texas

330 56

Well ID	Top of Casing (NGVD)	Depth to Water ³ (feet)	Total Depth of Well (feet)	Groundwater Elevation (NGVD)
HM-125	629.37	19.03	33.08	610.34
HM-126	622.99	15.24	38.78	607.75
HM-127	624.04	25.89	37.76	598.15
ITMW-01T	N/A	12.98	21.7	N/A
LF01-1B	560.18	13.59	19.76	546.59
LF01-1C	562.15	17.36	32.59	544.79
LF01-1D	563.91	18.55	27.91	545.36
LF01-1E	562.11	16.96	32.16	545.15
LF04-01	629.16	32.5	41.33	596.66
LF04-02	623.44	29.72	38.52	593.72
LF04-04	611.95	19.54	19.91	592.41
LF04-10	626.47	33.75	47.44	592.72
LF04-4A	625.84	13.59	24.97	612.25
LF04-4B	619.95	19.6	25.34	600.35
LF04-4C	612.96	19.72	27.84	593.24
LF04-4D	615.13	21.49	27.84	593.64
LF04-4E	618.49	24.87	30.68	593.62
LF04-4F	625.28	30.59	36.57	594.69
LF04-4G	619.75	27.93	33.04	591.82
LF04-4H	613.35	0	18.87	613.35
LF05-01	621.88	19.98	27.56	601.90
LF05-02	622.61	26.01	29.98	596.60
LF05-14	611.79	0	10.06	611.79
LF05-18	611.71	19.69	23.62	592.02
LF05-19	606.05	14.68	19.43	591.37
LF05-5A	623.00	26.14	30.32	596.86
LF05-5B	597.17	4.7	12.54	592.47
LF05-5C	608.56	12.41	21.27	596.15
LF05-5D	611.40	14.15	21.05	597.25
LF05-5E	626.70	30.11	35.55	596.59
LF05-5F	618.86	25.45	35.84	593.41
LF05-5G	615.28	21.97	30.29	593.31
LF05-5H	610.61	16.81	16.82	593.80
LSA1628-3	601.73	10.49	17.92	591.24

Table 2.2 (continued)
Groundwater Elevation Summary - January 1997
NAS Fort Worth JRB, Texas

Well ID	Top of Casing (NGVD)	Depth to Water ³ (feet)	Total Depth of Well (feet)	Groundwater Elevation (NGVD)
MW-1	560.64	11.91	42.93	548.73
MW-10	558.85	13.7	32.98	545.15
MW-11	558.17	26.18	32.43	531.99
MW-11A	612.17	22.78	26.12	589.39
MW-12	559.62	9.2	27.44	550.42
MW-12A	559.61	16.43	16.43	543.18
MW-19	621.19	17.97	19.68	603.22
MW-1A	582.42	6.11	18.4	576.31
MW-2	557.55	11.29	47.9	546.26
MW-20	611.38	19.45	19.72	591.93
MW-3	576.48	11.6	19.88	564.88
MW-37	590.53	8.95	19.8	581.58
MW-38	604.11	16.18	18.6	587.93
MW-48	619.33	10.41	13.82	608.92
MW-5	563.69	3.24	8.13	560.45
MW-53	616.75	16.13	19.66	600.62
MW-56	614.32	8.03	19.44	606.29
MW-57	613.37	13.28	14.35	600.09
MW-57B	613.78	7.69	19.58	606.09
MW-6	562.87	2.32	10	560.55
MW-7	567.37	8.47	16.68	558.90
MW-8	557.04	7.45	26.93	549.59
MW-9	559.54	9.98	27.95	549.56
MW-IT-02T	612.13	34.62	57.73	577.51
MW1-16	573.86	9.76	15.4	564.10
OT-15C	564.25	8.44	15.54	555.81
PI-U9	567.81	0	0	567.81
SD13-01	573.09	12.26	17.47	560.83
SD13-02	573.28	13.16	16.47	560.12
SD13-03	571.41	11.17	16.64	560.24
SD13-04	569.08	9.66	14.41	559.42
SD13-05	571.54	9.13	13.77	562.41
SD13-06	557.68	10.21	13.86	547.47
SD13-07	560.44	17.86	21.49	542.58

Table 2.2 (continued)
Groundwater Elevation Summary - January 1997
NAS Fort Worth JRB, Texas

330 58

Well ID	Top of Casing (NGVD)	Depth to Water ³ (feet)	Total Depth of Well (feet)	Groundwater Elevation (NGVD)
SPOT35-1	613.59	22.89	36.62	590.70
SPOT35-2	613.64	21.76	26.36	591.88
SPOT35-4	612.74	20.77	24.5	591.97
SPOT35-5	614.09	22.21	27.55	591.88
SPOT35-7	616.41	7.73	20.42	608.68
ST14-01	575.95	13.89	18.4	562.06
ST14-02	575.51	12.15	19.45	563.36
ST14-03	576.68	9.78	19.88	566.90
ST14-04	575.61	12.56	18.08	563.05
ST14-14	575.64	7.29	20.72	568.35
ST14-24	594.14	11.18	17.04	582.96
ST14-25	592.93	6.1	16.89	586.83
ST14-26	581.09	11.72	27.46	569.37
ST14-27	573.85	8.93	15.92	564.92
ST14-28	574.44	11.85	17.13	562.59
ST14-29	571.45	9.6	15.78	561.85
ST14-30	566.87	5.62	14.06	561.25
ST14-W05	593.63	8.54	16.38	585.09
ST14-W06	581.42	9.66	22.7	571.76
ST14-W07	579.96	11.85	24.75	568.11
ST14-W08	580.54	10.84	25.21	569.70
ST14-W09	575.54	8.47	20.24	567.07
ST14-W10	573.99	6.48	19.6	567.51
ST14-W11	576.31	7.29	19.57	569.02
ST14-W12	575.52	5.74	17.75	569.78
ST14-W13	574.49	8.31	17.04	566.18
ST14-W15	573.47	10.49	18.85	562.98
ST14-W16	573.62	8.41	18.69	565.21
ST14-W18	573.79	9.19	17.58	564.60
ST14-W19	573.31	9.65	16.72	563.66
ST14-W20	573.48	9.17	15.98	564.31
ST14-W21	572.88	10.27	17.89	562.61
ST14-W22	571.30	9.99	11.08	561.31
ST14-W23	565.60	6.05	10.08	559.55

Table 2.2 (continued)
Groundwater Elevation Summary - January 1997
NAS Fort Worth JRB, Texas

330 59

Well ID	Top of Casing (NGVD)	Depth to Water ³ (feet)	Total Depth of Well (feet)	Groundwater Elevation (NGVD)
ST14-W31	571.23	10.53	13.81	560.70
ST14-W32	N/A	4.43	12.26	N/A
USGS01P	604.83	31.23	111.91	573.60
USGS01T	604.79	11.53	20.05	593.26
USGS02T	604.21	18.3	30.24	585.91
USGS03T	575.02	3.73	8.51	571.29
USGS04T	604.92	18.14	19.39	586.78
USGS05P	576.77	39.52	92.48	537.25
USGS06P	606.71	58.52	74.8	548.19
USGS06T	606.67	18.36	21.87	588.31
USGS07P	632.10	87.14	140.04	544.96
USGS07T	632.43	11.78	15.28	620.65
W-153	631.57	21.33	39.19	610.24
WP07-10A	626.50	30.28	37.81	596.22
WP07-10B	624.22	29.54	34.54	594.68
WP07-10C	617.18	21.33	29.65	595.85

Notes:

0 - Indicates a dry well.

NGVD - Feet above National Geodetic Vertical Datum.

N/A - Not available

Source: January 1997 Quarterly Monitoring (CH2M HILL, 1997)

Figure 2.11

Well Locations in Vicinity of SWMU 17

Air Force Center
 For Environmental Excellence
 Brooks AFB, Texas

LEGEND

- ROAD
- STREAM
- FENCE
- MONITORING WELL
- RECOVERY WELL LOCATION
- SWMU TO BE INVESTIGATED
- SWMU NOT IN CURRENT RFI/CMS



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Map Source:
 IT CORP., 1993

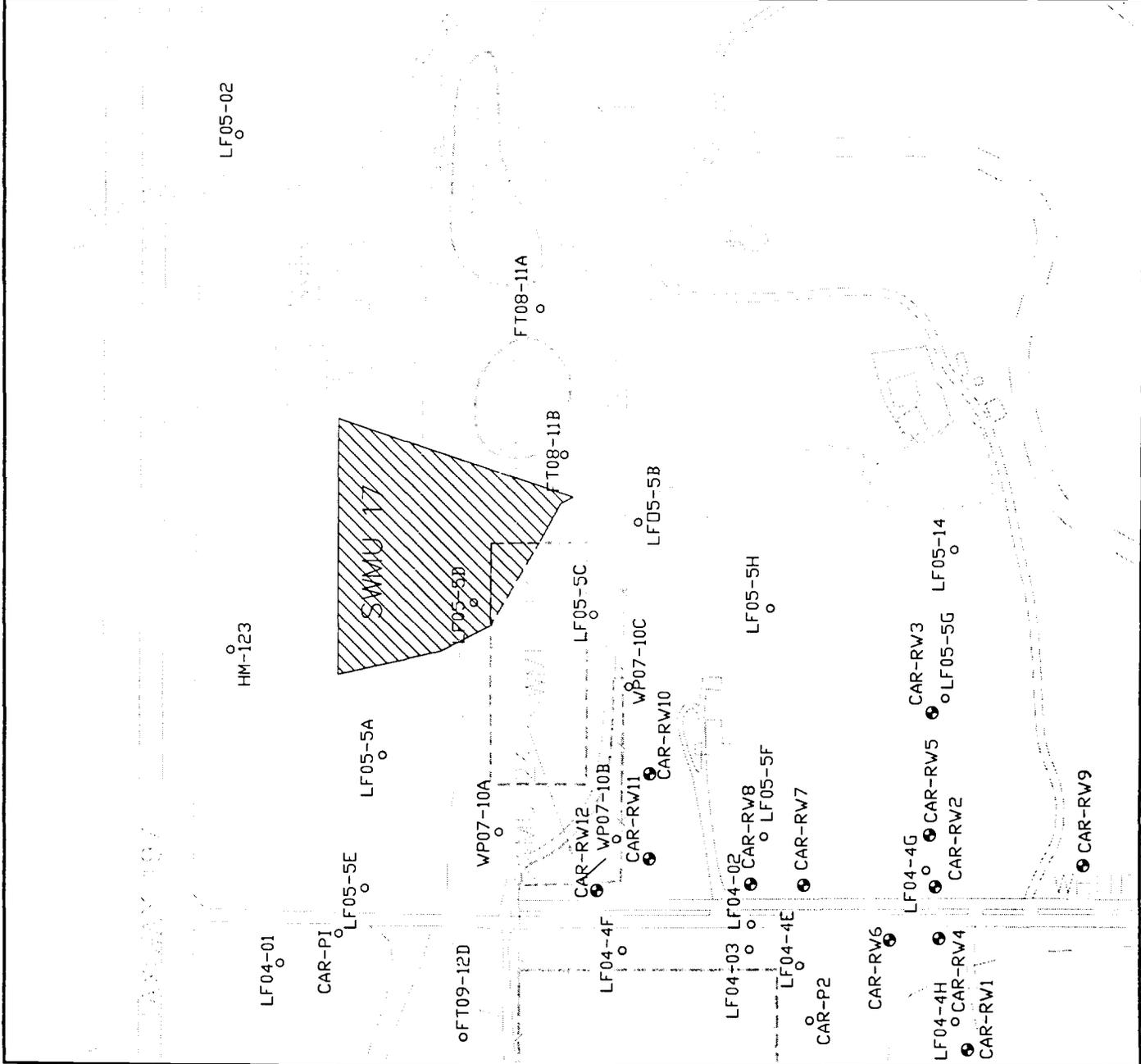


Table 2.3
Monitoring Well Construction Specifications—SWMU 17 Area
NAS Fort Worth JRB, Texas

Well ID	Borehole Depth (feet)	Screen Length (feet)	Screen Diameter (feet)	Depth to Screen (feet)	Depth to Sand Pack (feet)	Sand Pack Thickness (feet)	Depth to Seal (feet)	Seal Thickness (feet)
LF05-5A	32	10	2	18	16.5	15.5	14.5	2
LF05-5D	24	9	2	10.5	8	16	6	2
HM-123	NA	NA	NA	NA	NA	NA	NA	NA

NA = Not Available.

of the alluvial terrace is summarized in the tables and figures that comprise Appendix ~~330 T62~~ A.1 of Appendix A presents the results of the quarterly groundwater sampling conducted in January 1996. The analytical results from this sampling event are compared to draft background values (Jacobs, 1997) and TNRCC RRS2 MSCs. A summary of the January and April, 1997 quarterly groundwater analytical results are not currently available.

2.1.3.2 Goodland/Walnut Aquitard

The groundwater within the terrace deposits is isolated from groundwater within the lower aquifers by the low permeability rocks of the Goodland Limestone and Walnut Formation. The primary inhibitors to vertical groundwater movement within these units are the fine-grained clay and shale layers that are interbedded with layers of limestone. Some groundwater movement does occur between the individual bedding planes of both of these units, but the vertical hydraulic conductivity has been calculated to range between $1.2\text{E-}09$ cm/sec to $7.3\text{E-}11$ cm/sec for the NAS Fort Worth JRB and AFP-4 area. This corresponds to a vertical flow rate that ranges between $1.16\text{E-}03$ ft/d to $5.22\text{E-}03$ ft/d (ESE, 1994). At the AFP-4 “window area,” the Goodland/Walnut Aquitard is breached and the alluvial terrace groundwater is in direct communication with the groundwater in the Paluxy Aquifer. A significant number of wells and borings have been advanced on NAS Fort Worth JRB, and there is no evidence that a similar window exists on the Base property. Additionally, no evidence of contamination of the Paluxy aquifer has been found at NAS Fort Worth JRB.

2.1.3.3 Paluxy Aquifer

The Paluxy aquifer is an important source of potable groundwater for the Fort Worth area. Many of the surrounding communities, particularly White Settlement, develop their municipal water supplies from the Paluxy aquifer. Groundwater from the Paluxy is also used in some of the surrounding farms and ranches for agricultural purposes. Due to the extensive use of the Paluxy aquifer, water levels have declined significantly over the years. Water levels in the NAS Fort Worth JRB vicinity have not decreased as much as in the Fort Worth area due to its proximity to the Lake Worth recharge area and the fact that the Base does not develop water from the Paluxy aquifer. Drinking water at the Base is supplied by the City of Fort Worth which uses Lake Worth as its water source. The groundwater of the Paluxy aquifer is contained within the openings created by gaps between bedding planes, cracks, and fissures in the sandstones of the Paluxy Formation. Just as the Paluxy Formation is divided into upper and lower sand members, the aquifer is likewise divided into upper and lower aquifers. The upper sand is finer grained and contains a higher percentage of shale than the lower sand. Radian (1989) estimated the hydraulic conductivity and transmissivity to be 130 to 140 gpd/ft² and 1263 to 13808 gpd/ft, respectively.

2.1.3.4 Glen Rose Aquitard

Below the Paluxy aquifer are the fine grained limestone, shale, marl, and sandstone beds of the Glen Rose Formation. The thickness of the formation ranges from 250 to 450 feet. Although the sands in the Glen Rose Formation yield small quantities of groundwater in the area, the relatively impermeable limestone acts as an aquitard restricting water movement between the Paluxy aquifer above and the Twin Mountains aquifer below.

2.1.3.5 Twin Mountains Aquifer

330 63

The Twin Mountains Formation is the oldest and deepest water supply source used in the NAS Fort Worth JRB area. The Twin Mountains Formation occurs approximately 600 feet below NAS Fort Worth JRB with a thickness of between 250 to 430 feet. Recharge to the Twin Mountains aquifer occurs west of NAS Fort Worth JRB where the formation crops out. Groundwater movement is eastward in the downdip direction. Like the groundwater in the Paluxy aquifer, the Twin Mountains groundwater occurs under unconfined conditions in the recharge area and becomes confined as it moves downdip. Transmissivities in the Twin Mountain aquifer range from 1,950 to 29,700 gpd/ft and average 8,450 gpd/ft in Tarrant County. Permeabilities range from 8 to 165 gpd/ft² and average 68 gpd/ft² in Tarrant County (CH2M HILL, 1984).

2.1.3.6 Water Well Survey Results

An inventory of water supply wells within a one mile radius of the NAS Fort Worth JRB Boundary was conducted (Radian, 1989). Figure 2.12 illustrates the locations of thirty-nine existing and abandoned wells, which were identified from Texas Water Commission records. All of these wells were installed and completed in the Paluxy Aquifer or the Twin Mountains Aquifer. Water to the Base is supplied by the City of Fort Worth which receives their water from Lake Worth.

2.1.4 Surface Water

NAS Fort Worth JRB is located within the Trinity River Basin, adjacent to Lake Worth. The lake is a man-made reservoir, created by damming the Trinity River at a point just northeast of the Base. The surface area of the lake is approximately 2,500 acres. Lake Worth receives a limited amount of stormwater runoff from NAS Fort Worth JRB during and immediately after rainfall events. Runoff from SWMUs currently under investigation do not discharge to Lake Worth. Elevation of the water surface is fairly consistent at approximately 594 feet above NGVD, the fixed elevation of the dam spillway. Part of the eastern boundary of NAS Fort Worth JRB is defined by the West Fork of the Trinity River, a major river in north central Texas. River flow is towards the southeast into the Gulf of Mexico. Because the Trinity River has been dammed, the 100- and 500-year flood plains do not extend more than 400 feet from the center of the river or any of the tributaries.

NAS Fort Worth JRB currently has three stormwater discharge points that are subject to the National Pollution Discharge Elimination System (NPDES) from the Environmental Protection Agency (EPA). Each discharge point is monitored weekly for chemical oxygen demand, oil and grease, and pH. On numerous occasions, the permit has been violated. In 1979, these violations prompted the EPA to formally demand a corrective action (CH2M HILL, 1984). Several additional sampling points were established to determine the flow of pollutants onto and off the Base. Samples were collected for a variety of parameters (spills, fish kills, odors, and oil sheen) as circumstances dictate (Radian, 1989). Findings have included TCE, DCE, bromodichloromethane, and chloroform.

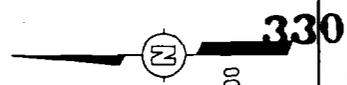
Figure 2.12

Location of Water Wells
 Within 1 Mile of
 NAS Fort Worth JRB, Texas

Air Force Center
 For Environmental Excellence
 Brooks AFB, Texas

LEGEND

- Former Property Boundary of Carswell AFB
- - - Property Boundary of AF Plant 4
- Water Wells Currently in Use
- ⊕ Water Wells Plugged, Abandoned, or Not Used



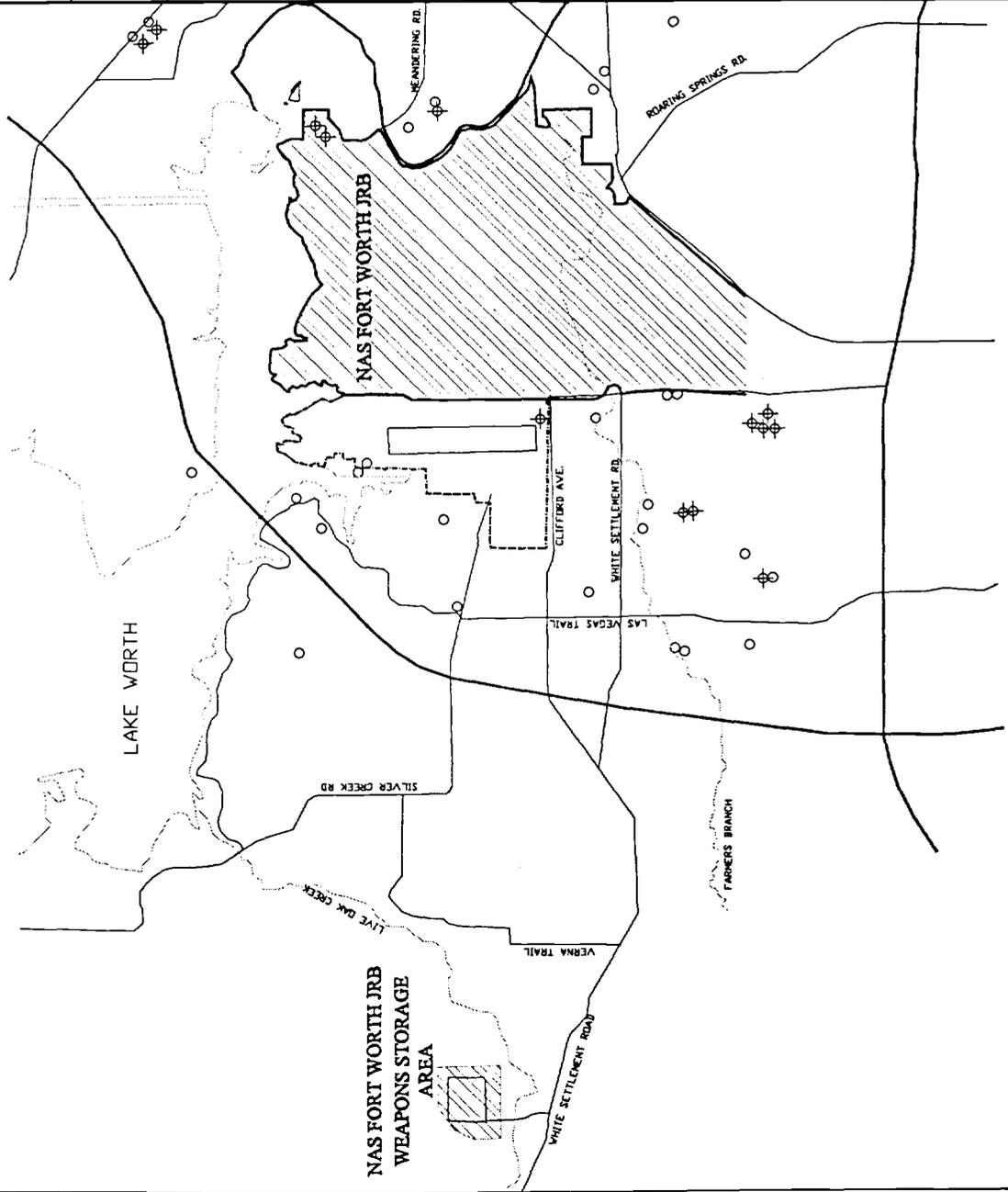
330 64

Drawn By: M. LAWLOR Date: 6/12/97

Checked By: K. HURLEY Date: 6/12/97

Filename: FIG2-12.DWG

Map Source:
 Radars, 1989



Surface drainage is mainly east towards the West Fork of the Trinity River. The Base is partly drained by Farmers Branch Creek, a tributary into the West Fork of the Trinity River. Farmers Branch Creek begins within the community of White Settlement and flows eastward. Just south of AFP-4, Farmers Branch flows under the runway within two large culverts identified as an aqueduct. Two unnamed tributaries flow across the Flightline area and discharge into Farmers Branch Creek. One flows along the south and east side of SWMU 22 and joins Farmers Branch Creek. The other runs along the west and north sides of SWMU 23 and east of SWMU 17, connects with two small ponds on the golf course before joining Farmers Branch Creek. Most of the Base drainage is intercepted by a series of storm drains and culverts, directed to oil/water separators, and discharged to the West Fork of the Trinity River downstream of Lake Worth. A small portion of the north end of the Base drains directly into Lake Worth.

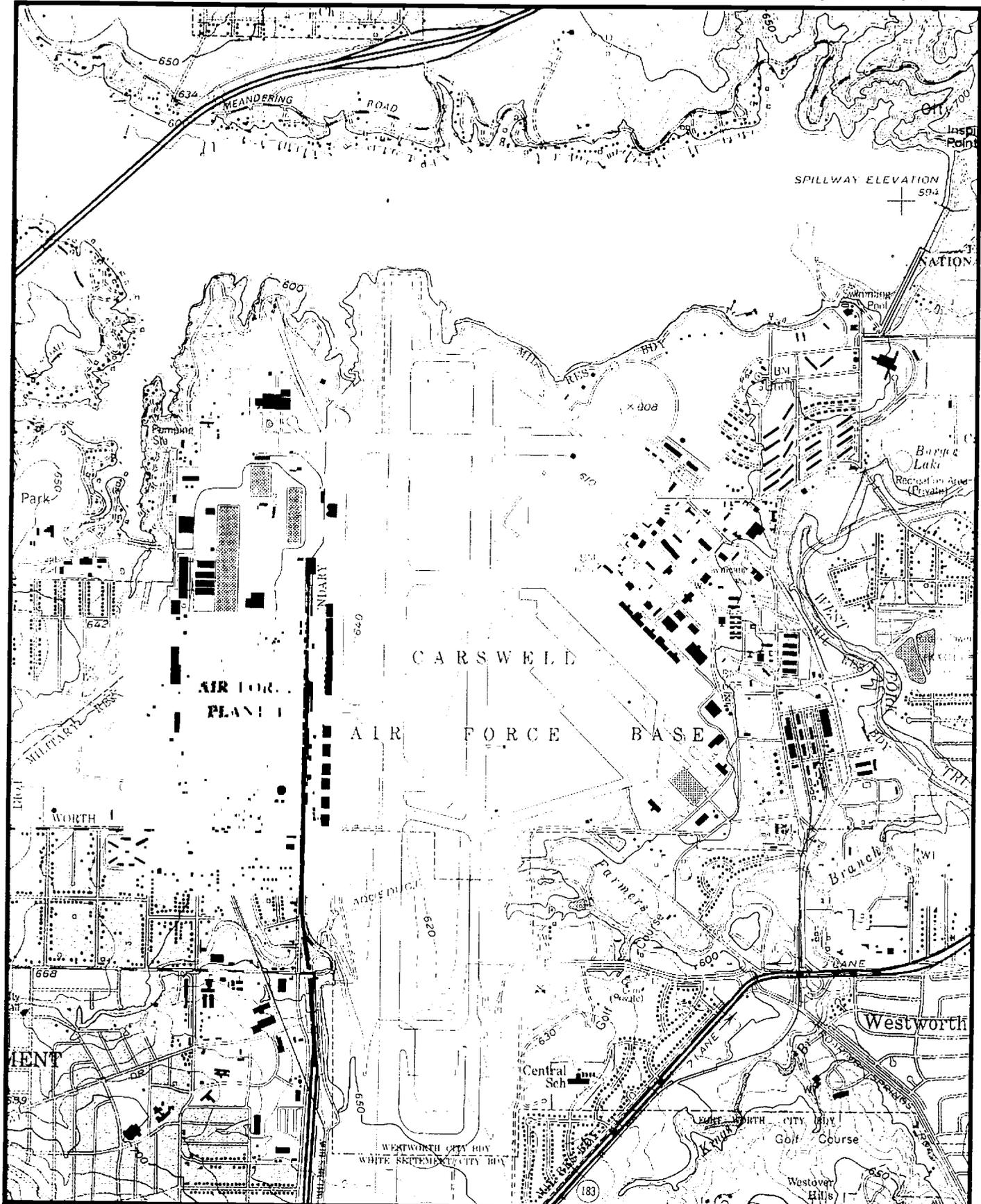
The topography of NAS Fort Worth JRB is fairly flat except for the lower lying areas along the tributaries of the Trinity River. The land surface slopes gently northeastward toward Lake Worth, and eastward, toward the West Fork of the Trinity River. Surface elevations range from about 690 feet above NGVD, at the southwest corner of the Base, to approximately 550 feet above NGVD, along the eastern side of the Base. Figure 2.13 is a smaller section of the Lake Worth, Texas U.S. Geological Survey Topographic Map showing the relief of the NAS Fort Worth JRB area.

2.1.5 Air

The climate in the Fort Worth area is classified as humid subtropical with hot summers and dry winters. Tropical maritime air masses control the weather during much of the year, but the passage of polar cold fronts and continental air masses can create large variations in winter temperatures. The average annual temperature in the area is 66 degrees Fahrenheit (°F) and monthly mean temperatures vary from 45°F in January to 86°F in July. The average daily minimum temperature in January is 35°F, and the lowest recorded temperature is 2°F. The average daily maximum temperature in July and August is 95°F, and the highest temperature ever recorded at the Base was 111°F in the month of June. Freezing temperatures occur at NAS Fort Worth JRB an average of 33 days per year.

Mean annual precipitation recorded at the Base is approximately 32 inches. The wettest months are April and May with a secondary maximum in September. The period from November to March is generally dry with a secondary minimum in August. Snowfall accounts for a small percentage of the total precipitation between November and March. Thunderstorm activity occurs at the Base an average of 45 days per year, with the majority of the activity between April and June. Hail may fall on two to three day per year. The maximum precipitation recorded in 24 hour period is 5.9 inches. On the average, measurable snowfall occurs two days per year.

Lake evaporation near NAS Fort Worth JRB is estimated to be approximately 57 inches per year. Evapotranspiration over land areas may be greater or less than lake evaporation depending on vegetative cover type and moisture availability. Average net precipitation is expected to be equal to the difference between average total precipitation and average lake evaporation, or approximately minus 25 inches per year. Mean cloud cover averages 50 percent at NAS Fort Worth JRB with clear weather occurring frequently during year round. Some fog is present on



Scanned By: C. Farmer	Date: 6/12/97	<p align="center">Legend</p> <p>Contour Interval 10 feet Scale 1:24,000 Scale in Feet</p>	<p align="center">Figure 2.13 Lake Worth Topographic Map NAS Fort Worth JRB</p> <p align="center">[From USGS, 1982]</p>
Checked By: K. Hurley	Date: 6/12/97		
Filename: Fig2-13.cdr			

an average of 83 days per year. Wind speed averages 7 knots; however, a maximum of 80 knots has been recorded. Predominant wind direction is from the south-southwest throughout the year.

Air quality in the Dallas-Fort Worth area meets EPA National Ambient Air Quality Standards for carbon monoxide, nitrogen dioxide, sulfur dioxide and respirable particulate matter. However, ozone levels exceed national standards and the ozone pollution level in the area has a federal classification of moderate. During 1996, ozone measurements showed an arithmetic mean concentration of 0.033 parts per million in North Tarrant County. Actual exceedances of the national standards for ozone concentrations was calculated to be two days for the measurement station in North Tarrant County. Additional control measures are being implemented as a result of 1990 Federal Clean Air Act mandates to bring the area into compliance with the national standard (TNRCC, 1996d).

2.1.6 Biology

Approximately 374 acres or 14 percent of NAS Fort Worth JRB is considered unimproved, indicating the presence of semi-natural to natural biological/ecological conditions. The Base lies in the Cross Timbers and Prairies Region of Texas where native vegetation is characterized by alternating bands of prairies and woodlands. The higher elevations on the Base are covered by native and cultivated grasses such as little bluestem, Indian grass, big bluestem, side oats, grama, and buffalo grass. Forested areas occur primarily on the lower land and along the banks of streams. Common wood species include oak, elm, pecan, hackberry, and sumac. Several non-native species such as catalpa and chinaberry are common (Radian, 1989).

Typical wildlife on the Base includes black-tailed jackrabbits in grassy areas along the runway. In addition, there are cotton-tail rabbits, gray squirrels, and opossums in the wooded areas. Common birds include morning doves, meadowlarks, grackles, and starlings. Hunting and trapping are not allowed on the Base, but in the nearby rural areas they are a very popular form of recreation (Radian, 1989).

Reported game fish include black bass, sunfish, and catfish, all of which can be found in Lake Worth, Farmers Branch Creek, and one small pond located on-base near the golf course equipment shed. According to the Texas Department of Parks and Wildlife and the United States Fish and Wildlife Service, there are no threatened or endangered species known to occur on NAS Fort Worth JRB. None of the Federally-listed endangered plant species for Texas are known to occur within 100 miles of Tarrant County. Of the federally-listed endangered animals species only the peregrine falcon, the bald eagle, and the whooping crane are known to occasionally inhabit the area; however, none of these is expected to reside in the vicinity of NAS Fort Worth JRB (Radian, 1989).

2.1.7 Demographics

The following sections describe the regional and site-specific demographics as they relate to the Fort Worth, Texas area and the NAS Fort Worth JRB.

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2.1.7.1 Regional Demographics

330 69

Approximately 1,278,606 people reside within Tarrant County, Texas (U.S. Department of Commerce, 1996). Of this population, 485,650 reside within the city limits of Fort Worth. Several smaller cities and villages make up the remainder of the population. The communities of White Settlement, Lake Worth, Westworth Village, River Oaks, and Sansom Park lie within a 3 mile radius of the NAS Fort Worth JRB. The following populations that reside in the cities and villages are based on 1994 census data: White Settlement (city) - 16,502, Lake Worth (city) - 4,694, Westworth Village - 2,502, River Oaks (city) - 6,747, and Sansom Park (city) - 4,136 (U.S. Department of Commerce, 1994). Six schools are within a 2-mile radius of NAS Fort Worth JRB, the closest is 0.5 miles south (RUST, 1995).

The area surrounding NAS Fort Worth JRB is highly urbanized due to its proximity to the city of Fort Worth. The area is comprised of a combination of residential, commercial, and light industrial properties, which employ the majority of local residents (RUST, 1995).

2.1.7.2 Site-Specific Demographics

The current full-time population at NAS Fort Worth JRB is approximately 3,600 people, which is comprised of 400 officers, 1,400 civilians, and 1,800 active reservists. Part time military reservists will increase this population to over 6,000 military personnel (CH2M HILL, 1997).

Approximately 86 percent of NAS Fort Worth JRB has been developed by way of buildings, roads, parking lots, runways, housing, or recreational areas. On-site activities include various maintenance and support activities for fuel systems, weapons, jet engines, aerospace ground support equipment, maintenance of specialized ground equipment, and inspection activities (HydroGeoLogic, 1997).

2.2 SITE-SPECIFIC ENVIRONMENTAL SETTING

The following sections describe the site-specific environmental setting at each of the SWMUs to be investigated under this DO. Site-specific information at SWMUs 27, 29, and 30 is very limited since previous investigations have not been performed.

2.2.1 Site Specific Soils

The United States Soil Conservation Service has identified four major soil associations in the area of NAS Fort Worth JRB. The surficial soils of SWMUs 17, 29, and 62 include the nearly level to gently sloping Clayey soils of the Sanger-Purves-Slidell Association. SWMU 27 is located in the Aledo-Bolar-Sanger Association, which is located within the southwestern portion of the Sanger-Purves-Slidell Association, and is characterized as an increasingly Loamy clayey soil of gentle to moderate slope. Soil at SWMU 30 belongs to the Clayey soils of the Frio-Trinity Association, which is located along the flood plain of the West Fork of the Trinity River. The fourth association that is present at the site and separates the Sanger-Purves-Slidell Association from the Frio-Trinity Association is the Bastsil-Silawa Association. This association is characterized as a Sandy clay loam of nearly level slope. Each of these soil associations are

summarized in Table 2.4 (ESE, 1994) and the areal limits of their occurrence onsite are shown in Figure 2.14 (ESE, 1994).

330 70

2.2.2 Site Specific Geology

The majority of NAS Fort Worth JRB is covered by alluvium deposited by the Trinity River during flood stages. The Quaternary Period alluvium (Holocene Epoch) occurs downstream from the Lake Worth Dam in the current flood plain of the West Fork of the Trinity River, on the east side of the facility. Older alluvial deposits and terrace deposits (Pleistocene Epoch) also occur onsite. The alluvium is composed of gravel, sand, silt, and clay of varying thicknesses and lateral extent. The thickness of these materials ranges from 0 to 60 feet. Fill material is also included within these deposits where landfills, waste pits, excavation sites, and other construction activities have altered the original land surface. This fill material is made up of clay, silt, sand, and gravel mixtures, but may also contain debris and other waste (Radian, 1989).

Below the alluvial terrace deposits are the Cretaceous-age Goodland and Walnut Formations which form the bedrock surface beneath NAS Fort Worth JRB. Both formations consist of interbedded, fossiliferous, hard limestone, and calcareous shale. The upper formation, the Goodland Limestone, is exposed on the southern portion of the Base, south of White Settlement Road. The Goodland is a chalky-white, fossiliferous limestone and marl. The thickness of the Goodland Limestone ranges from 20 to 25 feet. Below the Goodland Formation is the Walnut Formation (or Walnut Clay). The Walnut Formation is exposed in a small area along the shores of Lake Worth and Meandering Road Creek. This formation is a shell agglomerate limestone with varying amounts of clay and shale. It ranges in thickness from 25 to 35 feet across the site except where erosion has produced a few thinner areas. Subsurface investigations have located troughs and paleochannels that are eroded into the top of the bedrock at NAS Fort Worth JRB. These paleochannels are typical of an erosional surface modified by fluvial processes and are filled with sand and gravel deposits ranging in thickness from 15 to 35 feet (CH2M HILL, 1996b).

Below the Walnut Formation is the Paluxy Formation (or Paluxy Sand). The Paluxy Formation underlies all of NAS Fort Worth JRB. The Formation consists of several thick sandstone layers that are separated by thin discontinuous shale and claystone layers. Sandstones in the formation are primarily a fine to coarse-grained sand with minor amounts of clay, sandy clay, pyrite, lignite, and shale. The lower section of the Paluxy is generally coarser-grained than the upper section (CH2M HILL, 1996b). Total Formation thickness ranges from 130 to 175 feet, with variable thickness and occurrence of individual layers across the site. Only one unit in this formation, a shale/silty shale, can be extensively mapped across the Base.

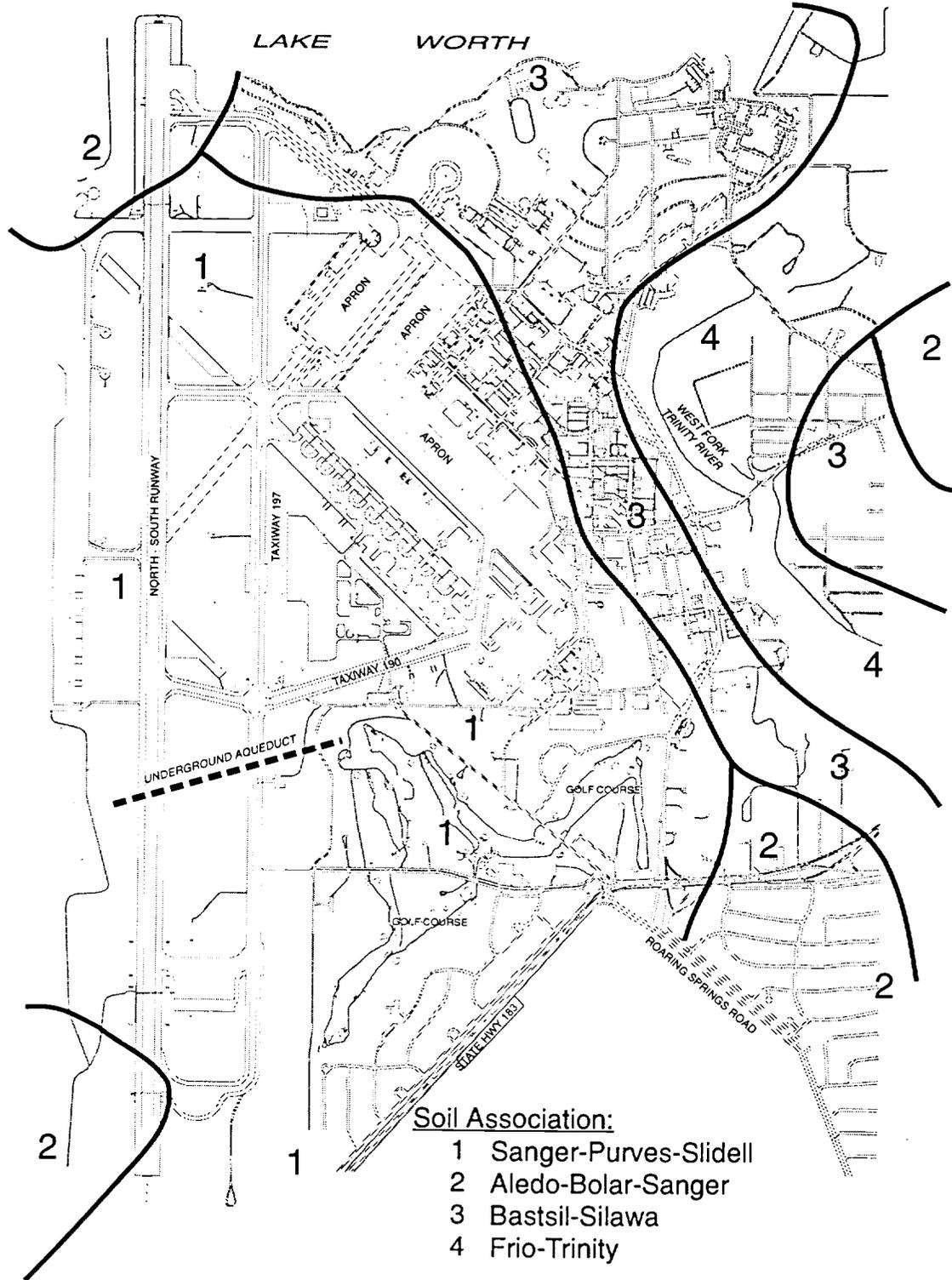
The older Glen Rose and Twin Mountains Formations are not exposed at NAS Fort Worth JRB. The Glen Rose Formation consists primarily of calcareous sedimentary rock and some sands, clays, and anhydrite. The Glen Rose caps the Twin Mountain Formation, which is the oldest Cretaceous Formation in the NAS Fort Worth JRB area. The Twin Mountain Formation consists of a basal conglomerate of chert and quartz, grading upward into coarse- to fine-grained sand interspersed with varicolored shale.

Table 2.4
Soil Associations at SWMUs 17, 27, 29, 30, 62
NAS Fort Worth JRB, Texas

Association	Description	Thickness (inches)	Percent Clay <2mm (%)	pH (S.U.)	Permeability (cm/sec)	Available Water Capacity (in/in)
Sanger-Purves-Sidell: Clayey soils of nearly level to gently sloping uplands.	Clay loam Clay over bedrock Silty clay	8 - 80	35 - 60	7.4-8.4	$<4.2 \times 10^{-5}$ to 3×10^{-4}	0.12 - 0.20
Aledo-Bolar-Sanger: Loamy and clayey soils of gently sloping to moderately steep uplands.	Clay loam over bedrock Clay loam	8 - 70	20 - 60	7.9-8.4	$<4.2 \times 10^{-5}$ to 9×10^{-4}	0.05 - 0.18
Frio-Trinity: Clayey soil on nearly level flood plains.	Silty clay or loam Clay	25 - 75	35 - 80	7.4-8.4	$<4.2 \times 10^{-5}$ to 3×10^{-4}	0.11 - 0.20
Bastil-Silawa: Loamy soils on nearly level to sloping stream terraces.	Sandy clay loam	40 - 80	7 - 35	4.5-7.8	9×10^{-4} to 3×10^{-3}	0.08 - 0.17

Sources: Summary of Hydrologic and Chemical Characterization Studies (ES&E, July 1994).
Soil Survey of Tarrant County, Texas pps 202-203 (USGS, 1981)

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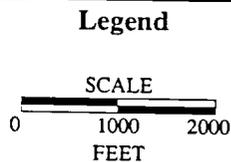


Figure 2.14
Soil Association Map
NAS Fort Worth JRB, Texas

[From Radian, 1989]

2.2.3 Contaminant Sources and Contamination

A summary of existing information from previous studies concerning the nature and extent of site contamination is presented in section 1.4 and Appendix A. The following sections describe the types of materials received and any documented hazardous constituents that may act as a source of contamination to the surrounding environment.

2.2.3.1 SWMU 17

The surface of the site is littered with small pieces of concrete, asphalt, and rocks that have weathered through the soil cover. The area is surrounded to the west and south by a drainage ditch. The northern extent of the SWMU is not defined other than where ground maintenance begins. SWMU 17 reportedly received solid wastes such as concrete, asphalt, wood, trees. Although it is not documented, it is suspected that this SWMU may have also received small amounts of hazardous materials typically associated with air force activities during its period of operation. The area is currently covered by various grasses and weeds that are not maintained.

2.2.3.2 SWMU 27

This site consists of a ditch approximately 8 feet deep by 20 feet wide and 400 feet long surrounded by a two acre graded area. This varies from the RFA description of the ditch, which was described as 20 feet wide by 80 feet long. The ditch typically has approximately 4- to 5-feet of water during the winter months and eventually dries out during the summer months due to evaporation and infiltration. Drums were observed in the ditch during HydroGeoLogic's visual site inspection. Since there is no documentation as to the source of these drums, they may have contained material which could act as a source of potential contamination. The site is partially covered with vegetation. This area has not been previously investigated.

2.2.3.3 SWMU 29

This inactive landfill is surrounded by an 8-foot chain linked fence that provides security for Building 1055. This building occupies approximately one fourth of the 4.4 acre site. The remaining portion of the site is either occupied by temporary trailers or is grass-covered. This former borrow pit was converted to a landfill in 1952 and accepted construction debris and moderate quantities of unspecified hazardous wastes (AFCEE, 1997). In 1956, the landfill was no longer needed and the site was covered. This area has not been previously investigated.

2.2.3.4 SWMU 30

This inactive landfill received construction debris in the form of concrete, asphalt, steel, and wood. A ditch, which drains to the West Fork of the trinity River, has been created by runoff draining from an upgradient parking area located adjacent to Building 2570. In this ditch, concrete, asphalt, telephone poles, and reinforcing steel have washed out of the west bank. Given its proximity to industrial shops, this SWMU may have received hazardous materials associated with these operations. The site is covered by vegetation and current land use is limited to

maintenance workers. The future location of a water line has been staked for installation through the middle of the site. This area has not been previously investigated.

2.2.3.5 SWMU 62

SWMU 62 is located between Roaring Springs Road and Haile drive, across from the golf course. The site consists of a sparsely grass-covered area that is currently being unofficially used for stock piling debris laden fill dirt. The site was first identified in the RFA conducted by A. T. Kearney, Inc. (1989) as a construction and debris landfill but was not investigated until the PA/SI conducted by the USACE (1993). It was documented that “three drums of hydraulic fluid were placed in a centrally located pit, which collected groundwater that seeped into the landfill”. It is not clear from this quote, taken directly from the RFA, whether the drums or the pit were designed to collect groundwater (A.T. Kearney, 1989). Debris that was reportedly accepted by the landfill included trees, construction rubble, and miscellaneous trash. Given the proximity of the site to the flightline shops, however, it is possible that small quantities of hazardous waste or hazardous constituents may have been buried.

3.0 PROJECT TASKS

330 75

The following sections present the Applicable or Relevant and Appropriate Requirements, the background characterization, the data needs and the proposed field investigation tasks.

3.1 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS IDENTIFICATION

Applicable or Relevant, and Appropriate Requirements (ARARs), as mandated by CERCLA are required to be addressed and satisfied by remedial actions. Federal statutes specifically included in CERCLA include: Solid Waste Disposal Act, RCRA, Toxic Substances Control Act, Safe Drinking Water Act, Clean Air Act, Clean Water Act, Endangered Species Act, Fish and Wildlife Coordination Act, and the Marine Protection Research and Sanctuaries Act. CERCLA also mandates that if state ARARs are more stringent than Federal ARARs, they must also be met. The ultimate objective of this project is to obtain closure under the TNRCC RRS program.

There are three general types of ARARs:

- Chemical specific requirements are usually health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment.
- Location specific requirements are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they occur in special locations.
- Action specific requirements are usually technology based requirements or limitations on actions taken with respect to hazardous wastes.

Tables which present a preliminary list of ARARs to be considered during this investigation are included as Appendix B. As more information becomes available through the project, the ARARs list will be further refined.

3.2 CHARACTERIZATION OF BACKGROUND CONDITIONS

Jacobs Engineering (Jacobs, 1997) conducted a base-wide background study in 1996 to establish background concentrations of 24 inorganic constituents in surface soil, subsurface soil, alluvial terrace groundwater, surface water and sediments at NAS Fort Worth JRB. The study quantified groundwater concentrations in the alluvial terrace using both low stress and bailer sampling techniques. All samples were collected and analyzed for metals, volatile and semi-volatile compounds. Sampling locations were selected based on the proximity to known sources of contamination and contaminated media. Inorganic sample results were not included in the statistical determination of background concentrations at locations where organic compounds were detected above detection limits.

Results of the background study for each media are presented in Tables C.1 through C.6 and Appendix C. Jacobs (1997) used the Tolerance Interval method to estimate upper tolerance limits (UTLs) of the distribution of each constituent in the background data population. The UTL_{95,95} values listed in the tables are the values that, with 95 percent confidence, will exceed 95 percent of the background concentrations. This background data set will be used for all of the investigative work to be completed during this RFI.

3.3 DATA NEEDS IDENTIFICATION

Information from previous investigations have indicated that contamination may be present as a result of past waste handling practices at SWMUs 17 and 62. The investigation at these sites will be performed to confirm the contamination detected in previous studies, identify the source of any potential contamination, and to define the magnitude and spatial extent of any impact to the soil or groundwater beneath the sites.

Because SWMUs 27, 29 and 30 have not been previously investigated, this investigation is intended to identify if the waste buried at the sites have resulted in impacts to the soil, groundwater, sediments and surface water at the sites. If contamination is present in the samples collected during this investigation, the study will be expanded in order to determine the extent of the contamination. Physical and chemical properties of the soil and groundwater beneath the sites will also be obtained to better understand the properties of these media.

Four primary objectives have been identified for this project: 1) Fill data gaps with respect to the hydrogeological regime at each site. This will be accomplished by installing monitoring wells to determine depth to bedrock, the lithologic unit which represents bedrock, the depth to groundwater and the direction of groundwater flow; 2) The physical boundaries of each SWMU must be identified. This will be determined by evaluating the vertical and lateral extent of buried wastes at the site. Field methods for determining the total of buried wastes include geophysical surveys, test pits, and soil borings; 3) If contamination is present, then the source must be determined. Field methods that will be utilized include geophysical surveys, test pits (SWMUs 17 & 62 only), soil borings, installing and sampling additional monitoring wells, sampling existing monitoring wells, and collecting surface water samples (SWMU 27 only); and 4) The nature and extent of the contamination must be characterized. This will be accomplished by defining the vertical and lateral extent of chemicals that exceed RRS1. Field methods that will be utilized include geophysical surveys; soil sampling during test pit excavation, soil boring installation, and monitoring well installation; and groundwater sampling from monitoring wells. These project objectives are summarized in Table 3.1.

Table 3.1
Project Objectives and Data Needs
SWMU 17, 77, 29, 30, and 62
NAS Fort Worth JRB, Texas

Primary Objectives	Data Needs	Work Task
Characterize site specific geology/hydrogeology at each of the SWMUs	Depth to groundwater Depth to bedrock Unit represented by bedrock Groundwater flow direction	Installation of additional monitoring wells Sampling/gauging of existing monitoring wells
Define physical boundaries of landfill	Lateral and vertical extent of buried waste	Geophysical survey Test pits with visual waste classification Soil borings with visual waste classification
Characterize potential source of contamination	Identify if waste disposed in landfill has impacted the environment	Geophysical survey Test pits (SWMU 17, 62 only) with surface/subsurface soil sampling Soil borings with surface and subsurface sampling (SWMU 17, 27, 29, 30, & 62) MW installation with surface and subsurface soil sampling MW sampling Surface water samples (SWMU 27 only)
Determine nature and extent of any detected contamination	Lateral and vertical extent of contamination in soil and groundwater	Geophysical survey Soil borings with surface and subsurface sampling MW installation with surface and subsurface sampling MW sampling

3.4 FIELD INVESTIGATION TASKS

The proposed field tasks described in the following sections will be conducted to achieve the project objectives. As previously noted, each of the SWMUs received various types and amounts of construction debris throughout their respective periods of operation. Although suspected, documentation confirming unauthorized dumping of hazardous wastes and hazardous constituents has not been obtained. The field tasks described in the following sections were chosen by evaluating the type and purpose of data required to characterize the various SWMUs. Geophysical surveys, installation of soil borings, installation of monitoring wells, and excavation of test pits will serve as a cost-effective means for gathering samples for visual observation, field screening and laboratory analysis.

The following sections describe the tentative locations of the geophysical surveys, soil borings, monitoring wells, and test pits for each of the SWMUs. These locations may change due to site specific conditions such as utilities, fences, buildings, etc. encountered during the field implementation.

3.4.1 SWMU 17

Proposed field activities to be conducted at SWMU 17 will include a geophysical survey to identify any potential “hot spots,” defined as areas of conductivity anomalies. Figure 3.1 illustrates the SWMU and the spatial orientation of the grid to be surveyed. Figure 3.2 presents the intrusive sampling locations proposed at SWMU 17 during this investigation.

Two geophysical tools will be used to conduct the geophysical survey. The survey grid will be tested using an electromagnetic induction tool that is designed to determine if conductivity anomalies are present. These anomalies may represent buried conductive material such as drums or tanks. Following completion of the electromagnetic induction survey, the grid will be resurveyed using a magnetometer/gradiometer. This tool will be used to evaluate magnetic anomalies which may also be associated with buried metallic objects. The magnetometer/gradiometer will also be used in an effort to determine the extent of undisturbed soil. The magnetic alignment of native earth will have a slightly different magnetic response than the soil disturbed during the operation of the landfill. This magnetic profile difference may register on the magnetometer/gradiometer.

Three test trenches are presented on Figure 3.1. The actual location of these trenches may be modified if results of the geophysical study provide evidence of “hot spots” or a larger area where wastes were buried. The test trenches will be used to visually classify the waste buried at the former landfill. Two soil samples for laboratory analysis will also be collected at each test pit location. One sample will be collected from the surface soil before the excavation is initiated, and one soil sample will be collected at the base of the excavation. These soil samples will be used to characterize the chemical characteristics of the fill material within the landfill.

Six soil borings will be drilled to test for soil contamination. These borings are proposed around the perimeter of the unit. Three of these borings will be terminated at the top of groundwater, the

Figure 3.1

Geophysical Survey Grid Layout SWMU 17

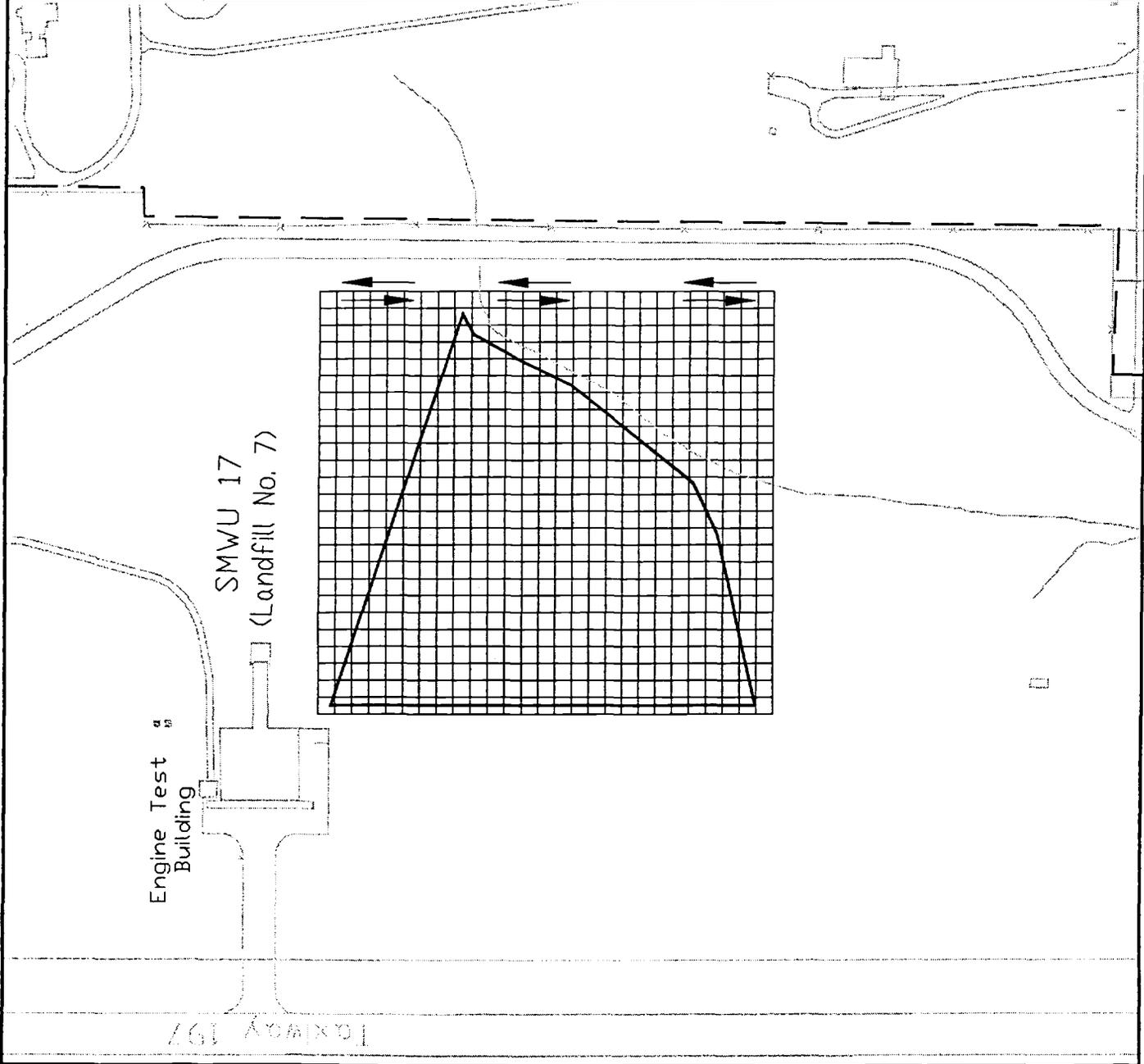
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LEGEND

-  SWMU Area
-  Approximate NAS Fort Worth JRB Site Boundary
-  Building
-  Fence
-  Road
-  Proposed Trench
 Note: Actual Size = 30' X 4'
-  Path of Survey Measurements
-  Stream
-  Geophysical Grid



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Figure 3.2

Proposed Investigation
 Activities
 SWMU 17

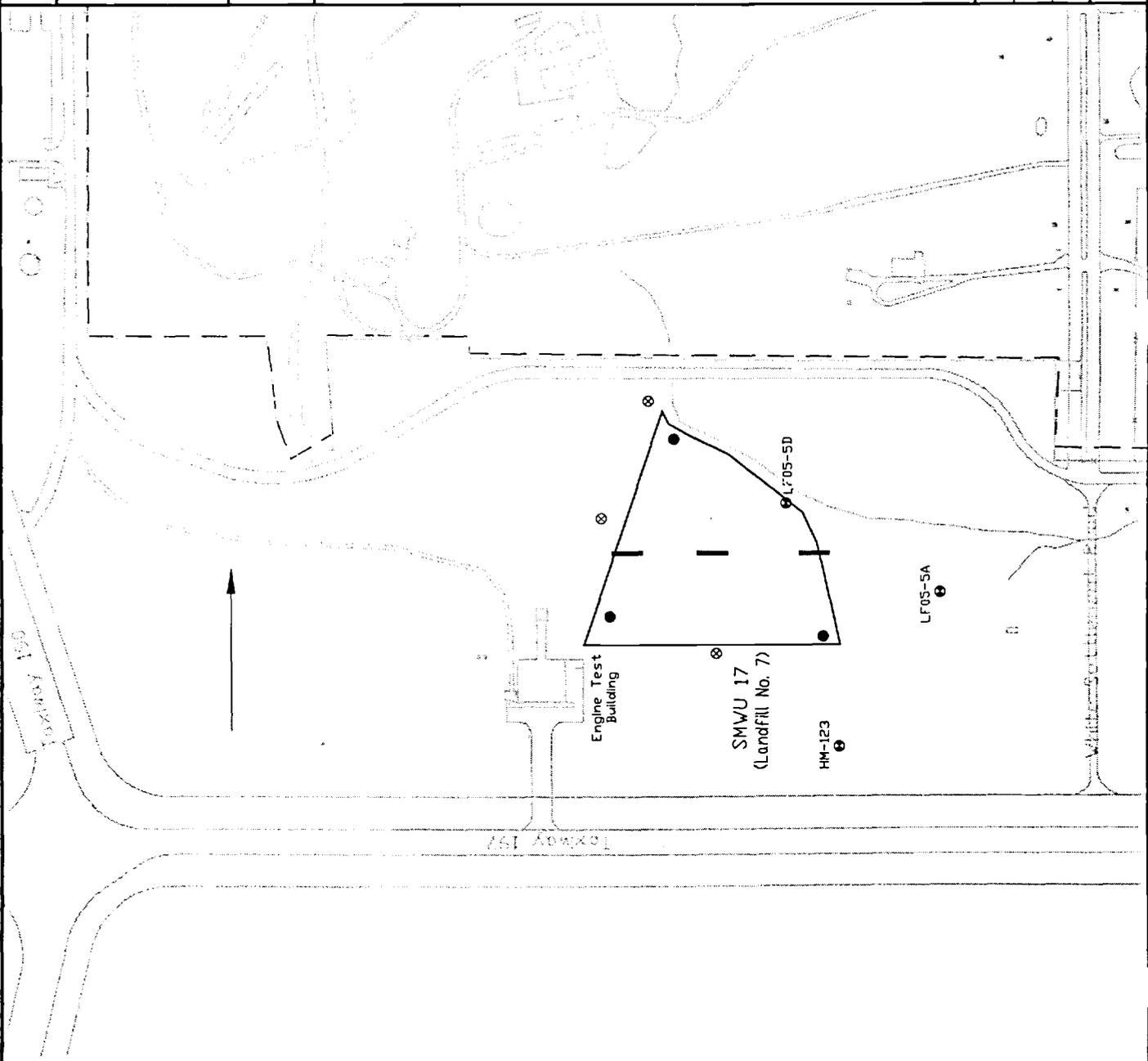
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LEGEND

-  SWMU Area
-  Approximate NAS Fort Worth JRB Site Boundary
-  Proposed Monitoring Well
-  Proposed Soil Boring
-  Building
-  Fence
-  Road
-  Existing Monitoring Well
-  Proposed Trench
 Note: Actual Size = 30' X 4'
-  Groundwater Flow Direction
-  Stream



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Map Source: JACOBS, 1996	



other three will be converted to monitoring wells. Surface soil samples and subsurface samples will be collected at each location. The surface soil sample will be collected using a stainless steel trowel or hand auger prior drilling the borehole. Continuous split spoon sampling will be conducted to the top of the water table. The subsurface sample for laboratory analysis will be collected at the interval with the highest relative organic vapor concentration as determined using an Organic Vapor Analyzer (OVA) equipped with a Photoionization detector (PID). 330 81

Groundwater flow is generally west to east at NAS Fort Worth JRB. Near SWMU 17, the local groundwater flow has a slight northerly component. The installation and sampling of new monitoring wells, and the sampling of existing monitoring wells, is designed to evaluate the relative quality of the groundwater upgradient of SWMU 17 versus the quality downgradient of the unit (Figure 3.2). The proposed well located west of the unit, HM-123 and LF05-5A, will be used to evaluate the groundwater quality as it enters the unit. The other two proposed wells along the north side of the unit, and existing well LF05-5D, will be used to determine the groundwater quality as it exits the unit. The difference between the physical and chemical characteristics of the groundwater upgradient versus downgradient of the unit will be used to determine if the waste buried within the unit has impacted groundwater quality.

The analytical results obtained from samples collected at soil borings, monitoring wells, and test pits are intended to determine whether potential contamination in the SWMU is leaching to the underlying groundwater and potentially contributing to the existing TCE plume that originates at AFP-4. Due to a lack of historical records of waste buried within the unit, a full suite of VOCs, SVOCs, herbicides, pesticides/PCBs, and priority pollutant metals will be analyzed for all soil and groundwater samples collected at this unit. A summary of the proposed sampling is presented in Table 3.2. Additional monitoring wells may be installed, at a later date, to delineate the extent of contamination originating from the SWMU, if the proposed monitoring wells identify contamination above RRS.

3.4.2 SWMU 27

Field investigation tasks at this site include a geophysical survey, soil borings, and monitoring well installation. A geophysical survey around the perimeter of the trench will be conducted to identify any potential “hot spots,” defined as areas of conductivity anomalies. Figure 3.3 illustrates the SWMU and the spatial orientation of the grid to be surveyed.

Four monitoring wells will be drilled around the perimeter of the trench to a depth of 1-foot into the bedrock to determine depth to bedrock, the lithologic unit which comprised bedrock, the depth to groundwater, and the direction of groundwater flow. Soil and groundwater samples will also be collected from these proposed locations to characterize the physical and chemical characteristics beneath the unit.

Eight surface soil samples will be collected from the bottom of the trench to determine whether any of the wastes deposited at the site have impacted the soil along the bottom of the trench. Two surface water samples will be collected from standing water, if present, at the north and south ends of the trench to determine if wastes buried at the site have impacted the surface water. Surface

Table 3.2
Proposed RFI Sampling Locations
NAS Fort Worth JRB, Texas

SWMU	Matrix	Sample Collection Method	Depth	Number of Locations/ SWMU	Analyses
17	Soil	Split Spoons	Top 2 feet of soil, and soil with highest PID reading or depth directly above water.	6	VOC ¹ , SVOC ² , PP Metals ³ , Pesticides/PCB ⁴ Herbicides ⁵
17	Soil	Test Pit	Top 2 feet of soil, and soil with highest PID reading or depth directly above water.	3	VOC, SVOC, PP Metals, Pesticides/PCB ⁴ Herbicides
17	Groundwater	Submersible Pump	Middle of well screen	6	VOC, SVOC, PP Metals, Pesticides/PCB ⁴ Herbicides
27	Soil	Split Spoons	Top 2 feet of soil, and soil with highest PID reading or depth directly above water.	4	VOC, SVOC, PP Metals, Pesticides/PCB ⁴ Herbicides
27	Soil	Grab Samples	Top 4 inches of sediment.	8	VOC, SVOC, PP Metals, Pesticides/PCB ⁴ Herbicides
27	Surface Water	Grab Samples	Top of surface water	2	VOC, SVOC, PP Metals, Pesticides/PCB ⁴ Herbicides
27	Groundwater	Submersible Pump	Middle of well screen	4	VOC, SVOC, PP Metals, Pesticides/PCB ⁴ Herbicides
29	Soil	Split Spoons	Top 2 feet of soil, and soil with highest PID reading or depth directly above water.	7	VOC, SVOC, PP Metals, Pesticides/PCB ⁴ Herbicides
29	Groundwater	Submersible Pump	Middle of screen	3	VOC, SVOC, PP Metals, Pesticides/PCB ⁴ Herbicides
62	Soil	Test Pit	Top 2 feet of soil, and soil with highest PID reading or depth directly above water.	3	VOC, SVOC, PP Metals, Pesticides/PCB ⁴ Herbicides
30	Soil	Split Spoons	Top 2 feet of soil, and soil with highest PID reading or depth directly above water.	9	VOC, SVOC, PP Metals, Pesticides/PCB ⁴ Herbicides

Table 3.2 (continued)
Proposed RFI Sampling Locations
NAS Fort Worth JRB, Texas

SWMU	Matrix	Sample Collection Method	Depth	Number of Locations/ SWMU	Analyses
30	Groundwater	Submersible Pump	Middle of screen	6	VOC, SVOC, PP Metals, Pesticides/PCB ⁴ Herbicides
62	Soil	Split Spoons	Top 2 feet of soil, and soil with highest PID reading or depth directly above water.	4	VOC, SVOC, PP Metals, Pesticides/PCB ⁴ Herbicides
62	Soil	Test Pit	Top 2 feet of soil, and soil with highest PID reading or depth directly above water.	3	VOC, SVOC, PP Metals, Pesticides/PCB ⁴ Herbicides
62	Groundwater	Submersible Pump	Middle of screen	4	VOC, SVOC, PP Metals, Pesticides/PCB ⁴ Herbicides

Notes:

- ¹ Analytical method for VOCs are SW846 Method 8260A.
- ² Analytical method for SVOCs are SW846 Method 8270B.
- ³ Analytical method for Metals are SW846 Methods 6010A.
- ⁴ Analytical method for Pesticides are SW846 Methods 8080A.
- ⁵ Analytical method for Herbicides are SW846 Methods 8150B.

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Figure 3.3
Geophysical Survey
Grid Layout
SWMU 27

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LEGEND

-  Disposal Trench
-  Area of Sparse Vegetation
-  Proposed Monitoring Well
-  Proposed Sediment Sampling Location
-  Proposed Surface Water Sampling Location
-  Building
-  Fence
-  Road
-  Railroad
-  Path of Survey Measurements
-  Geophysical Grid

NOTE: Geophysical Investigation will not be performed in the disposal trench if water is present.

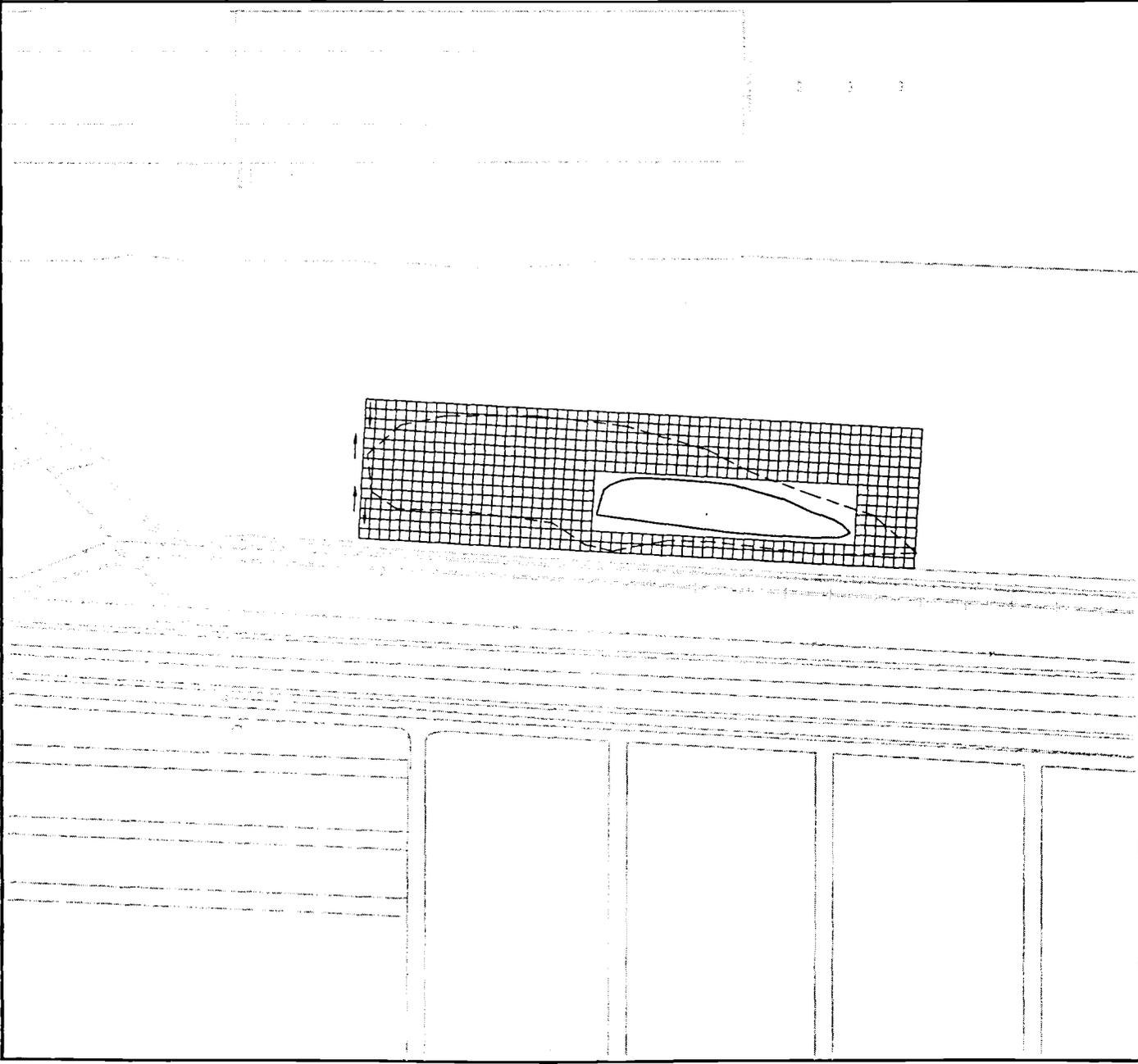


SCALE IN FEET



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Adapted Source:
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water samples may not be able to be collected during summer months due to evaporation and infiltration. Very little historical documentation of wastes buried at the unit is available. Therefore, all groundwater, soil and surface water samples will be analyzed in the laboratory for a full suite of VOCs, SVOCs, herbicides, pesticides/PCBs, and priority pollutant metals. All of the proposed sampling locations are presented in Figure 3.4. A summary of proposed sampling locations are presented in Table 3.2. Additional soil borings and monitoring wells may be installed, at a later date, to delineate the extent of contamination originating from the SWMU, if the proposed locations identify contamination above RRS.

3.4.3 SWMU 29

Proposed field activities to be conducted at this SWMU include a geophysical survey to identify potential “hot spots,” defined as areas of conductivity anomalies. The geophysical survey will also attempt to determine the extent of the fill material to estimate the lateral extent of the former landfill. Figure 3.5 illustrates the SWMU and the spatial orientation of the grid to be surveyed.

Seven soil borings, six along the inside-perimeter of the SWMU and one in the center of the SWMU, will be drilled to evaluate the physical and chemical characteristics of the soil and groundwater beneath the unit. The soil borings will be drilled to the top of the water table. Four of the soil borings that will be converted to 2-inch diameter monitoring wells. These borings will be advanced deeper and terminated 1-foot into the bedrock. All of the boring locations may need to be shifted based on accessibility and utility clearance. The samples collected from the soil borings and monitoring wells are intended to evaluate the potential for contamination from the SWMU. Two soil samples will be collected from each of the boring locations. One sample will be collected from the surface soil and the other sample will be collected from the depth of the highest relative PID reading.

Groundwater flow at the Base is generally west to east. One of the objectives of the investigation will be to provide additional information on local groundwater flow direction and velocity. Three of the monitoring wells are proposed in what appears to be the upgradient direction. These wells are designed to evaluate quality of the groundwater as it enters the unit. The other monitoring well is proposed to evaluate the groundwater quality as it exits the unit. The relative difference in the groundwater quality upgradient versus downgradient of the unit will be used to evaluate if the waste buried in the unit is impacting groundwater quality. The monitoring wells will also provide valuable information as depth to bedrock, the lithologic unit represented as bedrock, and the depth to groundwater.

Based on the lack of available historical records of buried debris and suspected contaminants associated with the SWMU, all soil and groundwater samples will be analyzed for a full suite of VOCs, SVOCs, herbicides, pesticides/PCBs, and priority pollutant metals. Proposed locations for soil borings and monitoring wells are presented in Figure 3.6. A summary of the proposed locations and analyses are presented in Table 3.2. Additional soil borings and monitoring wells may be installed at a later date to delineate the extent of contamination originating from the SWMU if the proposed monitoring wells identify contamination above RRS.

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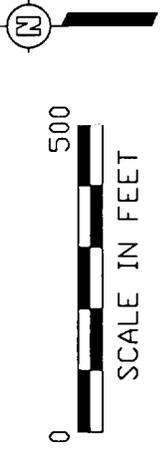
Figure 3.4

Proposed Investigation
 Activities
 SWMU 27

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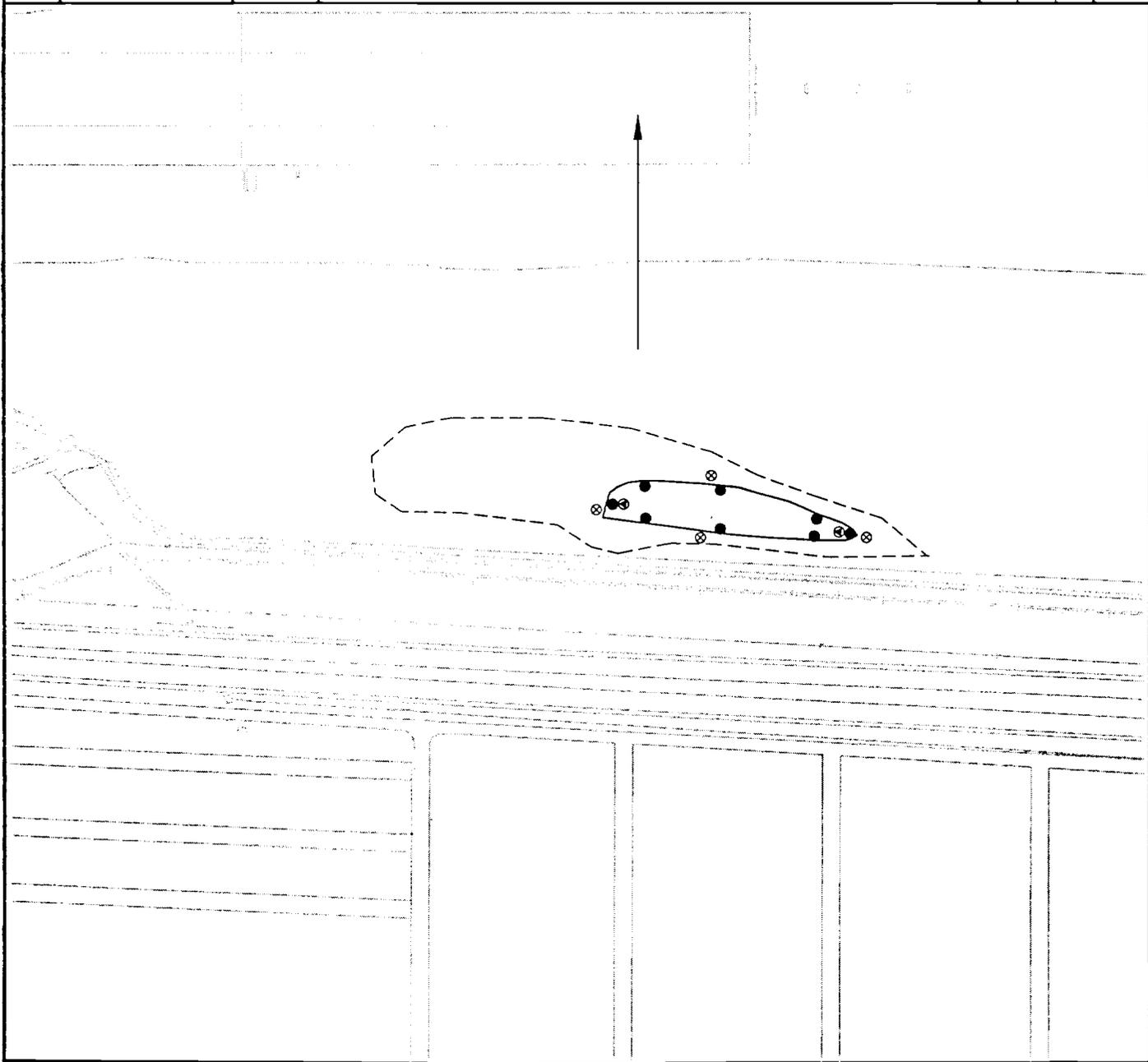
LEGEND

-  Disposal Trench
-  Area of Sparse Vegetation
-  Proposed Monitoring Well
-  Proposed Surface Soil Sampling Location
-  Proposed Surface Water Sampling Location
-  Groundwater Flow Direction
-  Fence
-  Road
-  Railroad



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Map Source:
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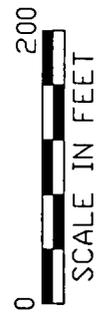
Figure 3.5

Geophysical Survey Grid Layout SWMU 29

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LEGEND

-  SWMU Area
-  Building
-  Fence
-  Road
-  Path of Survey Measurements
-  Geophysical Grid



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SWMU 29
 (Landfill No. 2)

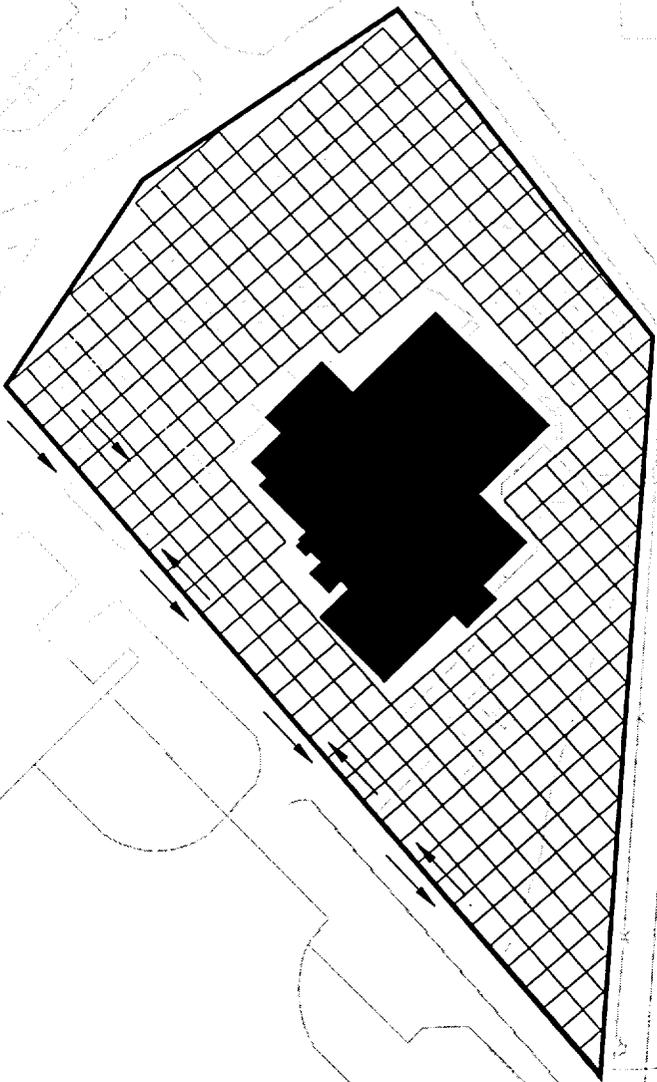


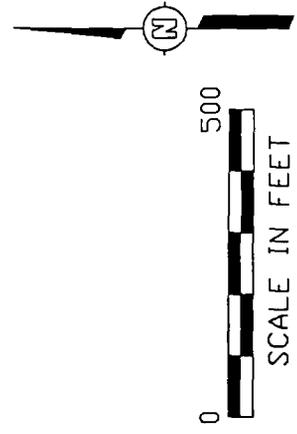
Figure 3.6

Proposed Investigation
Activities
SWMU 29

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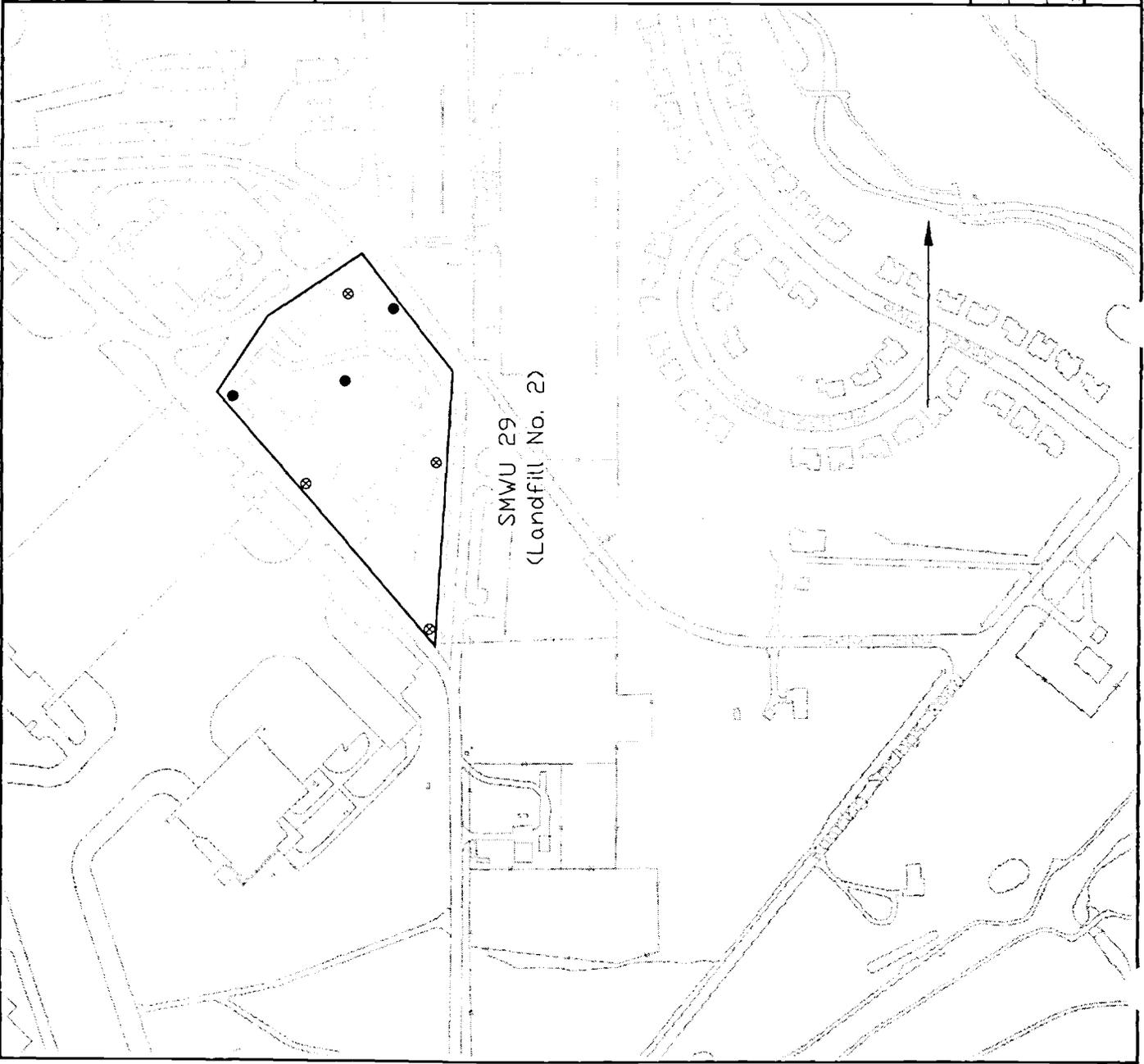
LEGEND

-  SWMU Area
-  Proposed Monitoring Well
-  Proposed Soil Boring
-  Building
-  Fence
-  Road
-  Groundwater Flow Direction



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Map Source:
JACOBS 1996



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3.4.4 SWMU 30

A geophysical survey will be conducted at this site to identify any potential “hot spots,” defined as areas of conductivity anomalies. Figure 3.7 illustrates the SWMU and the spatial orientation of the grid to be surveyed.

Nine soil borings will be drilled to evaluate the soil and groundwater characteristics beneath this unit. Six of these soil borings will be completed as 2-inch diameter monitoring wells. The soil borings will be terminated at the top of groundwater, the monitoring wells will be drilled 1-foot into the bedrock.

Soil samples will be collected at the surface and the subsurface zone of highest relative PID reading from each of the boring and well locations. The soil samples will be used to evaluate the physical and chemical characteristics of the soil beneath the unit. This information will be used in an attempt to determine if the waste buried at the unit has adversely impacted the environment.

Groundwater flow in the vicinity of this unit is estimated to be to the southeast toward the West Fork Trinity River. The monitoring well locations are proposed to evaluate the depth to bedrock, the lithologic unit represented as bedrock, the depth to groundwater, the groundwater flow direction, and the chemical/physical characteristics of the groundwater. The wells are proposed around the perimeter of the unit to ensure that upgradient and downgradient characteristics are represented. The relative groundwater quality between the upgradient samples and the downgradient samples will be used to evaluate the impact resulting from waste buried in the unit.

Since little historical data of debris buried in the landfill is available, all soil and groundwater samples will be analyzed for VOCs, SVOCs, herbicides, pesticides/PCBs, and priority pollutant metals. Proposed locations for soil borings and monitoring wells are presented in Figure 3.8. Proposed analyses for soil and groundwater are presented in Table 3.2. Additional soil borings and monitoring wells may be installed at a later date to delineate the extent of contamination originating from the SWMU, if the proposed monitoring wells identify contamination above RRS.

3.4.5 SWMU 62

Proposed field activities to be conducted at this SWMU include a geophysical survey to identify any potential “hot spots,” areas of conductivity anomalies. Figure 3.9 illustrates the SWMU and the spatial orientation of the grid to be surveyed.

Three test pits are proposed to investigate the waste buried within the unit. The proposed location of these test pits are presented on Figure 3.10. The actual location of the test pits may be changed based on the result of the geophysical survey and actual field conditions. One surface soil sample will be collected prior to excavating each test pit. One subsurface soil sample will be collected at the base of each test pit.

Figure 3.7

Geophysical Survey Grid Layout SWMU 30

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LEGEND

-  SWMU Area
-  Approximate NAS Fort Worth JRB Site Boundary
-  Building
-  Fence
-  Road
-  Trench
-  Path of Survey Measurement
-  Geophysical Grid



SCALE IN FEET

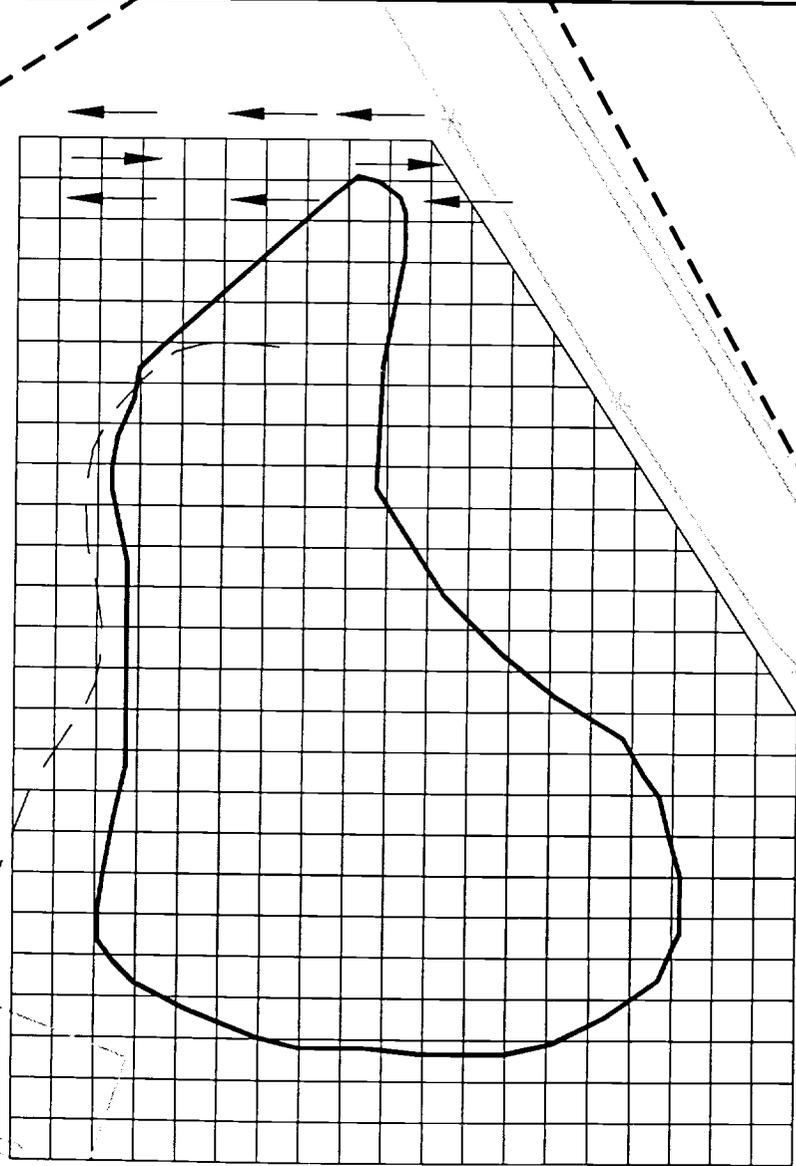
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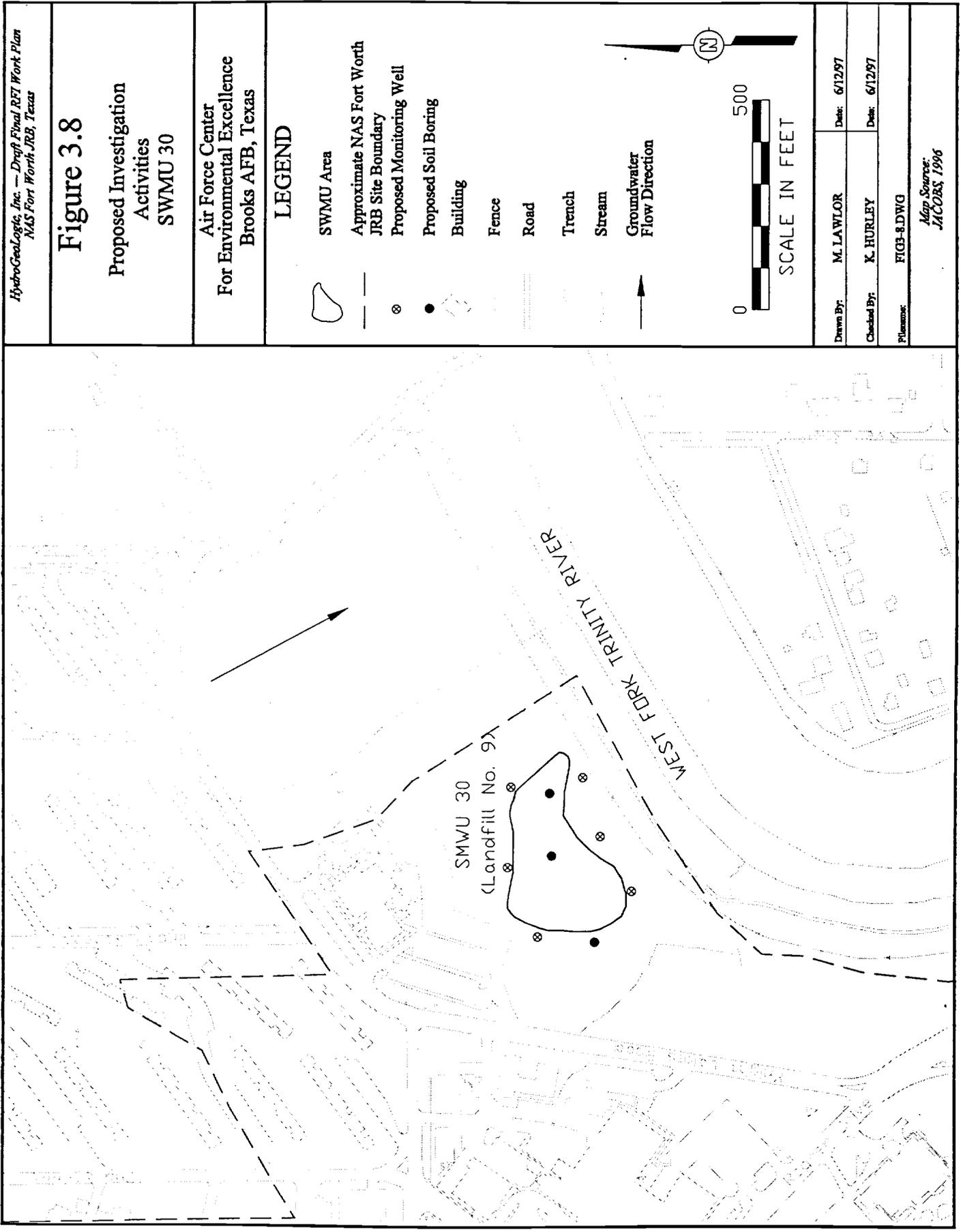
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Map Source:
 JACOBS, 1996

SWMU 30
 (Landfill No. 9)

WEST FORK TRINITY RIVER





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Figure 3.9

Geophysical Survey
Grid Layout
SWMU 62

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LEGEND

-  SWMU Area
-  Proposed Monitoring Well
-  Building
-  Fence
-  Road
-  Path of Survey Measurements
-  Geophysical Grid

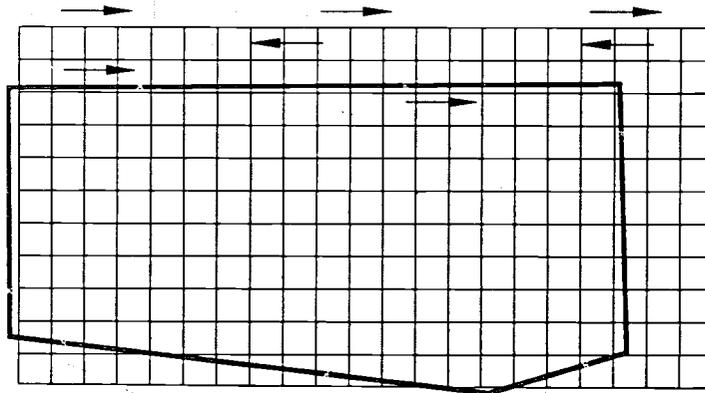


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Map Source:
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SWMU 62
(Landfill No. 6)

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Figure 3.10

Proposed Investigation
 Activities
 SWMU 62

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LEGEND

-  SWMU Area
-  Proposed Monitoring Well
-  Building
-  Fence
-  Road
-  Proposed Trench
 Note: Actual Size = 30' X 4'
-  Groundwater Flow Direction

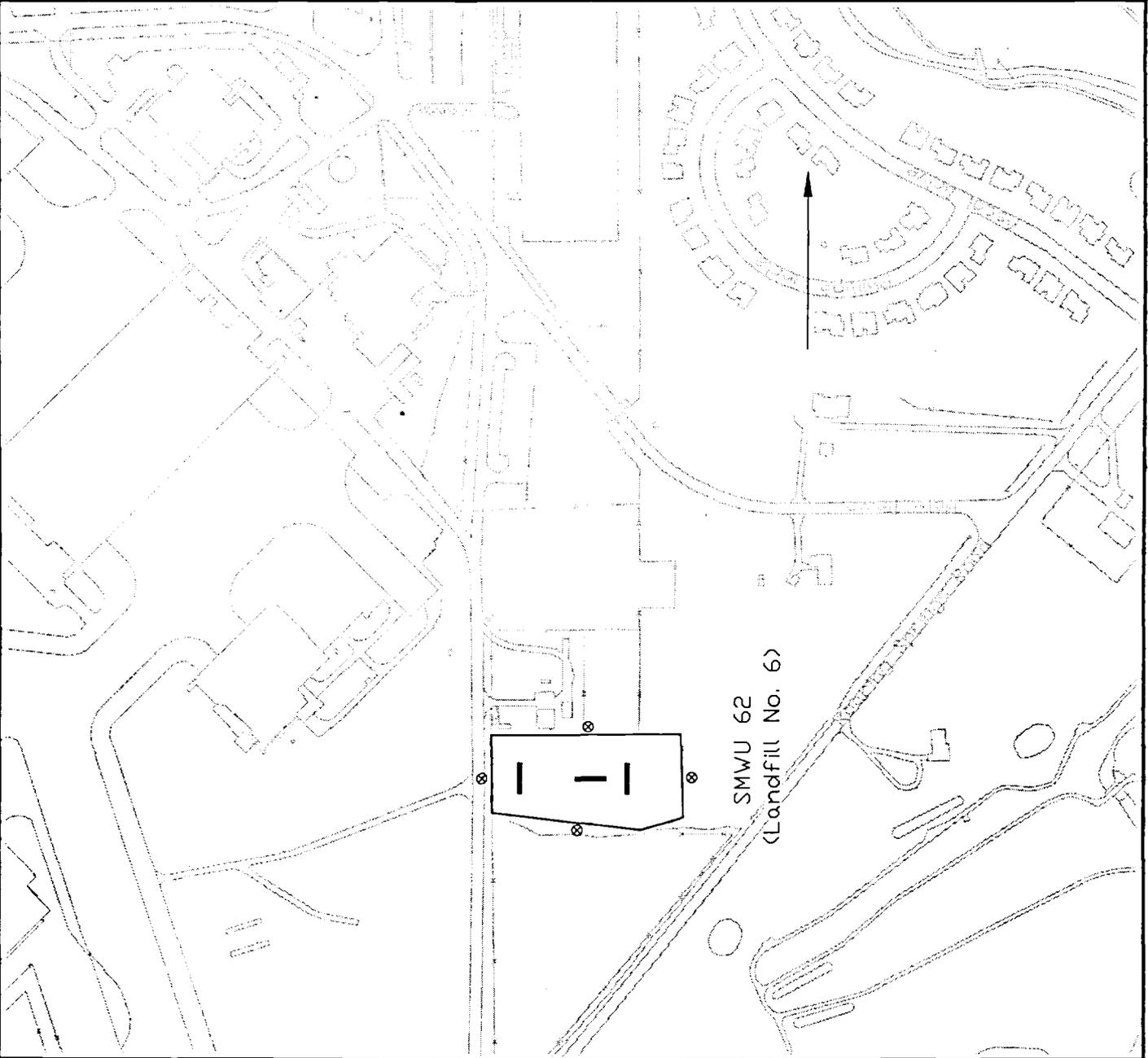


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Filename: FIG3-10.DWG

Map Source:
 JACOBS, 1996



Four soil borings will be installed around the perimeter of the unit as presented on Figure 3.10. One surface soil sample and one subsurface soil sample will be collected for laboratory analysis while drilling each of these soil borings. The subsurface sample will be collected from the depth of the maximum relative PID reading, or the top of the water table, in accordance with the procedures described in the attached FSP.

Each of these soil borings will be drilled to 1-foot into bedrock and completed as 2-inch diameter monitoring wells. Groundwater flow is generally from the west to the east in the alluvium beneath NAS Fort Worth JRB. The monitoring wells are proposed on each of the four sides of the unit to confirm groundwater flow direction, determine depth to bedrock, evaluate the unit represented as bedrock, determine depth to groundwater and characterize the physical/chemical characteristics of groundwater beneath the unit. The ultimate goal of the groundwater sampling program at this unit is to determine if the waste buried in the unit has impacted groundwater quality beneath the site. This will be determined by comparing the groundwater quality upgradient of the unit with the quality of the groundwater downgradient of the unit.

Based on the lack of historical records of buried debris and suspected contaminants associated with the SWMU, all soil and groundwater samples will be analyzed for VOCs, SVOCs, herbicides, pesticides/PCBs, and priority pollutant metals. Proposed analyses for soil and groundwater are summarized in Table 3.2. Additional soil borings and monitoring wells may be installed at a later date to delineate the extent of contamination originating from the SWMU, if the original suite of monitoring wells identify contamination above RRS.

3.4.6 Mobilization

Mobilization to the field is expected to begin as soon as relevant portions of the WP are approved. Several basic requirements for conducting field activities have already been put in place. Contractor photographic identification badges have already been obtained for lead personnel who will escort subcontractors in and out of restricted areas. Field equipment will be stored in the Former Radar Building 4100, atop SWMU 22 located at the west end of White Settlement Road. This area is surrounded by a fence that will restrict access and provide security for drilling rigs, associated support vehicles, and materials. During field activities, uncharacterized wastes will be containerized and stored within this fenced area for security. These materials will be segregated from existing materials already being stored at the site. Building 4100 will also provide work area, a source of potable water for the decontamination of equipment, and electricity for the recharging of equipment. A designated decontamination pad will also be located within the fenced area surrounding Building 4100.

3.4.7 Aquifer Testing

Aquifer testing will not be conducted during this field effort. Existing aquifer data collected by Radian (1991) is sufficient for this study.

3.4.8 Geophysical Surveys

Two geophysical tools will be used during each survey. One tool will be used to evaluate electromagnetic induction (EM), and the other tool will be used to conduct a magnetometer/gradiometer survey. These surveys will be conducted to evaluate the extent of the former landfills by identifying where soils have been disturbed (i.e., anomalous lows) and “hot spots” caused by ferromagnetic constituents such as drums(i.e., anomalous highs). The EM surveys (20-foot grid) will be used to initially identify and pinpoint areas with conductivity contrasts, i.e., “hot spots.” The EM surveys will measure the electrical response created by buried materials to identify waste locations. For example, a 55-gallon drum can provide a relatively high response of greater than 30 millisiemens per meter at depths of 10-15 feet below ground surface.

The 20-foot grid from the EM survey will be re-surveyed using a magnetometer/gradiometer for confirmation, as well as delineation of the lower extent of the SWMU. The magnetometer/gradiometer can detect variation in the subsurface by measuring the total field or earth’s magnetic field vector and the magnetic vertical gradient.

Measured geophysical survey data can be plotted and contoured for analysis. Magnetic highs can indicate buried ferromagnetic materials while magnetic lows can indicate disturbed soils. The extent of the disturbed soils may indicate the boundary of the former landfill. This information will be used to assure that optimal installation of test pits and soil sampling locations are selected. Geophysical investigations will be conducted in accordance with Section 5.3 of the FSP. Resistivity surveys were not selected because they are labor and time intensive since they require physical placement of probes in the ground.

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4.0 RISK ASSESSMENT

A brief description of the methods proposed for conducting human health and ecological risk assessment tasks is outlined in this section. Preliminary conceptual models have been developed to identify potential release and transport mechanisms, potential receptors, and exposure pathways associated with past disposal of debris and waste materials at the five landfills. The objective of the risk assessments is to characterize the potential risks associated with exposure to site media and, where the risks are unacceptable, to develop site-specific remediation goals protective of human health and the environment for use in the evaluation of remedial alternatives at the site.

4.1 HUMAN HEALTH RISK ASSESSMENT

The approach that will be used to assess human health risk at the five landfill sites is consisted with the United States Environmental Protection Agency (USEPA)'s Risk Assessment Guidance for Superfund (RAGS) Volume 1: Human Health Evaluation Manual (Part A) and Development of Risk-based Preliminary Remediation Goals (B) (USEPA, 1989 and 1991) and TNRCC's Risk Reduction Program (31 TAC 335, Subchapter S) (TNRCC, 1996b). Additional guidance may include State of Texas guidance for the closure of municipal landfills under RCRA Subtitle D (30 TAC Chapter 33, Subchapter J).

The TNRCC approach consists of three Risk Reduction Standards, RRS1 is based on background concentration levels and will serve as an initial screen for No Further Action site closures. RRS2 allows closure and/or remediation to health risk-based standards and criteria which are based on default assumptions concerning potential exposures. RRS2 will be used as a secondary screen for No Further Action site closures. If detected concentrations at the investigated SWMUs exceed RRS1 and RRS2, site closure will proceed under RRS3.

4.1.1 Technical Approach

If site closure cannot be completed because site concentrations exceed RRS1 and RRS2, baseline risk assessments will be prepared which will consist of the following five steps:

1. Data evaluation and identification of constituents of potential concern
2. Exposure assessment
3. Toxicity assessment
4. Risk characterization
5. Development of site-specific remediation goals

Step 1: Data Evaluation and Identification of Constituents of Potential Concern

Data will first be evaluated to assess the achievement of data quality objectives for the project. The constituents of potential concern (COPCs) will be those constituents detected in environmental media at the site at concentrations greater than background (RRS1) and risk-based screening levels (RRS2). The COPCs will be identified in accordance with guidance provided by TNRCC and USEPA. The COPCs are expected to be primarily organic and metal compounds.

Step 2: Exposure Assessment

Exposure assessment estimates the magnitude, frequency, duration, and routes of exposure. An assessment may include current and future exposures. Exposure assessment involves three distinct processes: 1) characterizing the exposure setting, 2) identifying exposure pathways, and 3) quantifying exposure.

- **Characterizing the Exposure Setting.** This step characterizes the exposure setting in terms of physical characteristics of the site and populations that might be exposed. Physical characteristics include climate, vegetation, groundwater, and surface water hydrology. Population characteristics include the location of receptors, the presence of sensitive subpopulations, and activity patterns of current and future populations.
- **Identifying Exposure Pathways.** This step identifies potential exposure pathways with respect to nearby populations. Exposure pathways are determined by the locations of sources, types of release mechanisms, types of contaminants, fate and transport mechanisms, and the location and activities of the receptors.
- **Quantifying Exposures.** This process is conducted in two steps: 1) estimation of exposure concentrations and 2) calculation of intakes. Exposure concentrations are based on analytical data from the site. Chemical intakes are expressed in terms of mass of chemical intake per day per unit body weight. Intakes are calculated using standard equations which represent specific exposure pathways. Parameters include exposure concentration, fraction ingested, contact rate, exposure duration and frequency, body weight, and averaging time.

Step 3: Toxicity Assessment

Toxicity assessment consists of two stages: hazard identification and dose-response assessment. Hazard identification evaluates whether a particular chemical can cause a particular health effect (such as cancer or birth defects) and whether the adverse health effect occurs in humans. Hazard identification also evaluates the nature and strength of the evidence of causation. Dose-response assessment quantitatively evaluates toxicity information for the chemical to determine the relationship between the administered dose of the chemical to the incidence of a particular adverse effect in the exposed population. Toxicity values for carcinogens are expressed in units of cancer incidence per unit dose of the chemical; for noncarcinogens, the toxicity values are expressed in terms of a threshold value below which adverse effects are not expected to be observed.

The toxicity assessment will include an identification of critical toxicity values for the constituents of potential concern. A database search will be conducted to identify human and ecological toxicity values. The USEPA's Integrated Risk Information System database and Health Effects Assessment Summary Tables will serve as the primary sources of human health toxicity values. Additional toxicity data may be obtained through consultation with the TNRCC and USEPA's National Center for Environmental Assessment. Ecological toxicity and/or benchmark values will be derived from the TNRCC documents and from the available scientific literature.

Step 4: Human Health Risk Characterization and Uncertainty Analysis

The final stage of the BLRA process is risk characterization and uncertainty analysis. Therefore, the risk characterization step integrates information from the toxicity and exposure assessments to express risk quantitatively. Carcinogenic risk is calculated as the product of the chemical-specific slope factor and the chemical intake. The risk is expressed as a dimensionless number. Noncarcinogenic effects are expressed in terms of dimensionless numbers called hazard quotients. A hazard quotient is the ratio of the chemical intake and the chemical-specific reference dose. In the event that the receptor is exposed to multiple contaminants through multiple pathways, the combined risk (for carcinogens) and hazard indices (for noncarcinogens) are presented as the weak sums of individual risks and hazard quotients. An analysis of uncertainties associated with assumptions associated with the risk assessment will be presented.

Step 5: Development of Risk Reduction Standards

Following the risk assessments, constituents that have an associated unacceptable noncarcinogenic and/or carcinogenic risk to humans and ecological receptors will be further addressed. Site-specific risk reduction standards will be developed, based upon cumulative risk, for such constituents detected in accordance with TNRCC and USEPA guidelines.

4.3 ECOLOGICAL RISK ASSESSMENT

The ecological risk assessment (ERAs) will be conducted in accordance with the protocols presented in the TNRCC "Draft Guidance for Conducting Ecological Risk Assessments Under the Texas Risk Reduction Program" (TNRCC, 1996a). In particular, the TNRCC guidance suggests using a tiered approach to assessing ecological risks. It should be noted that, given the highly developed nature of the NAS Fort Worth JRB and surrounding areas, ecological impacts are not expected to be a primary issue at the base. The need for ERAs will be determined based on field observations and analytical results. ERAs may be required for closures under RRS2 and for all closures under RRS3.

As a first step, Tier 1 assessments (i.e., completing the ecological assessment checklist) will be conducted. Depending on the results of this first step, Tier II assessments (screening-level assessments) and/or Tier III assessments (quantitative assessments) may be conducted. If these subsequent tiers are undertaken, further information defining the methodologies and approaches to be used will be developed. In general, the overall strategy for conducting Tier II and Tier III ERAs will be consistent with the TNRCC guidance, the USEPA guidance document "Ecological Risk Assessment for Superfund: Process for Designing and Conducting Ecological Risk Assessments" (USEPA, 1996a), and the "Tri-Services Procedural Guidelines for Performing Ecological Risk Assessments" (DoD, 1996).

4.4 EXPOSURE SETTING

Individual SWMUs to be investigated during this RFI, and their associated potential release and transport pathways include:

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- **SWMU 17** - This former landfill is approximately 3.4 acres in area and is currently vacant. The area is covered by various grasses and weeds that are not maintained. The surface of the site is also littered with small pieces of concrete, asphalt and rocks that have weathered through the soil cover. The area is surrounded to the west and south by a drainage ditch. The northern extent of the SWMU is not defined other than where ground maintenance begins. Potential contaminants that may have been released to the soil and underlying groundwater at this SWMU included metal and organic constituents. Unauthorized wastes that were discarded at this unit may include leftover paint containers and pesticide residues from runway maintenance and spent solvents from cleaning activities. The alluvial terrace groundwater may release contaminants to surface water in Farmers Branch Creek, two unnamed tributaries to Farmers Branch Creek and two ponds on the golf course.
- **SWMU 27** - This site consists of a ditch approximately 8 feet deep by 20 feet wide and 400 feet long. The ditch typically has approximately 4 to 5 feet of water during the winter months and usually dries out during the summer months due to evaporation and infiltration. The site is partially covered with vegetation. At least five drums of unknown content are currently present in the ditch and may have leaked contaminants to the local perched groundwater system, which may eventually percolate to the Paluxy aquifer. Potential contaminants which may have been released to the soil and underlying groundwater at this SWMU may include metals and organic constituents.
- **SWMU 29** - This inactive landfill is surrounded by an 8 foot chain linked fence that provides security for Building 1055. This building occupies approximately one fourth of the 4.4 acre site. The remaining portion of the site is either occupied by temporary trailers or is grass-covered. Moderate quantities of unspecified hazardous wastes may be present in surface and subsurface soils. Migration pathways of potential site contaminants such as metals and organic compounds may be by way of leaching to a drainage ditch that parallels the southern border of the site or to the underlying groundwater.
- **SWMU 30** - This inactive landfill is approximately 1.7 acres and received construction debris in the form of concrete, asphalt, steel and wood. A ditch has been created by runoff from an upgradient parking area located adjacent to Building 2570. In this ditch, concrete, asphalt, telephone poles, and reinforcing steel are visible in the west bank. Given its proximity to industrial shops, this SWMU may have received limited amounts of hazardous materials such as thinners, solvents, and POLs. This area has not been previously investigated. The site is currently covered by vegetation and current land use is limited to maintenance of the grass. The site is located near Building 2570 and is north of the West Fork Trinity River. A water line was recently installed across the eastern section of the site. Migration of potential contaminants may occur via leaching surface runoff and airborne redistribution of disturbed soils.
- **SWMU 62** - This inactive landfill is located between Roaring Springs Road and Haile Drive and is sparsely covered with vegetation. The site was identified in the PA/SI conducted by the USACE (1993) as a construction and debris landfill. It was documented that three drums of hydraulic fluid were placed in a centrally located pit, which collected

groundwater that seeped into the landfill. Several stock piles of fill dirt containing concrete, asphalt, crushed 55 gallon drums and wood have accumulated adjacent to the site. This appears to be the site's current unofficial purpose. Potential contaminants may have been released to soil and underlying groundwater at this SWMU. An initial site investigation was performed in 1993 which detected lead, BTEX constituents and TRPH in soil and groundwater.

4.5 RECEPTORS AND EXPOSURE SCENARIOS

This section represents an overview of the receptors and the potential exposure scenarios for the subject sites. To the extent that in many cases current and future receptors are in fact likely to be the same, their risks are already being considered under the "current" scenario. The receptor exposure scenarios in the conceptual model include:

- On-site Maintenance Worker Receptor - This exposure assumes that a worker conducts activities on an intermittent or short term basis. Exposure routes for this receptor may include:
 - Incidental ingestion of surface soil
 - Inhalation of fugitive dusts and volatile organics from the surface soil
 - Dermal contact with surface soil
 - Dermal contact with surface water and sediments

- On-site Worker - This exposure assumes a long-term employee is located at the site on a regular basis over their working career. Exposures for this receptor may include:
 - Incidental ingestion of surface soil
 - Inhalation of fugitive dusts and volatile organics from surface soil
 - Dermal contact with surface soil
 - Inhalation of volatile emissions in buildings which originated from soil

- On-site Construction Worker - This exposure assumes construction occurs on the site in the future which allows for a short - duration exposure scenario. Exposures for this receptor may include:
 - Incidental ingestion of soil
 - Inhalation of fugitive dusts and volatile organics in soil
 - Dermal contact with soil or surface water

- On-site Recreational Receptor - This exposure assumes that the receptor (i.e., an older child or young adult) visits an area intermittently. This receptor would only be exposed to contaminants in surface water/sediments in that the remaining units are secured due to military activities. The exposure routes evaluated for this receptor may include:
 - Dermal contact and incidental ingestion of chemicals in the surface water and sediments

- Future Off-site Resident Receptor - This exposure assumes that the receptor obtains all household water from private wells. Currently, the alluvial terrace groundwater unit does not impact any private wells. Additionally, there is no certainty that any private wells will be impacted in the future. Complete exposure pathways for groundwater will be determined subsequent to the evaluation of groundwater fate and transport to be conducted as part of the RFI. If it is determined that a future exposure pathway is complete for groundwater, then the exposure routes evaluated for this receptor may include:
 - Ingestion of groundwater
 - Inhalation of volatiles from groundwater
 - Dermal contact with chemicals in the groundwater
 - Ingestion of home-produced foodstuffs including fruits and vegetables

- Current and Future Ecological Receptors - Exposures for these receptors may include:
 - Dermal contact with sediment and surface water
 - Ingestion of surface water
 - Incidental ingestion of sediments and soil
 - Dermal contact with soil

4.6 CONCEPTUAL SITE MODEL

The conceptual model provides a basis for identifying and evaluating the potential risks to human health in the BLRA. The conceptual model facilitates consistent and comprehensive evaluation of risks by creating a framework for identifying the paths by which humans and ecological receptors may be impacted by the subject SWMUs at NAS Fort Worth JRB.

The elements necessary to construct a complete exposure pathway and develop the conceptual model include:

- Sources and potential chemicals of potential concern (COPCs)
- Release mechanisms
- Transport pathways
- Exposure pathway scenarios
- Receptors

The conceptual site model for potential human environmental exposures to the soils, sediments, surface waters, and groundwater are summarized in Figures 4.1 and 4.2. Figure 4.1 pertains to exposure and risks to contaminants contained in surface soil, while 4.2 pertains to contaminants in subsurface soils. This separation is significant, because certain release mechanisms, and corresponding exposure scenarios, such as exposure to dust and volatile emission from soil, are of concern only if contaminants are in fact present in surface soil. If surface soil sampling to be conducted during the RFI does not show the presence of contaminants in surface soil, these exposure pathway scenarios can accordingly be eliminated from the BLRA.

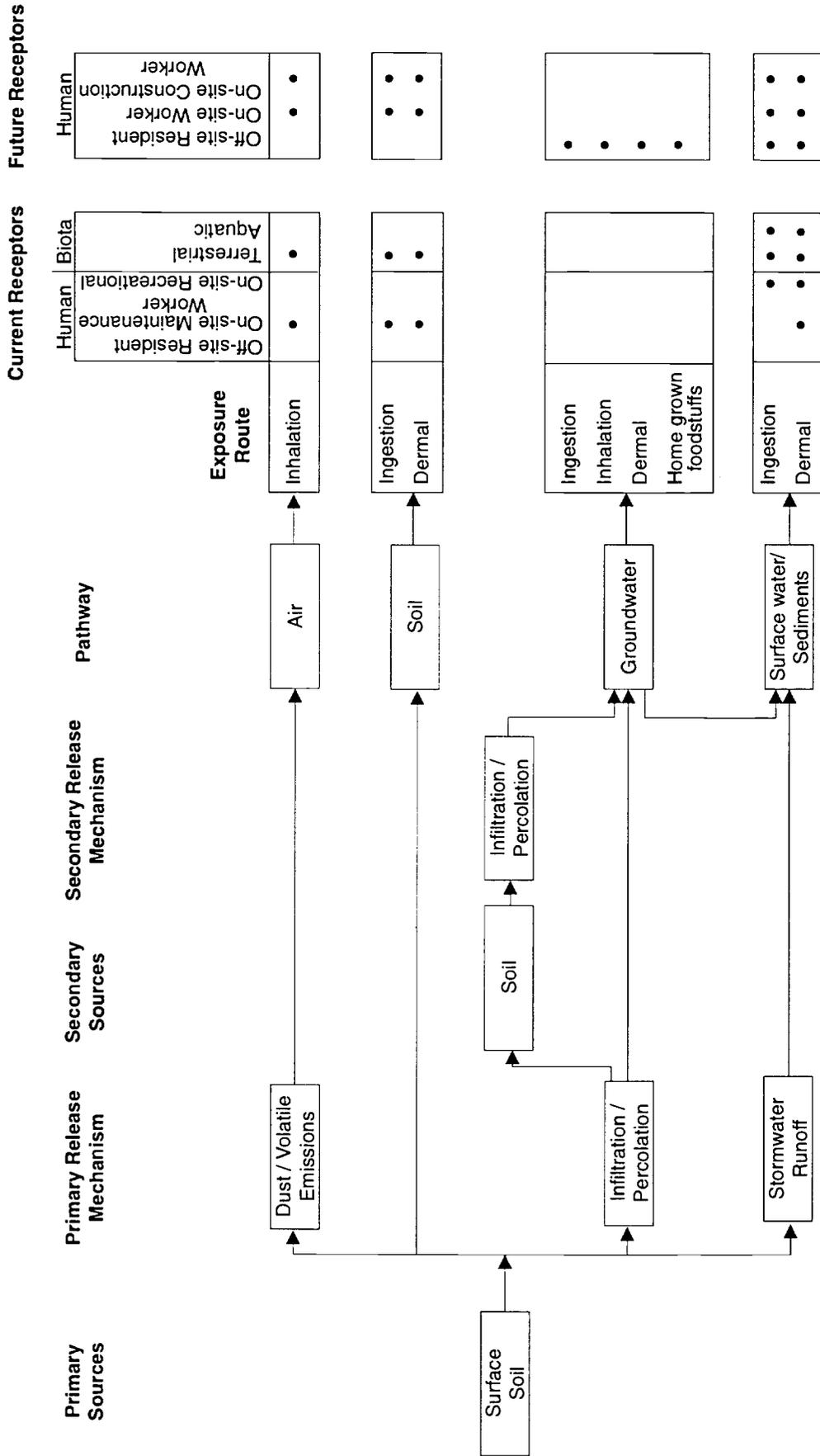


Figure 4.1
Conceptual Exposure Pathway Model
for Surface Soil
NAS Fort Worth JRB, Texas

Drawn By: M. LAWLOR	Date: 6/12/97
Checked By: K. HURLEY	Date: 6/12/97
Filename: FLOWCHRT.CDR	

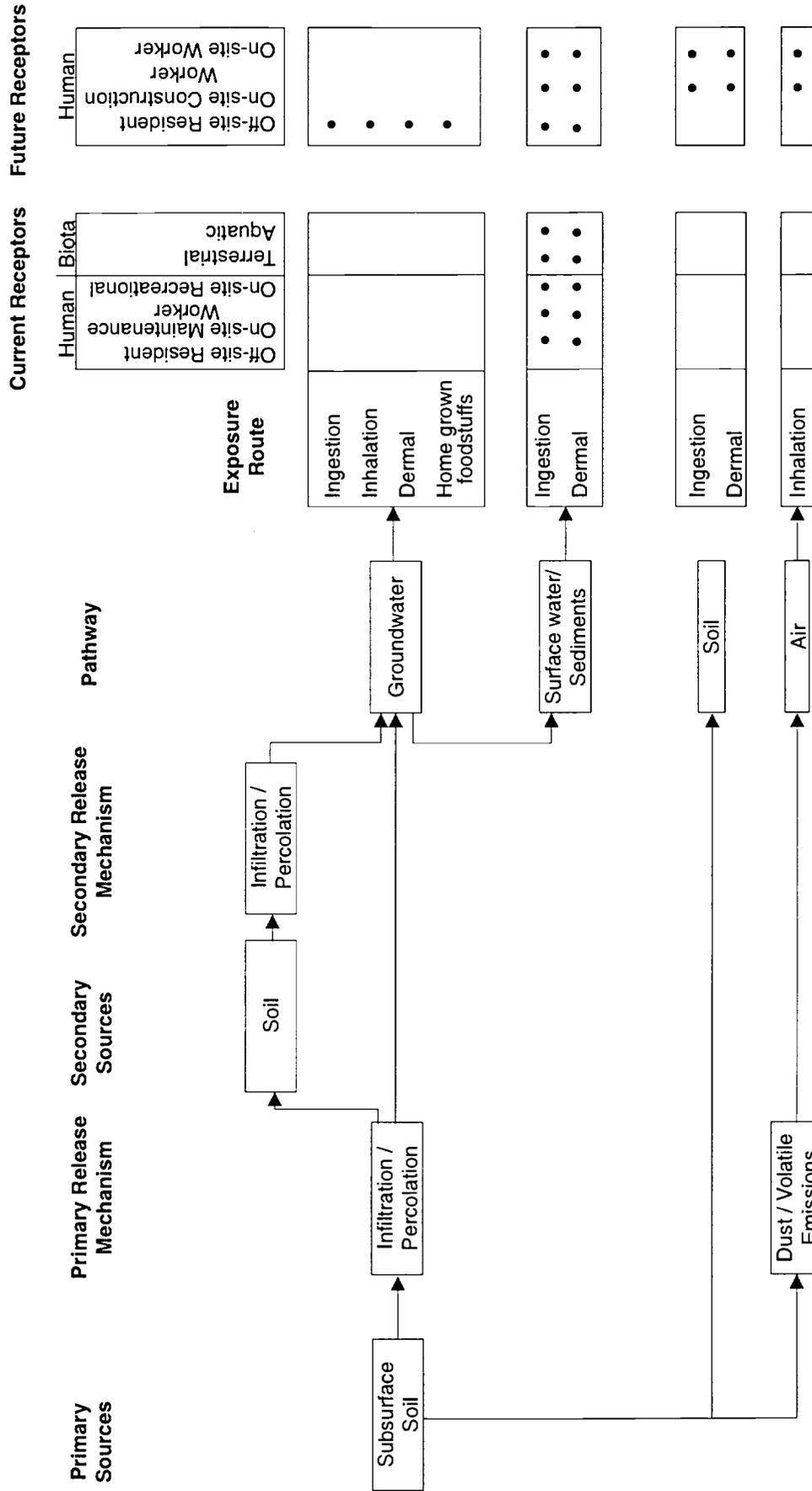


Figure 4.2
**Conceptual Exposure Pathway Model
 for Subsurface Soil
 NAS Fort Worth JRB, Texas**

Drawn By: M. LAWLOR	Date: 6/12/97
Checked By: K. HURLEY	Date: 6/12/97
Filename: FLOWCHRT.CDR	

5.0 REMEDIAL ACTION

If a BLRA is required at any of the subject SWMUs, and the results of this BLRA indicates an unacceptable threat to human health or the environment, a Corrective Measures Study (CMS) may be required. The purpose of the CMS is to develop and evaluate remedial alternatives to reduce risks to human health and the environment to acceptable levels. If the sites are closed under RRS1 or RRS2, or the results of the BLRA show that the SWMUs investigated do not pose unacceptable risks to human health and the environment, then a CMS will not be required.

5.1 REMEDIAL ACTION OBJECTIVES

Specific response objectives will be developed using ARARs and risk-based methods to define media specific cleanup levels that would reduce risks to public health and the environment to acceptable levels. Potential contaminant migration pathways and exposure pathways, identified in the BLRA will be examined further as a basis for estimating acceptable onsite residual contamination levels. Acceptable exposure levels for potential receptors will be identified and onsite cleanup levels will then be estimated by extrapolating from receptor points back to source areas along critical migration pathways. Development of the CMS objectives will also include refinement of ARARs specific to NAS Fort Worth JRB.

5.2 REMEDIAL ALTERNATIVES

Based on the objectives detailed in this work plan, potential contaminated media, site contaminants per media, and a list of potential remedial alternatives have been developed and evaluated. Tables 5.1 and 5.2 summarize these alternatives for soil and groundwater, respectively. The alternatives that pass the initial screening process will be further evaluated and compared.

The listed remedial technologies and alternatives will be screened to eliminate from further consideration technologies and alternatives that are undesirable regarding implementability, effectiveness, and cost. The list of alternatives being considered will be narrowed by eliminating the following types of technologies:

- Technologies and alternatives that are not effective because they do not provide for the overall protection of human health and the environment, or do not comply with ARARs.
- Technologies and alternatives that are not implementable or technically inapplicable.
- Technologies/alternatives that are more costly than other technologies/alternatives but do not provide greater environmental or public health benefits, reliability, or a more permanent solution. Costs alone will not be used to eliminate technologies but may be used to select representative process options.

For each alternative that warrants further investigation, detailed documentation will be included to evaluate compliance with each of the objectives listed below.

Table 5.1
Technology Types and Process Options for Soil/Sediment
NAS Fort Worth JRB, Texas

General Response Action	Technology Type	Process Options	Description	Comments
No-Action	None	Not Applicable	No-Action	Required to be retained by NCP
Institutional Controls	Access Restrictions	Access Restrictions	Physical limitations to prevent access to land and groundwater	Potentially applicable, retained for further consideration
		Deed Restrictions	Limiting land and groundwater use by subsequent owners	Potentially applicable, retained for further consideration
Containment	Barriers	Grout Curtains	Tubes of grout surround the contaminated area	Not applicable, does not control exposure pathways
		Slurry Walls	Inject clay slurry in continuous trench around contamination	Not applicable, does not control exposure pathways
		Sheet Piling	Driving interlocking steel walls around contamination	Not applicable, does not control exposure pathways
	Capping	Asphalt, clay, concrete, synthetic	Install near-impermeable cover to prevent infiltration to prevent contaminant movement	Potentially applicable
Treatment	Physical	Vapor Extraction	Extracting VOCs from the soil by creating a vacuum	Potentially applicable to VOC contamination
	Chemical	Soil Mixing	Use augers to mix in stabilizing chemicals	Not applicable for organic contaminants
		Soil Washing	Removing contaminants by adding solvents, surfactants to soil	Potentially applicable
		Immobilization	Using cement grout to immobilize contaminated soil	Questionable for organics, requires extensive testing
	Thermal	Incineration	Destroys organic contaminants	Potentially applicable

Table 5.1 (continued)
Technology Types and Process Options for Soil/Sediment
NAS Fort Worth JRB, Texas

General Response Action	Technology Type	Process Options	Description	Comments
Treatment (cont)	Thermal	Low temperature thermal oxidation	Drives off organic contaminants	Potentially applicable
	Biological	Aerobic	Microorganisms metabolize organic contaminants	Not applicable, difficult to implement in heterogeneous sites, such as landfills
		Anaerobic	Microorganisms metabolize organic contaminants	Not applicable, difficult to implement in heterogeneous sites, such as landfills
Removal/Disposal	Excavation	Excavation	Removing contaminated soil from area	Potentially applicable for both organic and inorganic contamination
	Disposal	On-site Disposal	Creating RCRA landfill and placing contaminated soil in the landfill or placing non-RCRA soil and sediment at existing landfill	New RCRA landfill not allowed by Air Force regulations, not applicable. Disposal of non-RCRA soil at existing site may be applicable
		Off-site Disposal	Sending waste to RCRA approved landfill, if it meets BDAT regulations	Potentially applicable

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Table 5.2
Technology Types and Process Options for Groundwater
NAS Fort Worth JRB, Texas

General Response Action	Technology Type	Process Options	Description	Preliminary Screening Comments
No Action	None	Not Applicable	No actions to remove contamination or sever the exposure pathway	Required for consideration by the NCP as a baseline comparison
Institutional Controls	Access Restrictions	Access Restrictions	Physical limitations to prevent access to land and groundwater	Potentially applicable, retained for further consideration
		Deed Restrictions	Limiting land and groundwater use by subsequent owners	Potentially applicable, retained for further consideration
	Monitoring	Monitoring	Water monitoring using existing wells	Potentially applicable, retained for further consideration
Containment	Physical Containment: Barriers	Sheet Piling	Driving interlocking steel walls around contamination	Subject to corrosion, difficult to install with fill, cobbles in soil, not applicable
		Slurry Walls	Inject clay slurry in continuous trench around contamination	Potentially applicable, retained for further consideration
	Capping	Asphalt, Clay, Concrete, Synthetic	Install impermeable cover to prevent infiltration and contaminant movement	Potentially applicable, retained for further consideration
Collection/Treatment/Disposal	Collection Technologies:	Vertical wells	Pump contaminated groundwater using vertical wells to remove contaminants from the aquifer	Potentially applicable to the uppermost groundwater
		Horizontal wells	Pump contaminated groundwater using horizontal wells to remove contaminants from the aquifer	Potentially applicable to the uppermost groundwater

Table 5.2 (continued)
Technology Types and Process Options for Groundwater
NAS Fort Worth JRB, Texas

General Response Action	Technology Type	Process Options	Description	Preliminary Screening Comments
Collection/ Treatment/Disposal (cont)	Groundwater extraction	Interceptor trench	Intercept dissolved contaminants in the subsurface	Potentially applicable to the uppermost groundwater
	Treatment technologies: Physical treatment	Air stripping	Remove dissolved volatile organics from groundwater with air	Potentially applicable to the uppermost groundwater
		Carbon adsorption	Adsorb dissolved organic compounds onto granulated carbon	Potentially applicable to the uppermost groundwater
		Oil/water separation	Separate emulsified, floating or sinking oils from water	Potentially applicable to the uppermost groundwater
	Chemical Treatment	UV/oxidation	Use ultraviolet light with ozone or hydrogen peroxide to destroy contaminants	Potentially applicable to the uppermost groundwater
		Fenton-like chemistry	Use Fenton-like chemistry to generate hydroxyl radicals to cleave organic bonds	New technology. Potentially applicable to uppermost groundwater
	Biological treatment	Ex-situ bioremediation	Use microorganisms to destroy or alter contaminants	Not reliable for chlorinated compounds, not considered
		In-situ bioremediation	Use microorganisms to destroy or alter contaminants	Not considered because still in the development stage for chlorinated hydrocarbons
		In-situ phytoremediation	Use plants to destroy or alter contaminants	Potentially applicable for Alluvial Terrace Groundwater

Table 5.2 (continued)
Technology Types and Process Options for Groundwater
NAS Fort Worth JRB, Texas

General Response Action	Technology Type	Process Options	Description	Preliminary Screening Comments
Collection/ Treatment/Disposal (cont)	In-situ treatment	Air sparging	Pump air into aquifer, volatilize dissolved organics	Difficult to control in heterogeneous media, could spread contamination, not considered
	Discharge technologies: On-site Discharge	Discharge to surface water	Discharge treated water to local surface water	Potentially applicable for the uppermost groundwater
	Off-site Discharge	POTW	Send water to an off-site treatment facility	Potentially acceptable

- Compliance with other laws and regulations
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume
- Short-term effectiveness
- Implementability
- Cost

To the extent possible, remedial alternatives that use permanent solutions and alternative treatment technologies will be considered. Tables 5.3 and 5.4 summarize the remedial alternatives for each SWMU in this investigation.

5.3 RECOMMENDED FINAL CORRECTIVE MEASURE ALTERNATIVE

For each alternative that warrants further investigation, detailed documentation will be included to evaluate compliance with each of the objectives listed below.

- Overall protection of human health and the environment
- Compliance with media cleanup standards
- Control the source of release
- Compliance with any applicable standards for management of wastes
- Long-term reliability and effectiveness
- Reduction in mobility, toxicity, or volume of wastes
- Short-term effectiveness
- Implementability
- Cost

To the extent possible, remedial alternatives that use permanent solutions and alternative treatment technologies will be considered.

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Table 5.3
Soil Remedial Alternatives and Data Needs
NAS Fort Worth JRB, Texas

SWMU	Materials Received/ Current Status	General Response Action	Remedial Alternative	Data Needs	
17	Construction waste and rubble; possibly small amounts of hazardous wastes. Inactive; no evidence of releases.	No Action	Not Applicable	<ul style="list-style-type: none"> • level of and type of contamination • level of groundwater • future level use • extent of contamination 	
		Containment	Capping		
		Treatment	Vapor Extraction		
			Soil Washing		
27	Concrete rubble, tree limbs, and street sweeping debris. Active for street debris disposal.	Removal/Disposal	Incineration		
		No Action	Excavation		
			Off-site Disposal		
29	Construction rubble and materials, moderate quantities of unspecified hazardous wastes. Inactive (partially covered by B1055); no evidence of releases.	No Action	Not Applicable	<ul style="list-style-type: none"> • level of and type of contamination • level of groundwater • future level use • extent of contamination 	
		Containment	Capping		
			Removal/Disposal		Excavation
					Off-site Disposal
		Treatment	Not Applicable		
			Vapor Extraction		
Soil Washing					

Table 5.3 (continued)
Soil Remedial Alternatives and Data Needs
NAS Fort Worth JRB, Texas

SWMU	Materials Received/ Current Status	General Response Action	Remedial Alternative	Data Needs	
30	Construction rubble and trees; possibly small amounts of hazardous materials. Inactive; no data found.	No Action	Not Applicable	<ul style="list-style-type: none"> level of and type of contamination level of groundwater future level use extent of contamination 	
		Containment	Capping		
		Treatment	Vapor Extraction		<ul style="list-style-type: none"> level of and type of contamination level of groundwater future level use extent of contamination
			Soil Washing		
Removal/Disposal	Incineration				
	Excavation				
62	Construction rubble, drums of hydraulic fluid, and small quantities of hazardous materials. Inactive (Navy uses for soil stockpiles).	No Action	Not Applicable	<ul style="list-style-type: none"> level of and type of contamination level of groundwater future level use extent of contamination 	
		Containment	Capping		
			Treatment		Vapor Extraction
		Removal/Disposal			Soil Washing
			Removal/Disposal		Incineration
		Removal/Disposal			Excavation
			Removal/Disposal		Excavation
		Removal/Disposal			Off-site Disposal

Sources: CH2M HILL, 1996b.
Carswell AFB Management Action Plan, October 1993.
RCRA Facility Investigation Statement of Work, January 1997.

Table 5.4
Groundwater Remedial Alternatives and Data Needs
NAS Fort Worth JRB, Texas

SWMU	Materials Received/ Current Status	General Response Action	Remedial Alternative	Data Needs
17	<p>Construction waste and rubble; possibly small amounts of hazardous wastes.</p> <p>Inactive; no evidence of releases.</p>	<p>No Action</p> <p>Institutional Controls</p> <p>Collection, Treatment, and Disposal</p>	<p>Not Applicable</p> <p>Monitoring</p> <p>Air Stripping</p> <p>Carbon Adsorption</p> <p>Oil/water Separation</p> <p>UV/oxidation</p> <p>POTW (on/off site)</p>	<ul style="list-style-type: none"> • level of and type of contaminant • level of groundwater • future land use • yield of aquifer • presence of NAPL • location of contaminant • groundwater flow direction • seasonal variation • extent of contamination
27	<p>Concrete rubble, tree limbs, and street sweeping debris.</p> <p>Active for street debris disposal.</p> <p>Construction rubble and materials, moderate quantities of unspecified hazardous wastes.</p> <p>Inactive (partially covered by B1055); no evidence of releases.</p>	<p>No Action</p> <p>Institutional Controls</p> <p>Collection, Treatment, and/or Disposal</p>	<p>Not Applicable</p> <p>Monitoring</p> <p>Air Stripping</p> <p>Carbon Adsorption</p> <p>Oil/water Separation</p> <p>UV/oxidation</p> <p>POTW (on/off site)</p>	<ul style="list-style-type: none"> • level of and type of contaminant • level of groundwater • future land use • yield of aquifer • presence of NAPL • location of contaminant • groundwater flow direction • seasonal variation • extent of contamination

Table 5.4 (continued)
 Groundwater Remedial Alternatives and Data Needs
 NAS Fort Worth JRB, Texas

SWMU	Materials Received/ Current Status	General Response Action	Remedial Alternative	Data Needs
29	Construction rubble and trees; possibly small amounts of hazardous materials. Inactive; no data found.	No Action	Not Applicable	<ul style="list-style-type: none"> • level of and type of contaminant • level of groundwater • future land use • yield of aquifer • presence of NAPL • location of contaminant • groundwater flow direction • seasonal variation • extent of contamination
		Institutional Controls	Monitoring	
			Air Stripping	
			Carbon Adsorption	
			Oil/water Separation	
			UV/oxidation	
		Collection, Treatment, and Disposal	POTW (on/off site)	<ul style="list-style-type: none"> • level of and type of contaminant • level of groundwater • future land use • yield of aquifer • presence of NAPL • location of contaminant • groundwater flow direction • seasonal variation • extent of contamination

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Table 5.4 (continued)
Groundwater Remedial Alternatives and Data Needs
NAS Fort Worth JRB, Texas

SWMU	Materials Received/ Current Status	General Response Action	Remedial Alternative	Data Needs	
30	Construction rubble, drums of hydraulic fluid, and small quantities of hazardous materials. Inactive (Navy uses for soil stockpiles).	No Action	Not Applicable	<ul style="list-style-type: none"> level of and type of contaminant level of groundwater future land use yield of aquifer presence of NAPL location of contaminant groundwater flow direction seasonal variation extent of contamination 	
			Institutional Controls		Monitoring
		Collection, Treatment, and Disposal	Air Stripping		<ul style="list-style-type: none"> level of and type of contaminant level of groundwater future land use yield of aquifer presence of NAPL location of contaminant groundwater flow direction seasonal variation extent of contamination
			Carbon Adsorption		
			Oil/water Separation		
			UV/oxidation		
POTW (on/off site)					
62	Construction waste and rubble; possibly small amounts of hazardous wastes. Inactive; no evidence of releases.	No Action	Not Applicable	<ul style="list-style-type: none"> level of and type of contaminant level of groundwater future land use yield of aquifer presence of NAPL location of contaminant groundwater flow direction seasonal variation extent of contamination 	
			Institutional Controls		Monitoring
		Collection, Treatment, and Disposal	Air Stripping		<ul style="list-style-type: none"> level of and type of contaminant level of groundwater future land use yield of aquifer presence of NAPL location of contaminant groundwater flow direction seasonal variation extent of contamination
			Carbon Adsorption		
			Oil/water Separation		
			UV/oxidation		
POTW (on/off site)					

Sources: CH2M HILL, 1996b.
Carswell AFB Management Action Plan, October 1993.
RCRA Facility Investigation Statement of Work, January 1997.

5.3.1 Overall Protection of Human Health and the Environment

Alternatives must adequately protect human health and the environment, in both the short- and long-term, from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the site by eliminating, reducing, or controlling exposures to contamination. Overall protection of human health and the environment draws on the assessments of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

5.3.2 Compliance with Media Cleanup Standards

Alternatives will be assessed as to whether they attain legally applicable or relevant and appropriate requirements or other Federal and state environmental and public health laws and guidance. ARARs for this project were discussed in Section 3.0 of this work plan.

5.3.3 Control the Source of Release

The source of the contamination at each of the SWMUs will be confirmed during the RFI process. Remedial alternatives to control future releases from these sources will be evaluated and built into the selected remedial alternative.

5.3.4 Compliance with Applicable Standards for Management of Wastes

A discussion will be included in the CMS as to how waste management activities associated with the remedial alternatives will be implemented. Factors that may affect the waste management activities may include evaluating the effect that closure regulations and land disposal restricting may have on the selected remedial alternative.

5.3.5 Long-term Reliability and Effectiveness

Alternatives will be assessed for the long term effectiveness and permanence they afford along with the degree of certainty that the remedy will prove successful. Each technology will be evaluated for the potential deterioration over time and the impact this may have on receptors.

5.3.6 Reduction in Mobility, Toxicity, or Volume of Wastes

The degree to which the corrective measure alternatives employ treatment that reduces toxicity, mobility, or volume will be evaluated. The evaluation will focus on the following specific factors for each potential corrective measures alternative:

- The treatment process and the materials it will treat
- The amount of hazardous material that will be destroyed or treated
- The degree to which the treatment will be irreversible

- The type and quantity of treatment residuals that will remain for treatment
- Whether the alternative would satisfy the statutory preference for treatment as a principal element.

5.3.7 Short-term Effectiveness

The effectiveness of the alternatives will be evaluated to determine the affect on human health and the environment during the period in which the remedial alternative is being constructed and implemented and until the cleanup criteria are met. Factors to be addressed in evaluation of short term effectiveness include:

- Protection of human health and the environment during the remedial action, including such factors as exposure to dust during construction and potential exposure during transportation.
- Protection of workers during the remedial alternative implementation.
- Evaluation of the impact caused to the environment from the implementation of the remedial action.
- Time required to reach the remedial alternative objectives.

5.3.8 Cost

For each alternative, the cost will be estimated within a range of generally -30 percent to + 50 percent. The cost analysis will include separate derivations developed for capital costs, operation and maintenance (O&M) costs, costs of 5 year reviews, net present value of capital and O&M costs, and potential future remedial actions.

6.0 DATA ASSESSMENT, RECORDS, AND REPORTING REQUIREMENTS ³³⁰¹¹⁹

The following sections provide an explanation for procedures that are used in the verification of data, the maintenance of that data, and how it will be reported throughout the course of the investigation.

6.1 DATA ASSESSMENT

The project chemist will review all data received from the laboratory. This review consists of the following:

- Sample analysis completeness - Were all samples analyzed? Were samples analyzed for the parameters listed in the Work Plans?
- Evaluation of holding times - Were samples analyzed within the specified holding and extraction times?
- Evaluation of quality control - Were standard curves within method control limits? Were preparation and method blanks contaminated? Were continuing calibration standards in control? Were matrix spikes and matrix spike duplicates performed? How did field duplicates compare? Were corrective actions taken?
- Establishment of detection limits - Were detection limits met? If not, why?

The project chemist utilizes Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analysis (EPA, 1988) and National Functional Guidelines for Organic Data Review (EPA, 1991 - Draft) as guidance documents to data validation.

In general (for GC), an initial 5-point calibration must exhibit RF of less than 20 percent RSD, or a calibration curve with a correlation coefficient of greater than 0.995, and the continuing calibration check standard should not vary over 15 percent of the initial calibration. Retention time windows must be established for each specific GC column initially, followed by daily retention time windows. Quality control check standards must be analyzed for every analytical batch, method blanks for every analytical batch, and an MS/MSD pair for every 20 samples. Surrogates must be added to all standards, blanks, and samples.

If any data points are qualified, they will receive the data qualifiers described on Table 8.2-1 of the Base-Wide QAPP (CH2M Hill, 1996). The data associated with compounds/analytes which exhibit either poor response, poor percent difference or relative percent difference in the initial calibration or continuing calibration standards, or poor recoveries in the LCS are considered quantitative estimates and are flagged (J, UJ, or R) accordingly. If IS or surrogate fail criteria (after corrective action was taken, compounds associated with the IS or surrogates would be flagged (J, UJ, or R) as estimated. If sample analysis exceeded holding times, the data would be flagged as estimated (J, UJ, or R). If the method blank was contaminated with common laboratory chemicals or field contamination, any result less than or equal to ten times that found in the blank

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would be flagged as estimated (U) (for common organics, less than or equal to five times for uncommon organics and for any inorganics). When data exhibit several deficiencies resulting in poor QA/QC support, then the data is rejected, considered unusable and flagged with an "R". Any MS/MSD data would be reviewed separately and qualified based on all the data available. Estimated data is not necessarily unusable data. All project-wide precision, accuracy, and completeness goals will be reviewed and the data will be validated subject to these goals. If these goals are not met, resampling and analysis may be necessary.

The project chemist also reviews the field and office sampling records made during sample collection along with the results from the field QC samples. This review consists of the following:

- Field record completeness: Were all field analysis performed as planned? Were all field samples collected per the Work Plans? Were any problems encountered and how were they resolved? Were all field records complete?
- Sampling and decontamination procedures review: Were all field duplicates collected? How did they compare? Were all rinsates collected? Did these rinsates show contamination? Were the trip blanks contaminated? Did samples arrive intact and in proper shipping protocol?
- Identification of valid samples: Were samples collected using the proper protocol? Were there probable sources of potential contamination during sampling?
- Correlation of field test data and identification of anomalous field test data: Did different methods of measurements for the same test correlate?

Review of the results of the field QC data such as rinsates, trip blanks, and duplicates can help in assessing sample integrity. The field data and laboratory data will be reviewed and evaluated to the established data quality objectives. Data quality evaluations will be performed on all NAS Fort Worth Joint Reserve Base samples (100 percent). However, formal data validation will only be conducted on ten percent of the samples collected from each media of concern during this investigation.

6.2 RECORD KEEPING

Records of field and laboratory activities will be documented on standard forms (Section 8.0 of the FSP) as noted in the accompanying FSP and QAPP, which are both part of the SAP. Project data such as geophysical surveys, groundwater level measurements, boring logs, survey data, well construction forms, chain-of-custody forms, and equipment calibration logs will be reviewed for accuracy and completeness. These documents will be reviewed by the Project Manager daily and retained in the project files.

6.3 REPORTING REQUIREMENTS

6.3.1 RCRA Facility Investigation

The primary report of the project will be the RFI. The report will characterize the environmental conditions at each site, check each sample package for completeness and quality, evaluate data from each site in the form of a quantitative risk assessment and recommend a future course of action for each site. Each site potentially has one of three recommended future courses: no action, further investigation, or advancement to CMS. Sites continuing to the CMS will be screened for potential remedial alternatives. One alternative will be selected and proposed as the remedial action to be conducted at the site.

6.3.2 Corrective Measures Study (CMS)

The purpose of the CMS is to develop and evaluate remedial alternatives to reduce risks to human health and the environment to acceptable levels. The risks to human health and the environment evaluated in the CMS will be based on the results of the RFI. If the results of the RFI show that the SWMUs investigated do not pose unacceptable risks to human health and the environment, then a CMS will not be required.

6.3.3 Remedial Action Plan (RAP)

A Remedial Action Plan (RAP) report will be submitted for sites where the RFI results indicate that remediation is warranted. The remedial alternative selected for the site will be based on the alternatives presented in the CMS. The recommendation presented will include preliminary designs, site specific drawings, cost estimates and schedules for the alternative.

6.3.4 Decision Documents

A decision document will be submitted for sites where no further action is the recommended alternative. Information presented in the RFI will support the alternative. The decision document will include historical information and data necessary to support no further action.

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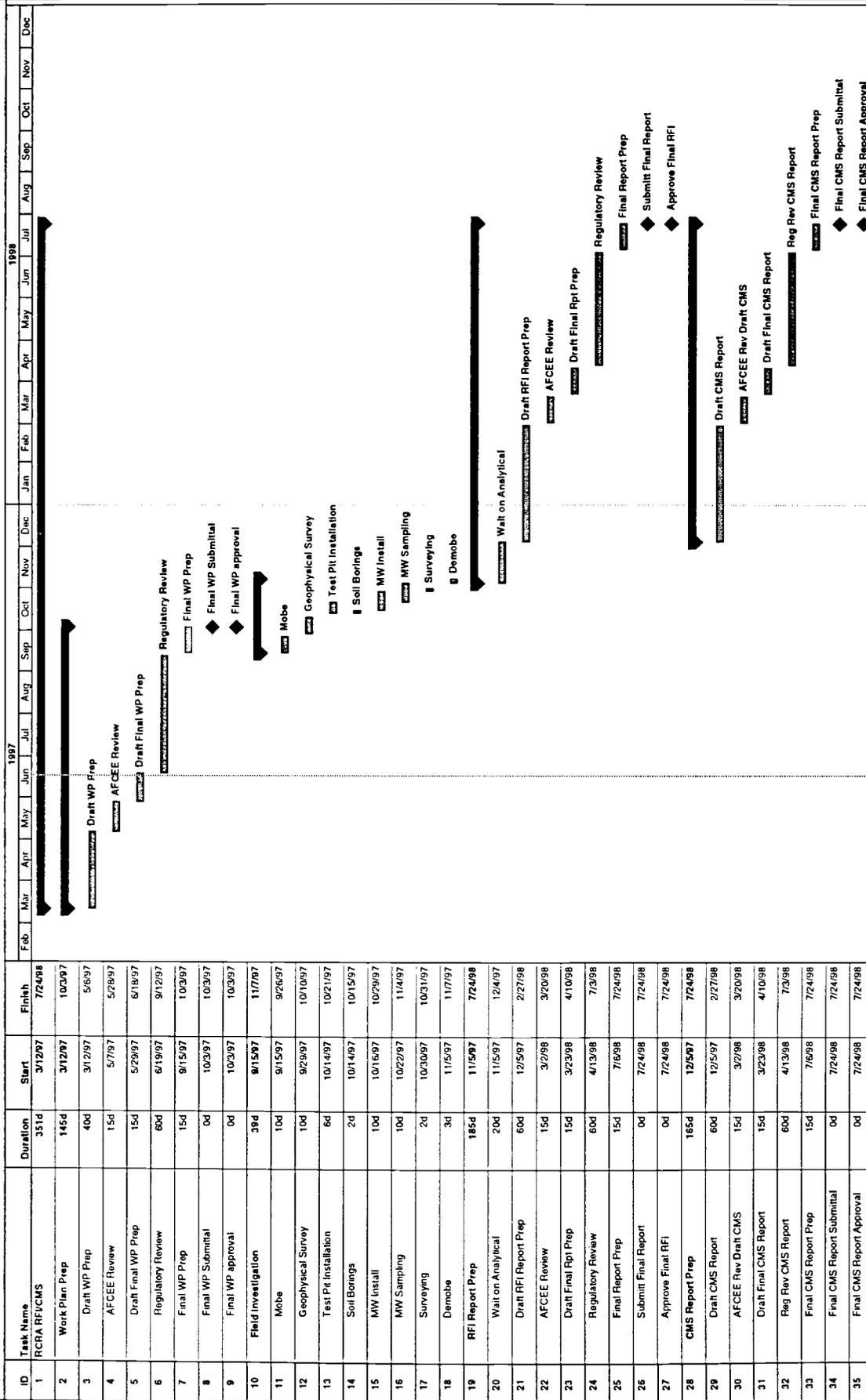
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7.0 PROJECT SCHEDULE AND REFERENCES

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The activities described in this WP will be implemented in accordance with the schedule provided in Figure 7.1. The starting date for the field effort will be the date of agency concurrence of the relevant portions of the WP. If possible, this schedule will be accelerated with select activities (e.g., procurement of materials and supplies) occurring when resolution of significant technical issues is made between NAS Fort Worth JRB and regulatory agencies.

Figure 7.1
Project Schedule
NAS Footh Worth JRB, Texas



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Project: D.O. 5 Schedule
Date: 6/17/97
* Duration 1hr - 4 in working days

Task
Progress

Milestone
Summary

Roll Up Task
Roll Up Milestone

Roll Up Progress

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**DRAFT FINAL
FIELD SAMPLING PLAN**

**RCRA FACILITY INVESTIGATION OF LANDFILLS
NAS FORTH WORTH JRB, TEXAS**

Contract Number F41624-95-D-8005

Prepared for:

U.S. Air Force Center for Environmental Excellence
Brooks AFB, Texas

Prepared by:

HydroGeoLogic, Inc.
1155 Herndon Parkway, Suite 900
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June 1997

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PREFACE

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This document is part of the Work Plan for a Resource Conservation Recovery Act (RCRA) Facility Investigation (RFI) at five Solid Waste Management Units (SWMUs) at Naval Air Station (NAS) Fort Worth Joint Reserve Base (JRB), Texas. The investigation is being conducted as part of the United States Air Force Installation Restoration Program. This work is authorized as Delivery Order 0005 under Air Force Center for Environmental Excellence (AFCEE) Contract No. F41624-95-D-8005. The Work Plans consist of a Work Plan (WP), a Sampling and Analysis Plan (SAP), and a Health and Safety Plan (HSP). The SAP consists of a Field Sampling Plan (FSP) and a Quality Assurance Project Plan (QAPP). The FSP describes in detail the proposed sampling and analysis and the specific procedures, measurements, and record keeping requirements for the field effort.

HydroGeoLogic's Program Manager, Mr. John Robertson, will be responsible for reviewing and approving this FSP. The Project Manager, Mr. James Costello, will be the prime point of contact with NAS Fort Worth JRB and AFCEE and will be responsible for technical, budget, and scheduling associated with this FSP. Quality Assurance, Laboratory, Technical, and Safety and Health Professionals will be responsible for maintaining a high degree of quality control for their associated tasks performed as part of the SAP.

Mr. Joseph Dunkle, AFCEE/ERD, the Contractor Officer Representative for this scope of work will be HydroGeoLogic's sole point of contact. The activities described in this SAP will begin after the date of agency concurrence on relevant portions of the SAP to Mr. Dunkle. Field investigative activities are tentatively scheduled to begin in September 1997 and should be completed by December 1997. Laboratory results for samples collected during the investigation should be available by January 1998.

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**DRAFT FINAL SAMPLING AND
ANALYSIS PLAN**

**NAS FORT WORTH JRB
AND
AIR FORCE CENTER
FOR ENVIRONMENTAL EXCELLENCE**

Preparer: _____ Date: _____

Approved: _____ Date: _____
Prime Contractor QA/QC Manager

Approved: _____ Date: _____
Prime Contractor Project Manager

Approved: _____ Date: _____
Applicable Subcontractor(s)

Approved: _____ Date: _____
Applicable State and Federal Regulatory Agencies

Approved: _____ Date: _____
Applicable State and Federal Regulatory Agencies

Approved: _____ Date: _____
AFCEE Team Chief

Contract Number F41624-95-D-8005/0005

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LIST OF ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AFCEE	U.S. Air Force Center for Environmental Excellence
AFP-4	Air Force Plant 4
ARARs	Applicable Relevant and Appropriate Regulations
ASTM	American Society for Testing and Materials
BLRA	Baseline Risk Assessment
°C	Celsius
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMS	Corrective Measures Study
COC	Chain-of-Custody
Cs	Cesium
DEQPPM	Defense Environmental Quality Program Policy Memorandum
DNAPL	Dense Non-Aqueous Phase Liquid
DO	Dissolved Oxygen
DoD	Department of Defense
DOT	Department of Transportation
EC	Electrical Conductivity
EM	Electromagnetic Induction
EPA	U.S. Environmental Protection Agency
ERA	Ecological Risk Assessment
FS	Feasibility Study
FSP	Field Sampling Plan
g	Gammas
GPR	Ground Penetrating Radar
HSC	Health and Safety Coordinator
HSP	Health and Safety Plan
IAW	In Accordance With
IDW	Investigative Derived Waste
IRP	Installation Restoration Program
IRPIMS	Installation Restoration Program Information Management System
JRB	Joint Reserve Base
KCl	Potassium Chloride
kHz	kiloHertz

LIST OF ACRONYMS AND ABBREVIATIONS

L	Liter
LF-02	Landfill No. 2 (a.k.a. SWMU 29)
LF-04	Landfill No. 4 (a.k.a. SWMU 22)
LF-05	Landfill No. 5 (a.k.a. SWMU 23)
LF-06	Landfill No. 6 (a.k.a. SWMU 62)
LF-07	Landfill No. 7 (a.k.a. SWMU 17)
LF-09	Landfill No. 9 (a.k.a. SWMU 30)
LF-10	Landfill No. 10 (a.k.a. SWMU 27)
LNAPL	Light Non-Aqueous Phase Liquid
mL/L	milliliters per Liter
nT	nanoTesla
NAS	Naval Air Station
NCP	National Contingency Plan
NGVD	National Geodetic Vertical Datum
NTU	Nephelometric Turbidity Unit
OSHA	Occupational Safety and Health Administration
OVA	Organic Vapor Analyzer
PCB	Polychlorinated biphenol
PID	Photoionization Detector
PM	Project Manager
POLs	Petroleum, Oil and Lubricants
PVC	Polyvinyl Chloride
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
SAP	Sampling and Analysis Plan
SARA	1986 Superfund Amendments and Reauthorization Act
SI	Site Investigation
SOW	Statement of Work
SVOCs	Semi Volatile Organic Compounds
SW-846	Solid Waste EPA Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, 3rd edition, 1986

LIST OF ACRONYMS AND ABBREVIATIONS

SWMU	Solid Waste Management Unit
SWMU 17	Solid Waste Management Unit No. 17 (a.k.a. LF-07)
SWMU 22	Solid Waste Management Unit No. 22 (a.k.a. LF-04)
SWMU 23	Solid Waste Management Unit No. 23 (a.k.a. LF-05)
SWMU 27	Solid Waste Management Unit No. 27 (a.k.a. LF-10)
SWMU 29	Solid Waste Management Unit No. 29 (a.k.a. LF-02)
SWMU 30	Solid Waste Management Unit No. 30 (a.k.a. LF-09)
SWMU 62	Solid Waste Management Unit No. 62 (a.k.a. LF-06)
TBD	To Be Determined
TCE	Trichloroethene
TNRCC	Texas Natural Resource Conservation Commission
US	United States
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USCS	United Soil Classification System
USGS	United States Geological Survey
VOC	Volatile Organic Compound
WP	Work Plan

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1.0 INTRODUCTION

The Field Sampling Plan (FSP) presents, in specific terms, the requirements and procedures for conducting field operations and investigations. This project specific FSP has been prepared to ensure (1) the data quality objectives specified for this project are met, (2) the field sampling protocols are documented and reviewed in a consistent manner, and (3) the data collected are scientifically valid and defensible. This site specific FSP and the Air Force Center for Environmental Excellence (AFCEE) Quality Assurance Project Plan (QAPP), shall constitute, by definition, an AFCEE Sampling and Analysis Plan (SAP).

The National Contingency Plan (NCP) specifies circumstances under which a FSP is necessary for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) response actions. For cleanup actions at the remedial investigation/feasibility study (RI/FS) stage, the NCP requires lead agents to develop SAPs which provide a process for obtaining data of sufficient quality and quantity to satisfy data needs. Such sampling and analysis plans must include a field sampling plan. 40 CFR 300.430 (b)(8)(i).

Guidelines followed in the preparation of this plan are set out in the: Data Quality Objectives Process for Superfund, Interim Final Guidance (U.S. Environmental Protection Agency [EPA], 1993). Additional reference documents followed in the preparation of this FSP include AFCEE's Model Field Sampling Plan (March, 1997) and the AFCEE Handbook for the Installation Restoration Program (IRP) for Remedial Investigations and Feasibility Studies (September, 1993). All laboratory analyses performed as part of this FSP will follow the Base-Wide Quality Assurance Project Plan (CH2M HILL, 1996).

This FSP is required reading for all staff participating in the work effort. The FSP shall be in the possession of the field teams during sample collection. HydroGeoLogic, Inc. (HydroGeoLogic) and its subcontractors shall be required to comply with the procedures documented in this FSP in order to maintain comparability and representativeness of the collected and generated data.

Controlled distribution of the FSP shall be implemented by HydroGeoLogic to ensure the current approved version is being used. A sequential numbering system shall be used to identify controlled copies of the FSP. Controlled copies shall be provided to applicable Air Force managers, regulatory agencies, remedial project managers, project managers, and quality assurance (QA) coordinators. Whenever Air Force revisions are made or addenda added to the FSP, a document control system shall be put into place to assure (1) all parties holding a controlled copy of the FSP shall receive the revisions/addenda and (2) outdated material is removed from circulation. The document control system does not preclude making and using copies of the FSP; however, the holders of controlled copies are responsible for distributing additional material to update any copies within their organizations. The distribution list for controlled copies shall be maintained by HydroGeoLogic.

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2.0 PROJECT BACKGROUND

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2.1 THE U.S. AIR FORCE INSTALLATION RESTORATION PROGRAM

The objective of the U.S. Air Force Installation Restoration Project (IRP) is to assess past hazardous waste disposal and spill sites at U.S. Air Force installations and to develop remedial actions consistent with the NCP for sites that pose a threat to human health and welfare or the environment. This section presents information on the program origins, objectives, and organization.

The 1976 Resource Conservation Recovery Act (RCRA) is one of the primary Federal laws governing the disposal of hazardous wastes. Sections 6001 and 6003 of RCRA require Federal agencies to comply with local and state environmental regulations and provide information to the EPA concerning past disposal practices at Federal sites. RCRA Section 3012 requires state agencies to inventory past hazardous waste disposal sites and provide information to the EPA concerning those sites.

In 1980, Congress enacted CERCLA (Superfund). CERCLA outlines the responsibility for identifying and remediating contaminated sites in the United States and its possessions. The CERCLA legislation identifies the EPA as the primary policy and enforcement agency regarding contaminated sites.

The 1986 Superfund Amendments and Reauthorization Act (SARA) extends the requirements of CERCLA and modifies CERCLA with respect to goals for remediation and the steps that lead to the selection of a remedial process. Under SARA, technologies that provide permanent removal or destruction of a contaminant are preferable to action that only contains or isolates the contaminant. SARA also provides for greater interaction with public and state agencies and extends the EPA's role in evaluating health risks associated with contamination. Under SARA, early determination of Applicable or Relevant and Appropriate Requirements (ARARs) is required, and the consideration of potential remediation alternatives is recommended at the initiation of an RI/FS. SARA is the primary legislation governing remedial action at past hazardous waste disposal sites.

Executive Order 12580, adopted in 1987, gave various Federal agencies, including the Department of Defense (DoD), the responsibility to act as lead agencies for conducting investigations and implementing remediation efforts when they are the sole or co-contributor to contamination on or off their properties.

To ensure compliance with CERCLA, its regulations, and Executive Order 12580, the DoD developed the IRP, under the Defense Environmental Restoration Program, to identify potentially contaminated sites, investigate these sites, and evaluate and select remedial actions for potentially contaminated facilities. The DoD issued the Defense Environmental Quality Program Policy Memorandum (DEQPPM) 80-6 regarding the IRP program in June 1980, and implemented the policies outlined in this memorandum in December 1980. The NCP was issued by EPA in 1980 to provide guidance on a process by which (1) contaminant release could be reported, (2) contamination could be identified and quantified, and (3) remedial actions could be selected. The

NCP describes the responsibility of Federal and state governments and those responsible for contaminant releases.

The DoD formally revised and expanded the existing IRP directives and amplified all previous directives and memoranda concerning the IRP through DEQPPM 81-5, dated 11 December 1981. The memorandum was implemented by a U.S. Air Force (USAF) message dated 21 January 1982.

The IRP is the DoD's primary mechanism for response actions on U.S. Air Force installations affected by the provisions of SARA. In November 1986, in response to SARA and other EPA interim guidance, the U.S. Air Force modified the IRP to provide for an RI/FS program. The IRP was modified so that RI/FS studies could be conducted as parallel activities rather than serial activities. The program now includes ARAR determinations, identification and screening of technologies, and development of alternatives. The IRP may include multiple field activities and pilot studies prior to a detailed final analysis of alternatives. Over the years, requirements of the IRP have been developed and modified to ensure that DoD compliance with Federal laws, such as RCRA, NCP, CERCLA, and SARA, can be met.

2.2 PROJECT PURPOSE AND SCOPE

The purpose of this field investigation is to gather sufficient data for closure of five solid waste management units (SWMUs) located at Naval Air Station (NAS) Fort Worth Joint Reserve Base (JRB) under the Texas Natural Resources Conservation Commission (TNRCC) Risk Reduction Standards Program (RRS). The five SWMUs are SWMU 17 (Landfill No. 7 or LF-07), SWMU 27 (Landfill No. 10 or LF-10), SWMU 29 (Landfill No. 2 or LF-02), SWMU 30 (Landfill No. 9 or LF-09), and SWMU 62 (Landfill No. 6 or LF-06).

Field studies that will be used to characterize the landfills include: (1) geophysical surveys using both magnetometry and electromagnetic methods will be conducted to determine the physical extent of each landfill and identify possible sources of contamination; (2) test pits will be completed at two of the SWMUs to visually observe the wastes buried in the landfills and to collect subsurface soil samples; (3) soil borings with continuous sampling will be advanced at each SWMU using hollow-stem auger drilling to determine the soil lithology and the nature and extent of soil contamination at each location; (4) surface soil samples will be collected at each test pit location, each soil boring location, and around the perimeter of the waste disposal pit at SWMU 27 to evaluate the chemical characteristics of the surficial soil; (5) monitoring wells will be completed from many of the soil borings to provide an indication of groundwater flow direction and chemical characteristics of groundwater at each SWMU location; and (6) surface water samples will be collected at one location to determine if contamination is present in the ponded surface water.

The data collected as part of this FSP shall be used to evaluate and determine if additional data will be necessary to proceed to closure under TNRCC Risk Reduction Standards.

2.3 PROJECT SITE DESCRIPTION

NAS Fort Worth JRB is located on 2,555 acres of land in Tarrant County, Texas, eight miles west of downtown Fort Worth. The areas covered by this FSP are five landfills throughout the NAS Fort Worth JRB site. These landfills are identified as SWMU 17 (Landfill No. 7 or LF-07), SWMU 27 (Landfill No. 10 or LF-10), SWMU 29, SWMU 30 (Landfill No. 9 or LF-09), (Landfill No. 2 or LF-02), and SWMU 62 (Landfill No. 6 or LF-06), and (CH2M HILL, 1996c).

2.3.1 SWMU 17

The area designated as SWMU 17 is located within the flightline area near the intersection of Taxiway 197 and White Settlement Road. This landfill reportedly received construction debris in the form of concrete, asphalt, wood, trees, and potentially small amounts of undocumented hazardous materials from 1978 to 1983 but unauthorized dumping may have continued for several years thereafter (AFCEE, 1997). This area consists of approximately 3.5 acres of mostly vacant land covered by grasses and weeds and is littered with small pieces of concrete, asphalt, and rocks.

2.3.2 SWMU 27

This site, located west of the runways and near the southwest corner of the base, consists of a ditch approximately 8 feet deep by 20 feet wide and 400 feet long surrounded by sparse vegetation. The ditch typically has approximately 4- to 5-feet of water during the winter months and eventually dries out during the summer months. Drums were observed in this ditch during a visual site inspection conducted by HydroGeoLogic. Since there is no documentation as to the source of these drums, they may and/or may have contained material which could act as a source of potential contamination. This area has not been previously investigated.

2.3.3 SWMU 29

This former borrow pit, located in the central section of the base near Haile Drive, was converted to a landfill in 1952 and accepted construction debris and moderate quantities of unspecified hazardous materials. In 1956, the site was covered (AFCEE, 1997). Currently, the site is surrounded by an 8-foot chain linked fence that provides security for Building 1055. This building occupies approximately one fourth of the 4.4-acre site. The remaining portion of the site is either occupied by temporary trailers or covered with asphalt or grass.

2.3.4 SWMU 30

This former landfill, located in the northeast section of the base adjacent to the West Fork Trinity River, received construction debris in the form of concrete, asphalt, and wood from 1978 to 1983 (AFCEE, 1997). At the eastern section of the landfill, a ditch has been created by runoff from an upgradient parking area located adjacent to Building 2570. Concrete, asphalt, telephone poles, and reinforcing steel are exposed in the newly formed banks of this ditch. The site is currently covered by vegetation and current land use is limited to maintenance workers.

2.3.5 SWMU 62

This area is located between Roaring Springs Road and Haile Drive and is sparsely covered with vegetation. The site was a converted borrow pit used for the burial of construction materials and rubble, possibly drums of hydraulic fluid, and small quantities of other hazardous materials. It operated from 1975 to 1978 and was then covered. It has been documented that three drums of hydraulic fluid were placed in a centrally located pit to collect groundwater that seeped into the landfill (CH2M HILL, 1996c). It is unclear from the file reviewed whether this statement implies that the drums contain hydraulic fluid or that they once contained hydraulic fluid and the drums were simply used as a sump for water to be pumped from. Several stock piles of fill dirt containing concrete, asphalt, crushed 55-gallon drums, and wood have accumulated adjacent to the site.

2.4 PROJECT SITE CONTAMINATION HISTORY

Section 1.0 of the Work Plan provides the history of environmental investigations conducted at each site and documents subsequent contamination present at each site. Please refer to this section for the contamination history of the sites.

3.0 PROJECT SCOPE AND OBJECTIVES

The following sections describe the objectives of the RFI and the specific field activities that will be conducted during the investigation.

3.1 OBJECTIVES

The data generated by this project must be of sufficient quality and quantity to support the overall project objective, which is closure of five SWMUs located at NAS Fort Worth JRB under TNRCC Risk Reduction Standards. The objectives and focus of this work will be to better define the geological/hydrogeological regime beneath each of the SWMUs, determine the lateral and vertical extent of the former landfills, determine if a source of contamination is present at each unit, characterize the nature and extent of any contamination detected, and if contamination is detected, determine if it poses an unacceptable risk to human health and the environment.

Data of the following categories are required for this study:

Site Characterization - Data will be used to evaluate physical and chemical properties of buried waste, soil, groundwater and surface water. The data will also be used to characterize the nature and extent of any contaminants detected, and provide an estimate of risk posed by these chemicals.

Health and Safety - Data will be used to establish the level of protection needed for the work party and other site related personnel. This data will be gathered by the use of organic vapor analyzers, Draeger tubes, and the explosimeter during intrusive activities.

Site characterization data will be a combination of screening data and definitive data. Health and safety data will be collected as screening data. The definitions of screening data and definitive data, as established by the Data Quality Objectives Process for Superfund Interim Final Guidance (EPA/540/G-93/071, 1993) are described below:

- Screening Data with Definitive Confirmation - Screening data are generated by rapid, less precise methods of analysis with less rigorous sample preparation. Sample preparation steps may be restricted to simple procedures such as dilution with a solvent, instead of elaborate extraction/digestion and cleanup. Screening data provides analyte identification and quantification. Although the quantification may be determined using analytical methods with QA/QC procedures and criteria associated with definitive data, screening data without associated confirmation data are not considered to be data of known quality.
- Definitive Data - Definitive data will be generated using rigorous analytical methods, such as approved EPA reference methods. Data will be analyte-specific, with confirmation of analyte identity and concentration. These methods produce tangible raw data (e.g., chromatograms, spectra, digital values) in the form of paper printouts or computer-generated electronic files. Data may be generated at the site or at an off-site location, as long as the QA/QC requirements are satisfied.

For the data to be definitive, either analytical or total measurement error must be determined.

The data generated by the laboratory analysis of samples must be sufficiently sensitive to allow comparison of the results to ARARs, particularly, the TNRCC Risk Reduction Standards. The Base-Wide QAPP (CH2M HILL, 1996) describes each method that will be performed as part of the investigation and outlines the quality assurance measures the contract laboratory must follow. The methods of analysis selected for samples collected from NAS Fort Worth JRB will produce screening as well as definitive data.

3.2 SAMPLE ANALYSIS SUMMARY

Samples collected as part of this FSP will be analyzed for the parameters listed in the AFCEE Base-Wide QAPP (CH2M HILL, 1996) for the following methods:

- Method SW8260A - Volatile Organics
- Method SW8270B - Semivolatile Organics
- Method SW6010A - Trace Elements (Metals)
- Method SW7470A/7471A - Mercury
- Method SW8080A - Organochlorine Pesticides and Polychlorinated Biphenyls
- Method SW8151 - Chlorinated Herbicides

Table 3.1 presents the list of the number of samples to be collected, and the analytical methods to be performed, for groundwater, surface water, and soil samples collected during the RFI field investigation.

3.3 FIELD ACTIVITIES

The proposed field tasks described in this FSP will be conducted to achieve the project objectives as presented in the Work Plan. Field investigative activities will be conducted at each of the five subject SWMUs. Table 3.2 contains a summary of the field activities planned during this RFI. Details as to the justification for each sample to be collected are presented in the Work Plan. Table 3.3 is a summary of the data quality levels and intended use for data collected during the RFI.

Table 3.1
Sample Analysis Summary
NAS Fort Worth JRB, Texas

Site	Method	Matrix	# Samples	# Equipment Blanks	# Ambient Blanks	# Trip Blanks	# Field Duplicates	# MS/MSD	Total # Samples
SWMU 17	8260A	GW	6	3	1	3	1	1	15
SWMU 17	8270B	GW	6	3	0	0	1	1	11
SWMU 17	6010A	GW	6	3	0	0	1	1	11
SWMU 17	7470A	GW	6	3	0	0	1	1	11
SWMU 17	8151	GW	6	3	0	0	1	1	11
SWMU 17	8080A	GW	6	3	0	0	1	1	11
SWMU 17	8260A	Soil	18	2	1	2	2	1	26
SWMU 17	8270B	Soil	18	2	0	0	2	1	23
SWMU 17	6010A	Soil	18	2	0	0	2	1	23
SWMU 17	7471A	Soil	18	2	0	0	2	1	23
SWMU 17	8151	Soil	18	2	0	0	2	1	23
SWMU 17	8080A	Soil	18	2	0	0	2	1	23
SWMU 27	8260A	GW	4	2	0	2	1	1	10
SWMU 27	8270B	GW	4	2	0	0	1	1	8
SWMU 27	6010A	GW	4	2	0	0	1	1	8
SWMU 27	7470A	GW	4	2	0	0	1	1	18
SWMU 27	8151	GW	4	2	0	0	1	1	8
SWMU 27	8080A	GW	4	2	0	0	1	1	8
SWMU 27	8260A	Soil	8	2	0	2	1	1	14
SWMU 27	8270B	Soil	8	2	0	0	1	1	12
SWMU 27	6010A	Soil	8	2	0	0	1	1	12
SWMU 27	7471A	Soil	8	2	0	0	1	1	12

Table 3.1 (continued)
Sample Analysis Summary
NAS Fort Worth JRB, Texas

Site	Method	Matrix	# Samples	# Equipment Blanks	# Ambient Blanks	# Trip Blanks	# Field Duplicates	# MS/MSD	Total # Samples
SWMU 27	8151	Soil	8	2	0	0	1	1	12
SWMU 27	8080A	Soil	8	2	0	0	1	1	11
SWMU 27	8260A	Sediment	8	1	0	1	1	1	12
SWMU 27	8270B	Sediment	8	1	0	0	1	1	11
SWMU 27	6010A	Sediment	8	1	0	0	1	1	11
SWMU 27	7471A	Sediment	8	1	0	0	1	1	11
SWMU 27	8151	Sediment	8	1	0	0	1	1	11
SWMU 27	8080A	Sediment	8	1	0	0	1	1	11
SWMU 27	8260A	SW	2	1	0	1	1	1	6
SWMU 27	8270B	SW	2	1	0	0	1	1	5
SWMU 27	6010A	SW	2	1	0	0	1	1	5
SWMU 27	7470A	SW	2	1	0	0	1	1	5
SWMU 27	8151	SW	2	1	0	0	1	1	5
SWMU 27	8080A	SW	2	1	0	0	1	1	5
SWMU 29	8260A	GW	4	2	0	2	1	1	10
SWMU 29	8270B	GW	4	2	0	0	1	1	8
SWMU 29	6010A	GW	4	2	0	0	1	1	8
SWMU 29	7470A	GW	4	2	0	0	1	1	8
SWMU 29	8151	GW	4	2	0	0	1	1	8
SWMU 29	8080A	GW	4	2	0	0	1	1	8
SWMU 29	8260A	Soil	6	1	0	1	1	1	10
SWMU 29	8270B	Soil	6	1	0	0	1	1	9

Table 3.1 (continued)
Sample Analysis Summary
NAS Fort Worth JRB, Texas

Site	Method	Matrix	# Samples	# Equipment Blanks	# Ambient Blanks	# Trip Blanks	# Field Duplicates	# MS/MSD	Total # Samples
SWMU 29	6010A	Soil	6	1	0	0	1	1	9
SWMU 29	7471A	Soil	6	1	0	0	1	1	9
SWMU 29	8151	Soil	6	1	0	0	1	1	9
SWMU 29	8080A	Soil	6	3	0	0	1	1	9
SWMU 30	8260A	GW	6	3	0	3	1	1	14
SWMU 30	8270B	GW	6	3	0	0	1	1	11
SWMU 30	6010A	GW	6	3	0	0	1	1	11
SWMU 30	7470A	GW	6	3	0	0	1	1	11
SWMU 30	8151	GW	6	3	0	0	1	1	11
SWMU 30	8080A	GW	6	3	0	0	1	1	11
SWMU 30	8260A	Soil	18	2	0	2	2	1	25
SWMU 30	8270B	Soil	18	2	0	0	2	1	23
SWMU 30	6010A	Soil	18	2	0	0	2	1	23
SWMU 30	7471A	Soil	18	2	0	0	2	1	23
SWMU 30	8151	Soil	18	2	0	0	2	1	23
SWMU 30	8080A	Soil	18	2	0	0	2	1	23
SWMU 62	8260A	GW	4	2	0	2	1	1	10
SWMU 62	8270B	GW	4	2	0	0	1	1	8
SWMU 62	6010A	GW	4	2	0	0	1	1	8
SWMU 62	7470A	GW	4	2	0	0	1	1	8
SWMU 62	8151	GW	4	2	0	0	1	1	8
SWMU 62	8080A	GW	4	2	0	0	1	1	8

Table 3.1 (continued)
 Sample Analysis Summary
 NAS Fort Worth JRB, Texas

Site	Method	Matrix	# Samples	# Equipment Blanks	# Ambient Blanks	# Trip Blanks	# Field Duplicates	# MS/MSD	Total # Samples
SWMU 62	8260A	Soil	14	2	0	2	2	1	21
SWMU 62	8270B	Soil	14	2	0	0	2	1	19
SWMU 62	6010A	Soil	14	2	0	0	2	1	19
SWMU 62	7471A	Soil	14	2	0	0	2	1	19
SWMU 62	8151	Soil	14	2	0	0	2	1	19
SWMU 62	8080A	Soil	14	2	0	0	2	1	19

Notes:

GW = Groundwater

SW = Surface Water

Equipment Blanks = One equipment blank will be taken per day, per analysis (for example, 3 equipment blanks represents 1 sample/day for 3 days).

Field Duplicates = Collected on a 10% basis of investigation samples.

Trip Blanks = One trip blank will be included per cooler when at least one sample is analyzed for VOCs from that cooler.

Ambient Blanks = One ambient blank will be collected at the beginning of the field investigation for soil and groundwater.

Table 3.2
Field Activities Summary
NAS Fort Worth JRB, Texas

Site	Activity	#
SWMU 17	Soil Borings	6
SWMU 17	Install Alluvial Terrace Monitoring Wells	3
SWMU 17	Sample Existing Alluvial Terrace Monitoring Wells	3
SWMU 17	Test Pits	3
SWMU 17	Geophysical Study (EM-31 and Magnetometer Surveys)	1
SWMU 27	Soil Borings	4
SWMU 27	Install Alluvial Terrace Monitoring Wells	4
SWMU 27	Surface Soil Sample Locations	8
SWMU 27	Surface Water Sample Locations	2
SWMU 27	Geophysical Study (EM-31 and Magnetometer Surveys)	1
SWMU 29	Install Alluvial Terrace Monitoring Wells	4
SWMU 29	Soil Borings	3
SWMU 29	Geophysical Study (EM-31 and Magnetometer Surveys)	1
SWMU 30	Soil Borings	9
SWMU 30	Install Alluvial Terrace Monitoring Wells	6
SWMU 30	Geophysical Study (EM-31 and Magnetometer Surveys)	1
SWMU 62	Soil Boring	4
SWMU 62	Install Alluvial Terrace Monitoring Wells	4
SWMU 62	Test Pits	3
SWMU 62	Geophysical Study (EM-31 and Magnetometer Surveys)	1

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Table 3.3
Data Quality Levels and Intended Use for Field and Laboratory Data
NAS Fort Worth
JRB, Texas

Sampling Matrix/Location	Parameters ^a	Analytical Method	Field/Lab Analysis	Data Quality Level	Intended Use
Soil, all locations	VOCs	PID	Field	Screening	Field screening for selecting samples for lab analysis
	EM inductance	Geophysical Survey	Field		Delineating the extent of the landfill, identification of "hot spots"
	Gravity response		Field		
		Boring Logs	Field		To differentiate the stratigraphy, to identify buried waste
Groundwater, all locations	Temperature	170.1	Field	Screening	Field screening to determine sufficient purging/development of monitoring well
	pH	150.1	Field	Screening	
	EC	120.1	Field	Screening	
	Turbidity	180.1	Field	Screening	
Groundwater	ICP Priority Pollutant metals	6010A	Lab	Definitive	Nature/extent of contaminants, risk assessment, corrective measures study
	Mercury	7470A	Lab	Definitive	
	VOCs	8260A	Lab	Definitive	
	SVOCs	8270B	Lab	Definitive	
	Pesticides/PCBs	8080A	Lab	Definitive	
	Herbicides	8151	Lab	Definitive	
Soil	ICP Priority Pollutant metals	6010A	Lab	Definitive	Nature/extent of contaminants, risk assessment, corrective measures study
	Mercury	7471A	Lab	Definitive	
	VOCs	8260A	Lab	Definitive	
	SVOCs	8270B	Lab	Definitive	
	Pesticides/PCBs	8080A	Lab	Definitive	
	Herbicides	8151	Lab	Definitive	

Notes:

- ^a VOCs= Volatile Organic Compounds
EC = Electrical Conductivity
SVOCs= Semivolatile Organic Compounds
NA = Not Applicable

The following sections describe the proposed field investigation activities for each site to be investigated during this study. More detailed descriptions of the rationale and justification for each of the proposed activities are presented in the Work Plan.

3.3.1 SWMU 17

Proposed field activities to be conducted at SWMU 17 include geophysical surveys to characterize the extent of the landfill and determine the presence of drums or other potentially hazardous materials; drilling and sampling of soil borings; installation, development and sampling of alluvial terrace monitoring wells; and excavation and sampling of test pits.

The survey procedure for SWMU 17 will begin by creating a grid over an approximate 8.2-acre area (660 feet [N-S] by 560 feet [E-W]) that will overlay the area expected to have been used as a landfill. The grid of the proposed geophysical survey is presented on Figure 3.1. Although the lateral extent of the landfill is not expected to be this large, a fringe around the landfill is desired and will serve as a background data set for comparison. Station locations will be placed on 20 foot centers using a tape measure for distance and a transit for trueness. The base station for this grid will be from a temporary stake near the road located to the east of the landfill. All distances on the geophysical survey will be measured in feet from this location.

Three soil borings will be drilled to the top of the water table. The other three borings will be drilled 1-foot into the bedrock and completed as 2-inch diameter monitoring wells. Two samples from each boring location (one surface and one subsurface) will be sent to the laboratory for analysis. The subsurface sample will be chosen based on field screening with a photoionization detector (PID) or an organic vapor analyzer (OVA). If no volatile compounds are detected with the field screening device, the sample interval directly above the water table will be chosen. Surface soil samples at each boring location will be collected using a stainless steel scoop or trowel.

In addition to the proposed new monitoring wells, existing monitoring wells LF05-5A, LF05-5D, and HM-123 will be sampled during this investigation. These wells were installed as part of the previous investigations of the flightline area. One round of groundwater samples will be collected from these three existing wells and the three proposed monitoring wells.

The three test pits will be excavated to bisect the SWMU and visually identify as much of the buried waste as possible. The test pits will provide a better means of observing the waste buried within the landfills than soil borings due to the volume of waste that can be visually observed from the test pit. One surface and one subsurface soil sample will be collected at each of the test pits and submitted for laboratory analysis. Proposed locations for soil borings/monitoring wells and the test pits are presented in Figure 3.2. Based on the results of the geophysical survey and specific site conditions, test pit locations may be shifted slightly to accommodate 'hot spots', utilities or other obstructions.

The samples collected from the soil borings, monitoring wells and test pits will provide additional information to determine whether the SWMU is contributing to the existing trichloroethene (TCE)

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plume that originates from AFP-4. Additionally, the samples will be used to evaluate if the waste buried in this SWMU has resulted in contamination originating from other organic or inorganic chemicals. Based on the lack of historical records of wastes buried within the SWMU, all soil and groundwater samples will be analyzed for a full suite of volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), herbicides, pesticides/PCBs, and priority pollutant metals.

HydroGeologic, Inc. -- Draft Final Field Sampling Plan
NAS Fort Worth JRB, Texas

Figure 3.1

Geophysical Survey
Grid Layout
SWMU 17

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

-  SWMU Area
-  Approximate NAS Fort Worth JRB Site Boundary
-  Building
-  Fence
-  Road
-  Proposed Trench
Note: Actual Size = 30' X 4'
-  Path of Survey Measurements
-  Stream
-  Geophysical Grid



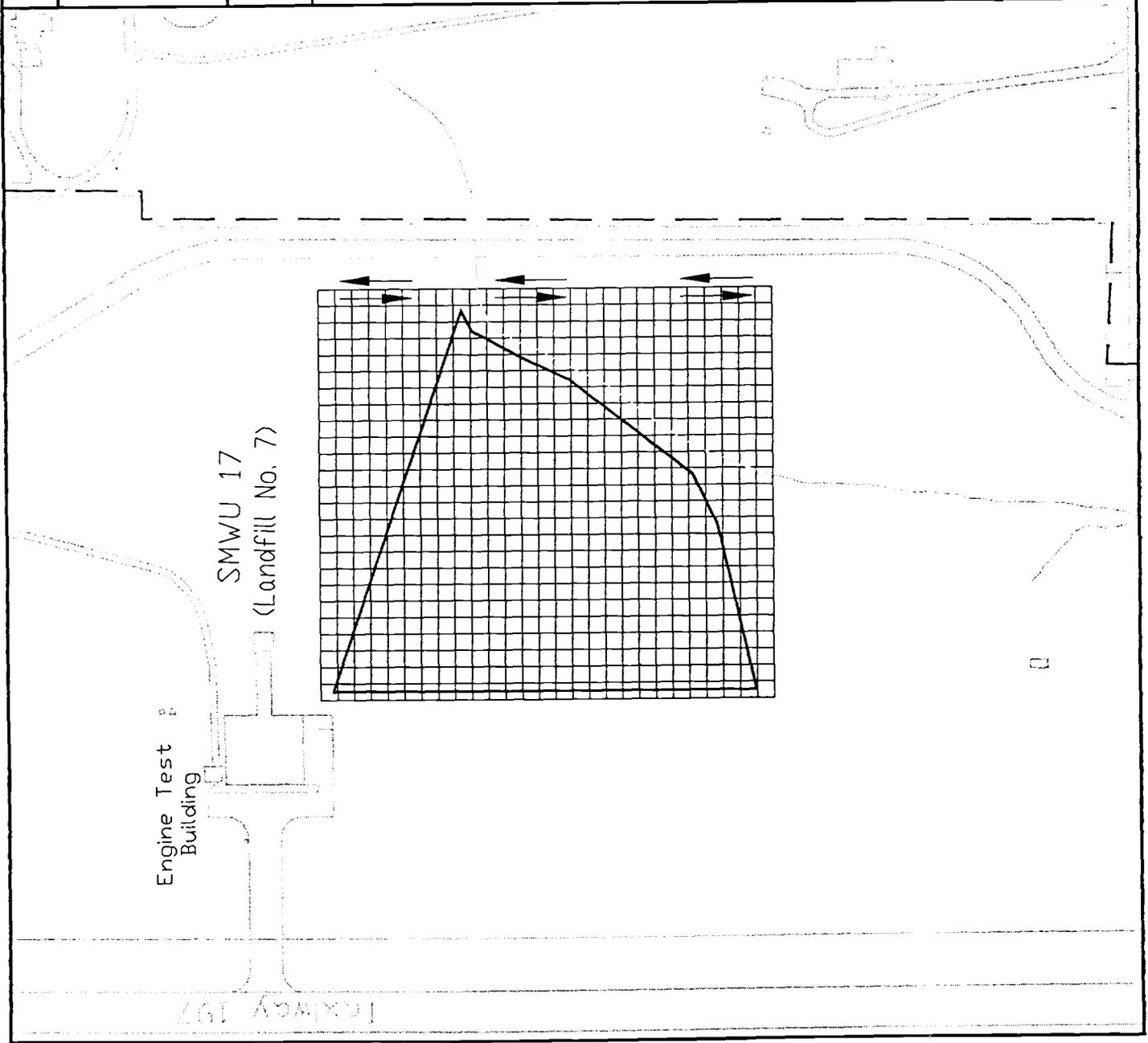
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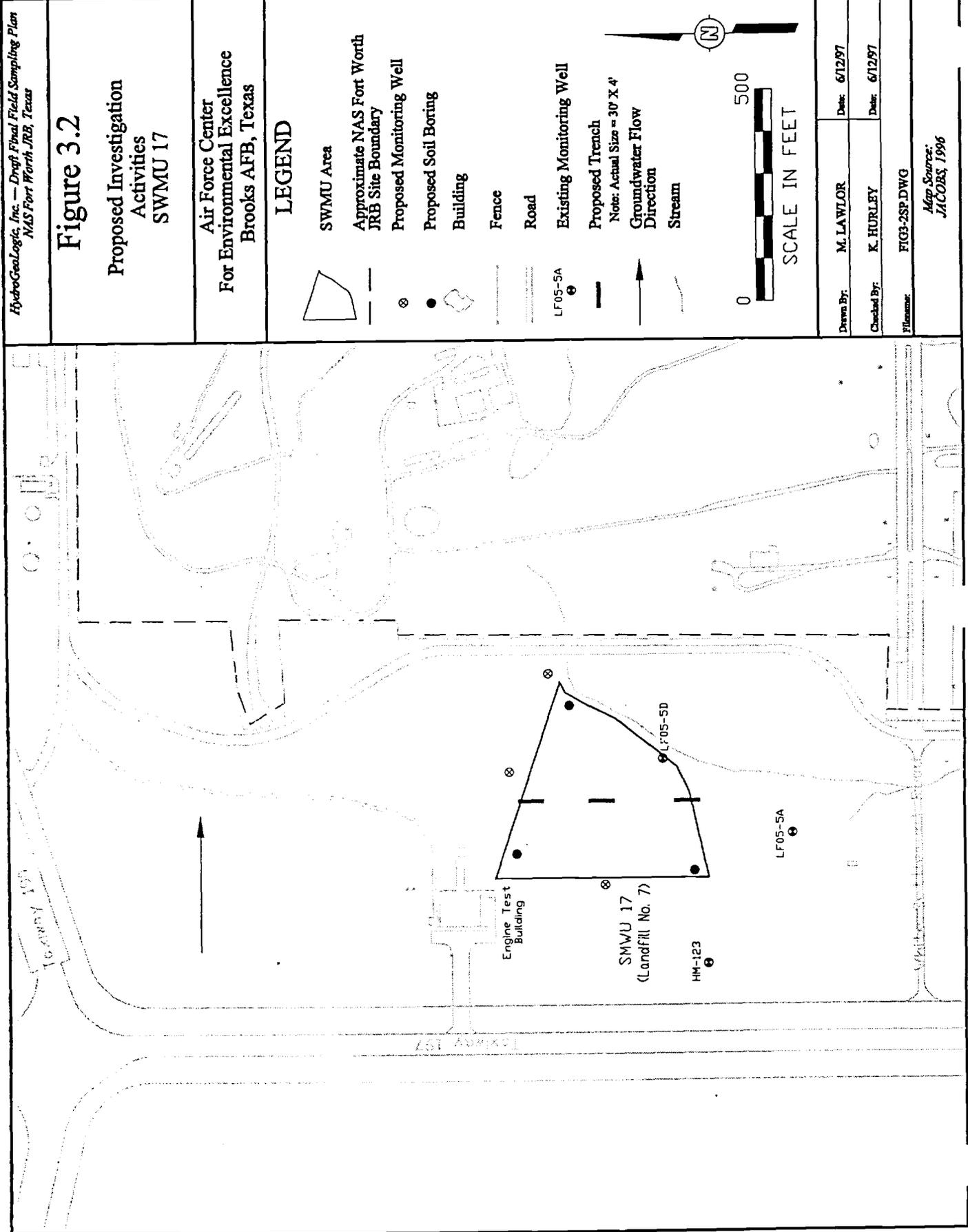
Drawn By: M. LAWLOR Date: 6/12/97

Checked By: K. HURLEY Date: 6/12/97

Filename: FIG3-ISP-DWG

Map Source:
JACOBS, 1996





3.3.2 SWMU 27

Proposed field activities to be conducted at this SWMU include a geophysical survey, drilling and sampling of soil borings, installing and sampling monitoring wells, collecting surface soil samples, and collecting surface water samples.

Two geophysical surveys will be conducted around the perimeter of the open trench to identify the extent of the landfill and potential “hot spots.” The survey procedure for SWMU 27 will begin by creating a grid over an approximate 7.3-acre area (1,140 feet [N-S] by 280 feet [E-W]) that will overlay the area suspected as having been used as a landfill (Figure 3.3). Although the lateral extent of the landfill is not expected to be this large, a fringe around the landfill is desired and will serve as a background data set for comparison. Station locations will be placed on 20 foot centers using a tape measure for distance and a transit for trueness. The base station for this grid will be at the northwest corner of the landfill. All distances on the geophysical survey will be measured in feet from this location.

Four soil borings will be drilled around the perimeter of the trench to a depth of 1-foot into the bedrock to determine if waste buried at this SWMU has impacted the local soil and groundwater. Soil samples will be collected continuously to the top of the water table to evaluate the presence of potential soil contamination in the alluvium. The remainder of the boring will be sampled continuously for lithologic characterization. Two samples from each boring location (one surface and one subsurface) will be sent to the laboratory for analysis. The subsurface sample will be chosen based on field screening with a PID. If no volatile compounds are detected with the field screening device, the sample interval directly above the water table will be chosen. Surface soil samples at each boring location will be collected using stainless steel scoops or trowels.

Each of these soil borings will be converted to 2-inch monitoring wells in order to evaluate if past waste handling practices at this site have impacted the alluvial terrace groundwater beneath the site. One round of groundwater samples will be collected from these monitoring wells. Proposed locations for soil borings and monitoring wells are presented in Figure 3.4.

Eight surface soil samples will be collected from the bottom of the trench for the purpose of determining whether debris placed in the trench has impacted the underlying soils. Two surface water samples will also be collected from the north and south ends of the trench to determine whether contamination is present in the surface water as a result of the buried debris. Figure 3.4 depicts the location of the surface water and surface soil samples to be collected at SWMU 27.

*HydroGeologic, Inc. - Draft Final Field Sampling Plan
NAS Fort Worth JRB, Texas*

Figure 3.3 Geophysical Survey Grid Layout SWMU 27

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Brooks AFB, Texas

LEGEND

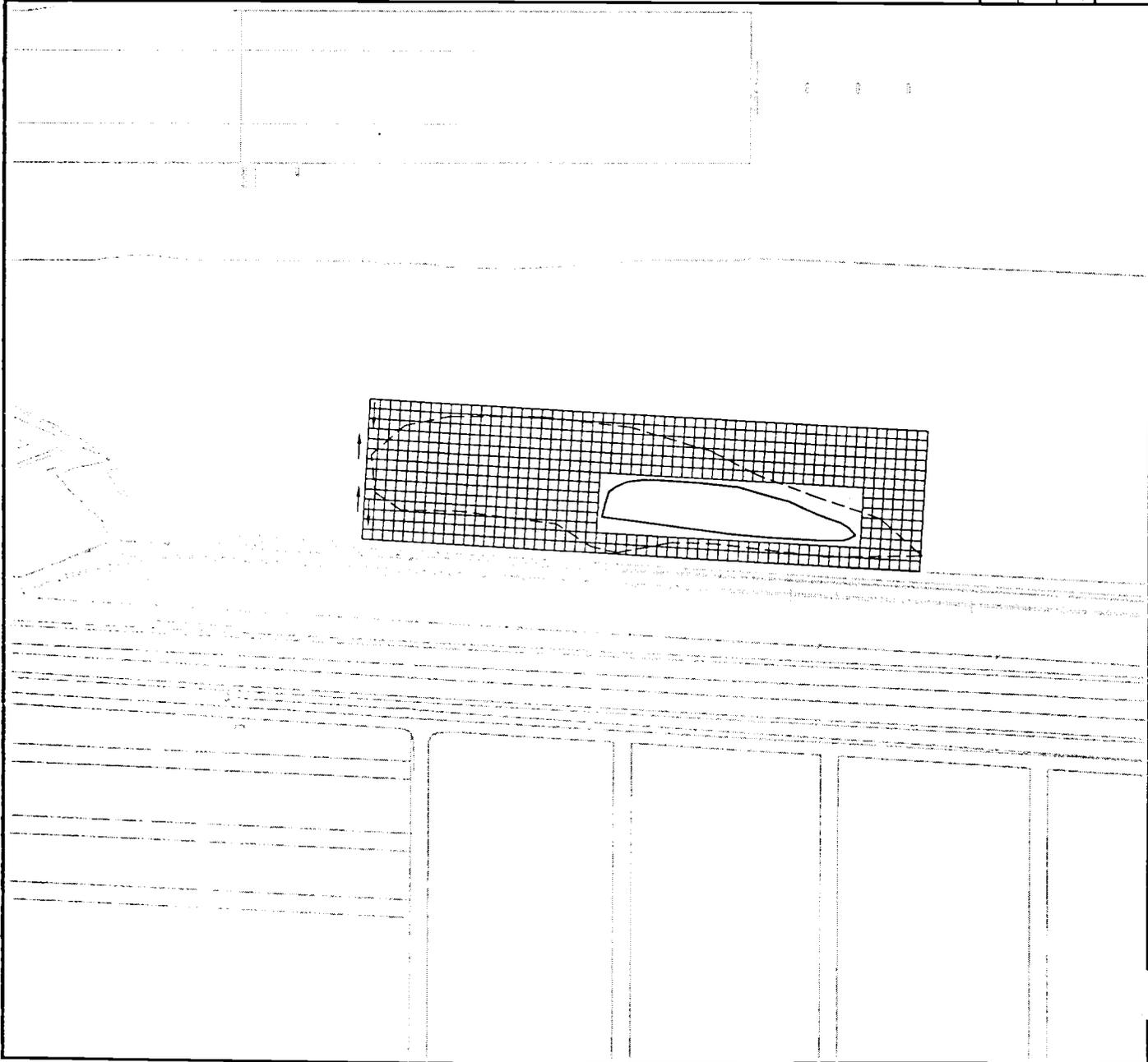
-  Disposal Trench
-  Area of Sparse Vegetation
-  Proposed Monitoring Well
-  Proposed Sediment Sampling Location
-  Proposed Surface Water Sampling Location
-  Building
-  Fence
-  Road
-  Railroad
-  Path of Survey Measurements
-  Geophysical Grid

NOTE: Geophysical Investigation will not be performed in the disposal trench if water is present.



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Map Source:
JACOBS, 1996



HydroGeoLogics, Inc. — Draft Final Field Sampling Plan
 NAS Fort Worth JRB, Texas

Figure 3.4

Proposed Investigation
 Activities
 SWMU 27

Air Force Center
 For Environmental Excellence
 Brooks AFB, Texas

LEGEND

- Disposal Trench
- Area of Sparse Vegetation
- Proposed Monitoring Well
- Proposed Sediment Sampling Location
- Groundwater Flow Direction
- Fence
- Road
- Railroad
- Proposed Surface Water Sampling Location

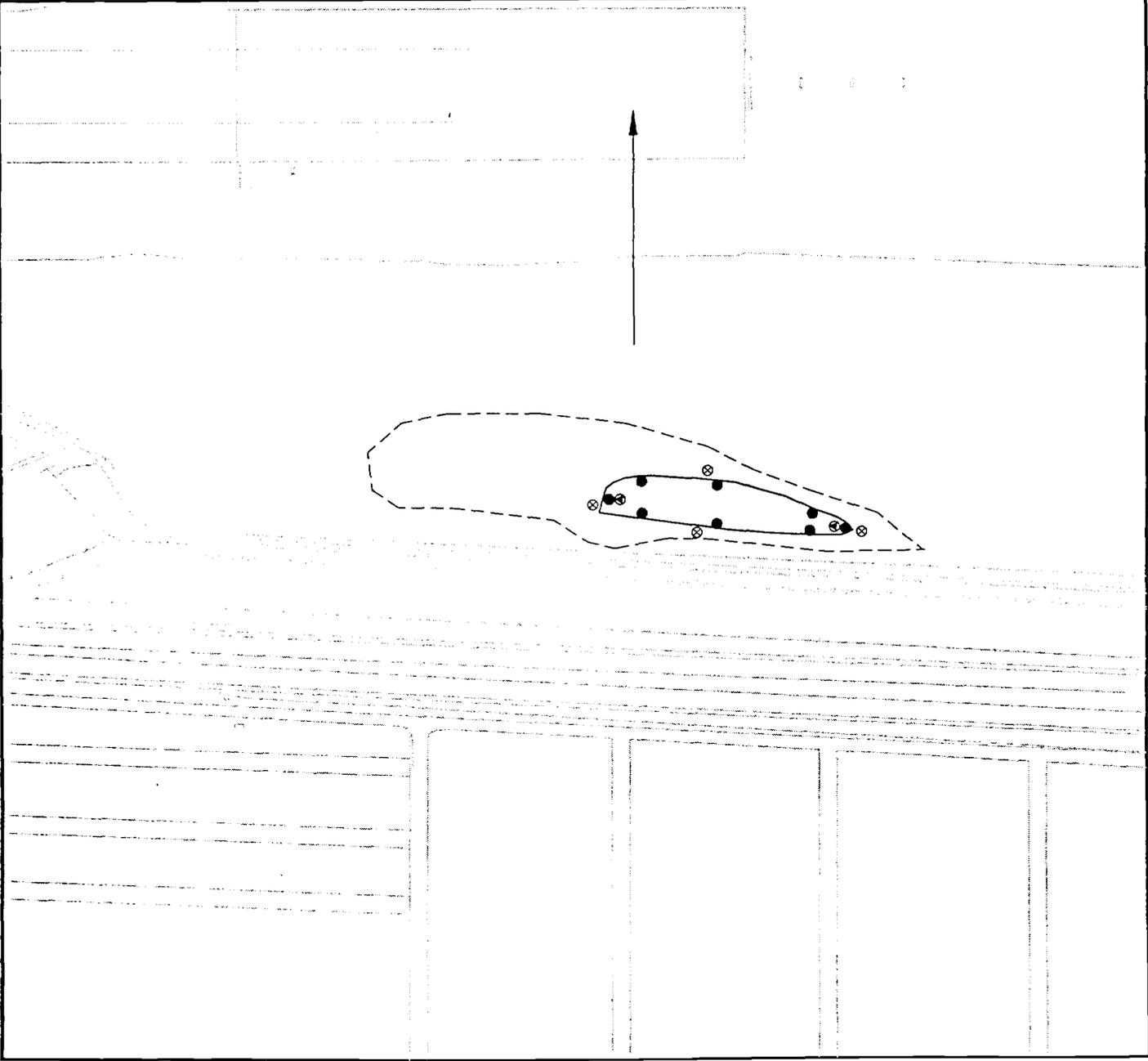


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Filename: FIG3-ASP.DWG

Map Source:
 JACOBS 1996



3.3.3 SWMU 29

Field activities to be conducted at SWMU 29 during this study include a geophysical study using electromagnetic induction and magnetometry, three soil borings to the top of the water table, and drilling four 2-inch diameter monitoring wells. Surface soil, subsurface soil and groundwater samples will be collected and sent to the laboratory for analysis.

The geophysical survey procedure for SWMU 29 will begin by creating a grid over an approximate 6.0-acre area (660 feet [N-S] by 400 feet [E-W]) that will overlay the area suspected as having been used as a landfill (Figure 3.5). Due to roads and fences that surround the SWMU, no fringe area around the SWMU will be surveyed during the geophysical surveys. Station locations will be placed on 20 foot centers using a tape measure for distance and a transit for trueness. The base station for this grid will be at the northwest corner of the landfill. All distances on the geophysical survey will be measured in feet from this location.

Three soil borings will be drilled to the top of the water table to evaluate the potential soil contamination that may originate from buried debris and leach to the alluvium. These soil borings will also be used to characterize the waste buried in the former landfill and to gather information as to the physical characteristics of the soil beneath SWMU 29. Two samples from each boring location (one surface and one subsurface) will be sent to the laboratory for analysis. The subsurface sample will be chosen based on field screening with a PID. If no volatile compounds are detected with the field screening device, the sample interval directly above the water table will be chosen. Surface soil samples at each boring location will be collected using stainless steel scoops or trowels.

Four additional soil borings will be converted to 2-inch monitoring wells in order to evaluate the extent of groundwater contamination underlying the alluvium. Surface and subsurface soil samples will be collected at these locations consistent with the procedures discussed in the preceding paragraph. One round of groundwater samples will be collected from these wells. Proposed locations for soil borings and monitoring wells are presented in Figure 3.6.

HydroGeologic, Inc. — Draft Final Field Sampling Plan
NAS Fort Worth JRB, Texas

Figure 3.5

Geophysical Survey
Grid Layout
SWMU 29

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

-  SWMU Area
-  Building
-  Fence
-  Road
-  Path of Survey Measurements
-  Geophysical Grid



SCALE IN FEET

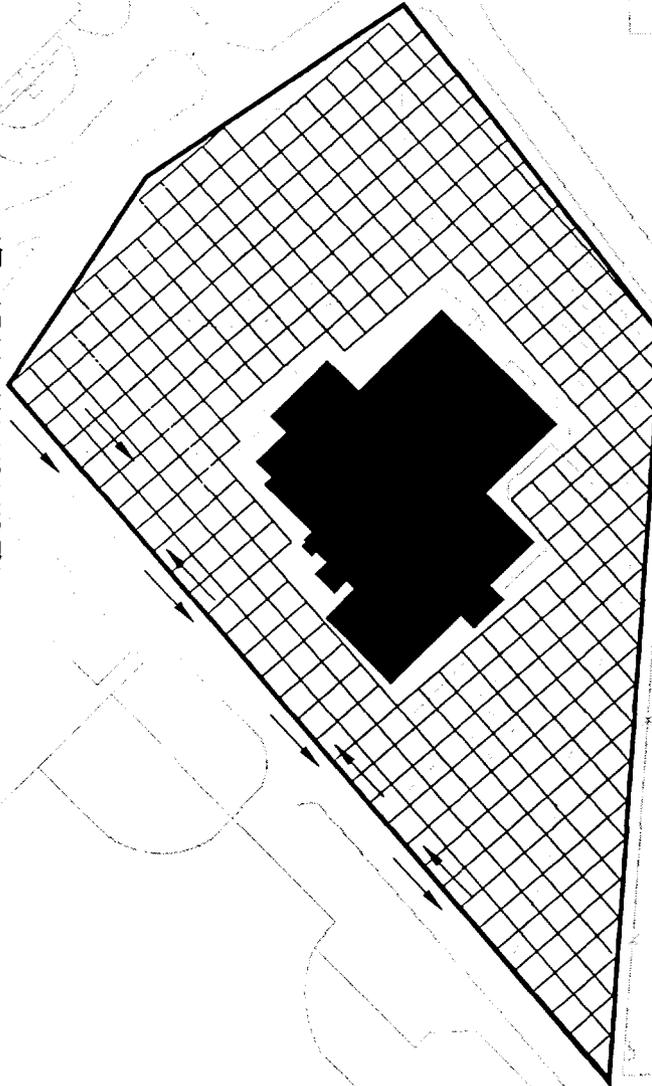
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Filename: FIG3-SSP.DWG

Map Source:
JACOBS, 1996

SWMU 29
(Landfill No. 2)



*HydroGeologic, Inc. — Draft Final Field Sampling Plan
NAS Fort Worth JRB, Texas*

Figure 3.6

Proposed Investigation
Activities
SWMU 29

Air Force Center
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Brooks AFB, Texas

LEGEND



Proposed Monitoring Well



Proposed Soil Boring



Building



Fence



Road



Groundwater
Flow Direction



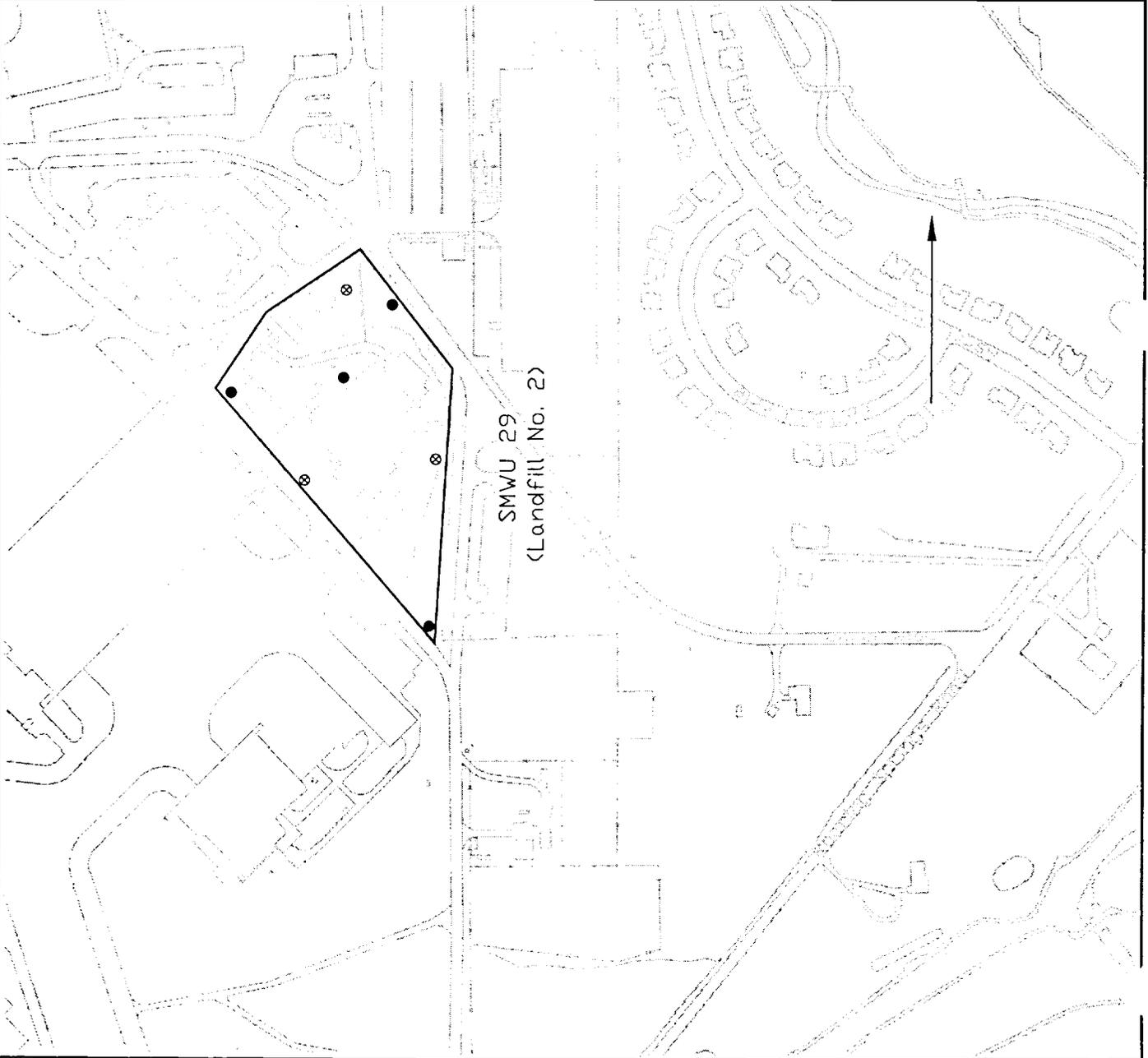
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Filename: FIG3-6SP.DWG

Map Source:
JACOBS, 1996



3.3.4 SWMU 30

A geophysical survey, three soil borings and six monitoring wells will be used to evaluate this site. The objectives of this investigation will be to characterize the waste buried at this unit, determine the physical and chemical characteristics of the soil and groundwater beneath the site, and evaluate if the waste buried in the unit poses an unacceptable risk to human health and the environment.

The geophysical survey procedure for SWMU 30 will begin by creating a grid over an approximate 4.4-acre area (500 feet by 380 feet) that will overlay the area suspected as the former landfill location (Figure 3.7). Although the lateral extent of the landfill is not expected to be this large, a fringe around the landfill is desired and will serve as a background data set for comparison. Station locations will be placed on 20 foot centers using a tape measure for distance and a transit for trueness. The base station for this grid will be along the fence to the south of the landfill. All distances on the geophysical survey will be measured in feet from this location. Three soil borings will be drilled throughout the SWMU to the top of the water table, and six soil borings will be drilled to 1-foot into bedrock and completed as monitoring wells. Soil samples will be collected continuously for lithologic characterization. The objective of these locations are to observe the waste buried in the landfill and to evaluate the extent of possible soil and groundwater contamination in the alluvium. The total of nine locations around the perimeter of this SWMU was chosen due to the close proximity of this SWMU to the West Fork Trinity River. Figure 3.8 illustrates that the minimum distance between borings is approximately 100 feet in the N-S direction and 200 feet in the E-W direction. Two samples from each boring location (one surface and one subsurface) will be sent to the laboratory for analysis. The subsurface sample will be chosen based on field screening with a PID. If no volatile compounds are detected with the field screening device, the sample interval directly above the water table will be chosen. Surface soil samples at each boring location will be collected using stainless steel scoops or trowels.

The six soil borings, three upgradient and three downgradient, that will be converted to 2-inch monitoring wells are proposed in order to evaluate the extent of groundwater contamination underlying the alluvium. One round of groundwater samples will be collected from these monitoring wells. Proposed locations for soil borings and monitoring wells are presented in Figure 3.8.

HydroGeoLogic, Inc. — Draft Final Field Sampling Plan
NAS Fort Worth JRB, Texas

Figure 3.7

Geophysical Survey
Grid Layout
SWMU 30

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

-  SWMU Area
-  Approximate NAS Fort Worth JRB Site Boundary
-  Building
-  Fence
-  Road
-  Trench
-  Path of Survey Measurement
-  Geophysical Grid



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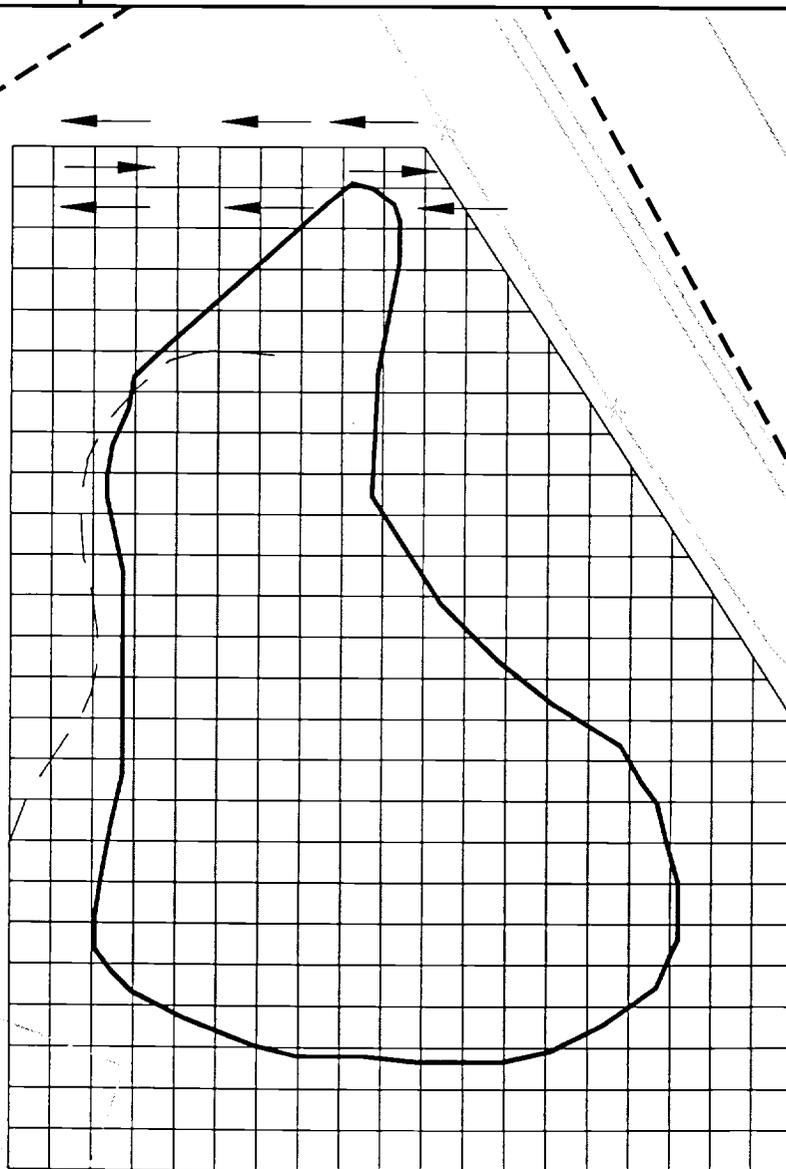
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Map Source:
JACOBS, 1996

SMWU 30
(Landfill No. 9)



WEST FORK TRINITY RIVER

HydroGeologic, Inc. — Draft Final Field Sampling Plan
 NAS Fort Worth JRB, Texas

Figure 3.8

Proposed Investigation
 Activities
 SWMU 30

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 Brooks AFB, Texas

LEGEND

-  SWMU Area
-  Approximate NAS Fort Worth JRB Site Boundary
-  Proposed Monitoring Well
-  Proposed Soil Boring
-  Building
-  Fence
-  Road
-  Trench
-  Stream
-  Groundwater Flow Direction



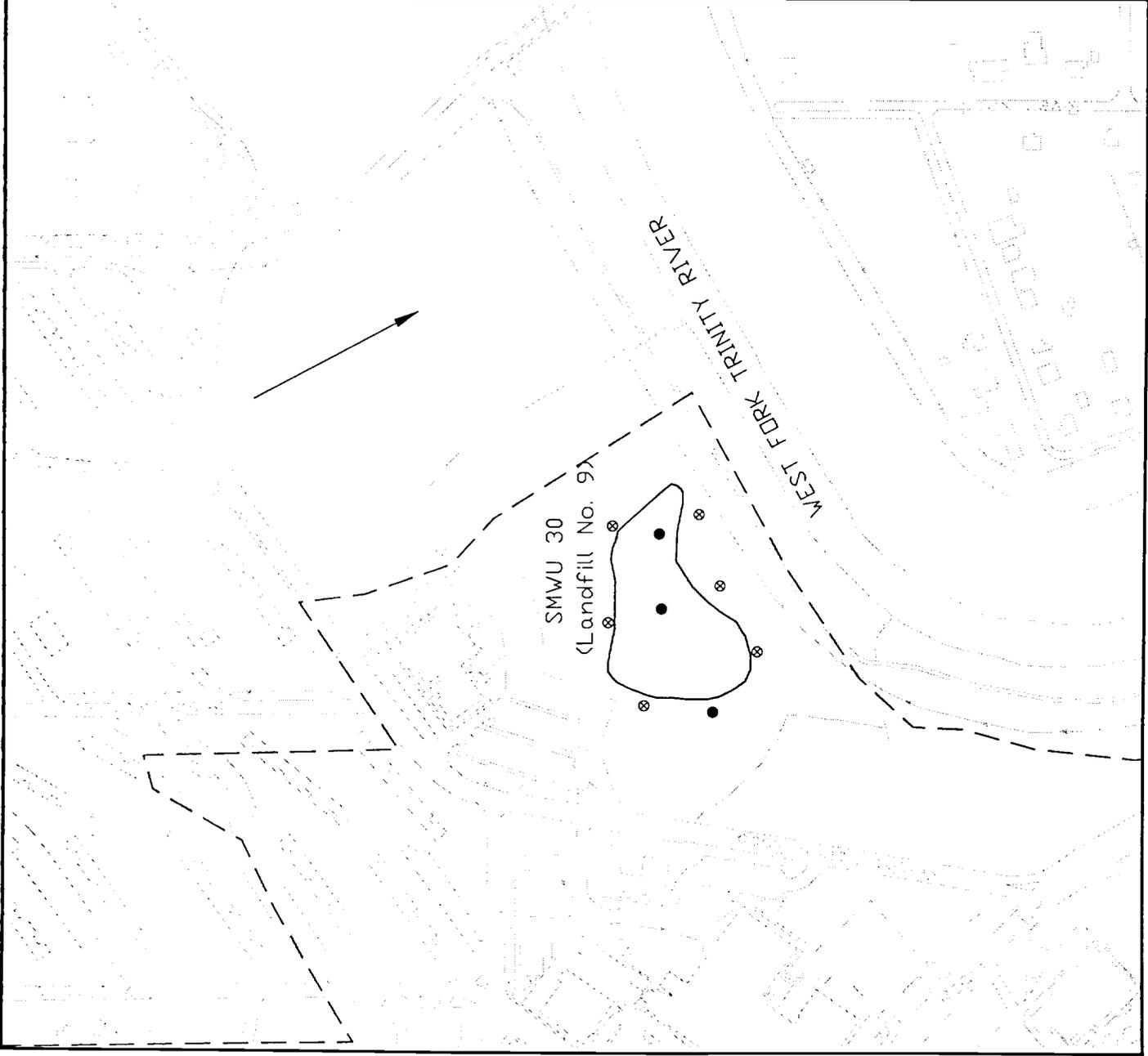
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Filename: FIG3-8SP.DWG

Map Source:
 JACOBS, 1996



3.3.5 SWMU 62

A geophysical survey, three test pits and four monitoring wells will be used to evaluate possible contamination as a result of waste buried at SWMU 62.

Two geophysical tools will be used to conduct surveys at SWMU 62 to delineate the extent of the landfill and identify “hot spots” that may be contributing to subsurface contamination. The survey procedure for SWMU 62 will begin by creating a grid over an approximate 2.5-acre area (460 feet [N-S] by 240 feet [E-W]) that will overlay the area expected to have been used as a landfill (Figure 3.9). Although the lateral extent of the landfill is not expected to be this large, a fringe around the landfill is desired and will serve as a background data set for comparison. Station locations will be placed on 20 foot centers using a tape measure for distance and a transit for trueness. The base station for this grid will be along the fence to the north of the landfill. Measurements will be taken at each of the grid nodes and recorded. All distances on the geophysical survey will be measured in feet from this location.

Four soil borings will be drilled 1-foot into the bedrock along the outside perimeter of the SWMU to evaluate the extent of possible soil contamination in the alluvium and to characterize the lithology underlying the SWMU. The borings will be located along the four sides of the SWMU to delineate the lateral and vertical extent of buried debris. Two of these soil borings will also serve as upgradient and downgradient monitoring wells to determine if any contaminants are flowing into and/or exiting the SWMU. Two samples from each boring location (one surface and one subsurface) will be sent to the laboratory for analysis based on field observations. The subsurface sample will be chosen based on field screening with a PID. If no volatile compounds are detected with the field screening device, the sample interval directly above the water table will be chosen. Surface soil samples at each boring location will be collected using stainless steel scoops or trowels. Each soil boring will be completed as a 2-inch monitoring well in order to evaluate the extent of possible groundwater contamination in the underlying alluvium. After development, one round of groundwater samples will be collected from the monitoring wells.

Three test pits will also be completed within the interior of the SWMU to characterize the wastes buried in the SWMU. Due to the relatively small area of SWMU 30, test pits were selected rather than additional soil borings because they will provide a better means of characterizing the waste. Subsurface and surface soil samples will be collected at each of the test pit locations and submitted to the laboratory for analysis. Proposed locations for soil borings/monitoring wells and the test pits are presented in Figure 3.10. To accommodate utility trenches and other physical obstructions, the location of each test pit may be shifted slightly.

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 NAS Fort Worth JRB, Texas

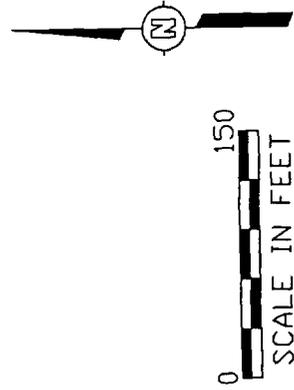
Figure 3.9

Geophysical Survey
 Grid Layout
 SWMU 62

Air Force Center
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 Brooks AFB, Texas

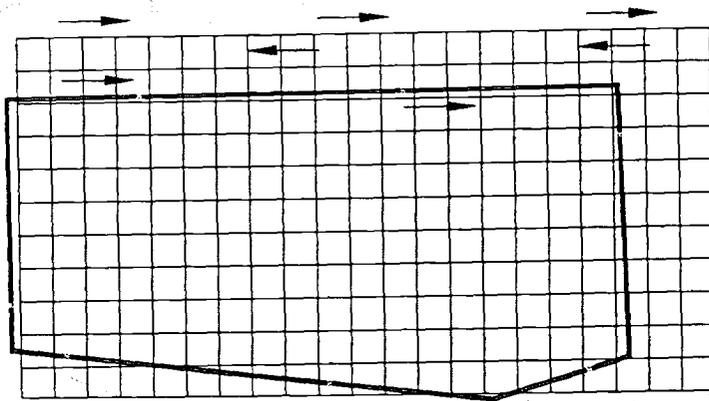
LEGEND

-  SWMU Area
-  Proposed Monitoring Well
-  Building
-  Fence
-  Road
-  Path of Survey Measurements
-  Geophysical Grid



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Map Source:
 JACOBS, 1996



SWMU 62
 (Landfill No. 6)

HydroGeoLogic, Inc. — Draft Final Field Sampling Plan
NAS Fort Worth JRB, Texas

Figure 3.10

Proposed Investigation
Activities
SWMU 62

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

-  SWMU Area
-  Proposed Monitoring Well
-  Building
-  Fence
-  Road
-  Proposed Trench
Note: Actual Size = 30' X 4'
-  Groundwater
Flow Direction



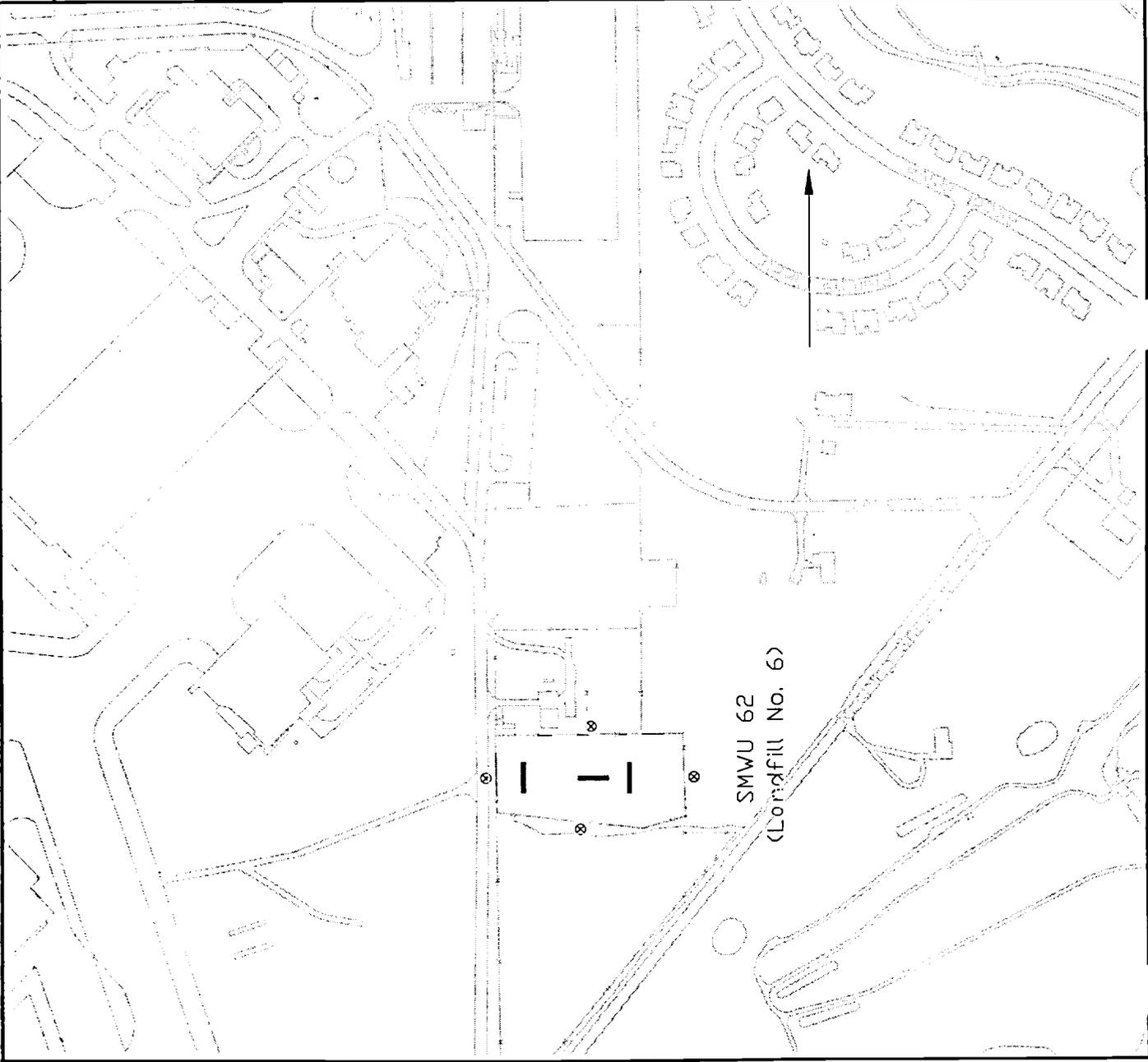
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Filename: FIG3-10SP.DWG

Map Source:
JACOBS 1996



4.0 PROJECT ORGANIZATION AND RESPONSIBILITY

Figure 4.1 shows the project organization, reporting relationships, and line authority. Table 4.1 lists key project personnel and their respective telephone numbers. Other personnel will be assigned as necessary. The specific responsibilities are described in the following subsections.

Table 4.1
Key Project Personnel
RCRA Facility Investigation - SWMUs 17,27,29,30, and 62
NAS Fort Worth JRB, Texas

Name	Title	Organization	Telephone
Joseph Dunkle	Team Chief	AFCEE/ERD	(210) 536-5290
John B. Robertson	Program Manager	HydroGeoLogic	(703) 478-5186
James Costello	Project Manager	HydroGeoLogic	(703) 478-5186
Gary Mayer	QA Manager	HydroGeoLogic	(703) 478-5186
Christopher Spill	Health & Safety Officer	HydroGeoLogic	(703) 478-5186
TBD	Lab Project Manager	TBD	TBD
TBD	Lab Operations Manager	TBD	TBD
TBD	Lab QA Officer	TBD	TBD
TBD	Lab Sample Custodian	TBD	TBD
Michael Rodtang	Project Geologist	HydroGeoLogic	(703) 478-5186
Omar Abdi	Data Mgmt. Supervisor	HydroGeoLogic	(703) 478-5186
Bruce Rappaport	Senior Reviewer	HydroGeoLogic	(703) 478-5186
Miquette Gerber	Senior Reviewer	HydroGeoLogic	(703) 478-5186

TBD - To Be Determined

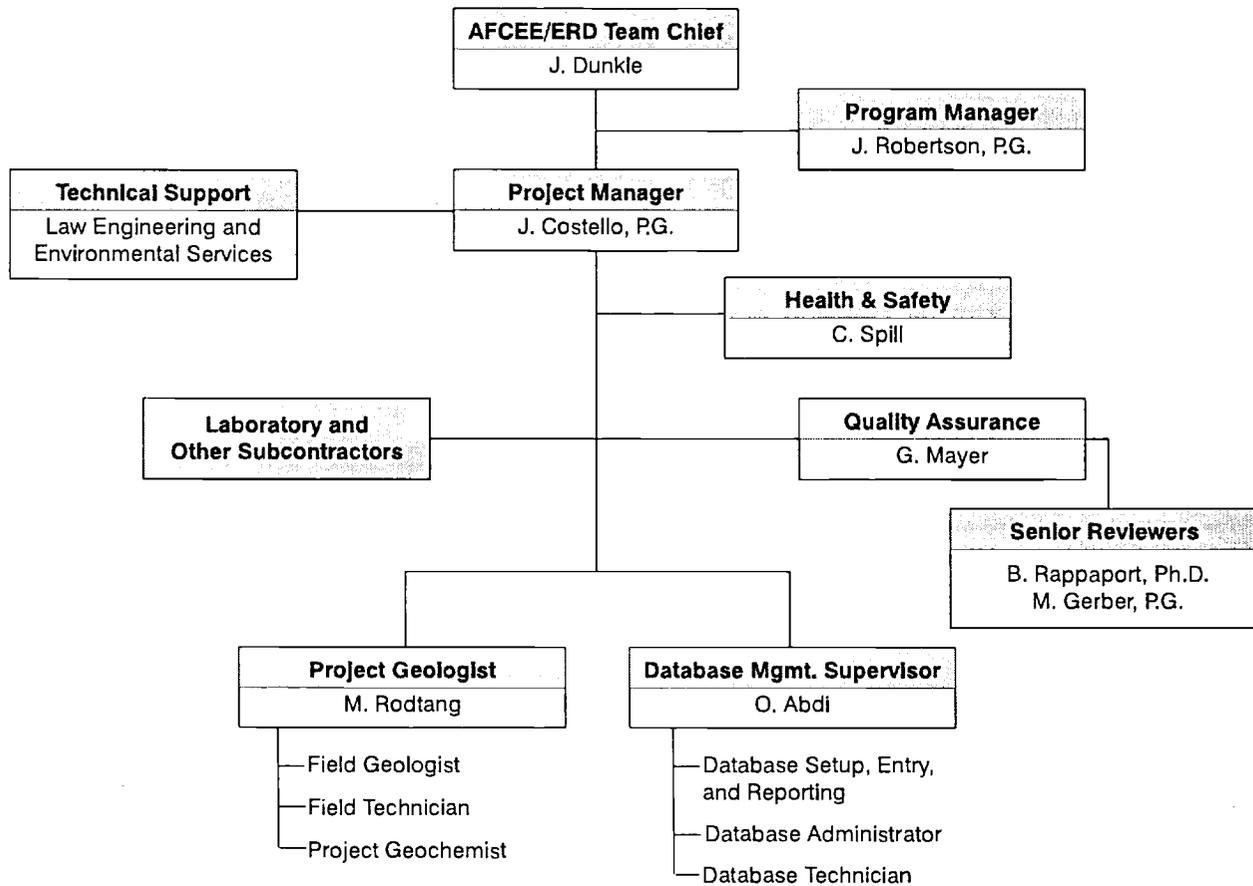


Figure 4.1 Project Organization Chart, NAS Fort Worth JRB

4.1 MANAGEMENT RESPONSIBILITIES

4.1.1 Program Manager

The Program Manager's responsibilities will include:

- Reviewing and approving the WP, QAPP, FSP, and HSP
- Providing sufficient resources to the project team so that it can respond fully to the requirements of the investigation
- Providing direction and guidance to the Project Manager
- Reviewing the final project report
- Providing other responsibilities as requested by the Project Manager

4.1.2 Project Manager

The Project Manager will be the prime point of contact with AFCEE and will have primary responsibility for technical, budget, and scheduling matters. His duties will include:

- Reviewing and approving project plans and reports
- Assigning duties to the project staff and orienting the staff to the needs and requirements of the project
- Obtaining the approval of the QA Manager for proposed variances to the WP and FSP
- Supervising the performance of project team members
- Providing budget and schedule control
- Reviewing subcontractor work and approving subcontract invoices
- Ensuring that major project deliverables are reviewed for technical accuracy and completeness, including data validity, before their release
- Ensuring all resources of the laboratory are available on an as-required basis
- Overseeing final analytical reports

4.2 QA AND HEALTH AND SAFETY RESPONSIBILITIES

4.2.1 QA Manager

Responsibilities of the QA Manager will include:

- Serving as official contact for QA matters for the project
- Identifying and responding to QA/QC needs and problem resolution needs, and answering requests for guidance or assistance
- Reviewing, evaluating, and approving the FSP and QAPP and all changes to these documents
- Verifying that appropriate corrective actions are taken for all nonconformances
- Verifying that appropriate methods are specified in the FSP and QAPP for obtaining data of known quality and integrity
- Fulfilling other responsibilities as requested by the Project Manager
- Evaluating subcontractor quality program
- Training Staff on QA subjects
- Supervising staff in QA Program related tasks
- Recommending changes in the QA Program

4.2.2 Health and Safety Coordinator

Responsibilities of the Health and Safety Coordinator (HSC) will include:

- Developing the HSP
- Ensuring that the requirements of the QAPP are satisfied
- Providing other responsibilities as identified in the HSP

4.3 LABORATORY RESPONSIBILITIES

4.3.1 Laboratory Project Manager

The laboratory's Project Manager will report directly to HydroGeoLogic's Project Manager and will be responsible for the following:

- Ensuring all resources of the laboratory are available on an as-required basis
- Overseeing final analytical reports

4.3.2 Laboratory Operations Manager

The laboratory's Operation Manager will report to the laboratory's Project Manager and will be responsible for:

- Coordinating laboratories analyses
- Supervising in-house chain-of-custody
- Scheduling sample analyses
- Overseeing data review
- Overseeing preparation of analytical reports
- Approving final analytical reports prior to submission to HydroGeoLogic

4.3.3 Laboratory QA Officer

The laboratory's QA officer has the overall responsibility for data after it leaves the laboratory. The QA officer will be independent of the laboratory but will communicate data issues through the laboratory's Project Manager. In addition, the QA officer will:

- Conduct audits of laboratory analyses
- Provide oversight of laboratory QA
- Provide oversight of QA/QC documentation
- Conduct detailed data review
- Determine whether to implement laboratory corrective actions, if required
- Define appropriate laboratory QA procedures
- Prepare laboratory Standard Operation Procedures

4.3.4 Laboratory Sample Custodian

The laboratory's Sample Custodian will report to the Operations Manager. Responsibilities of the Sample Custodian will include:

- Receiving and inspecting the incoming sample containers
- Recording the condition of the incoming sample containers
- Signing appropriate documents
- Verifying chain-of-custody and its correctness
- Notifying laboratory manager and laboratory supervisor of sample receipt and inspection
- Assigning a unique identification number and customer number, and entering each into the sample receiving log
- Initiating transfer of the samples to appropriate lab sections with the help of the laboratory operations manager
- Controlling and monitoring access/storage of samples and extracts

4.4 FIELD RESPONSIBILITIES

4.4.1 Project Geologist

The Project Geologist will be responsible for geologic interpretations as well as acting as lead coordinator for field activities. The Project Geologist's duties and responsibilities will include:

- Providing orientation and any necessary training to field personnel (including subcontractors) on the requirements of the FSP, HSP, and QAPP before the start of work
- Providing direction and supervision to the sampling crews
- Monitoring sampling operations to ensure that the sampling team members adhere to the QAPP and FSP
- Ensuring the use of calibrated measurement and test equipment
- Maintaining a field records management system
- Coordinating activities with the Project Manager
- Supervising geological data interpretation activities
- Overseeing field data documentation and conducting quality checks on interpretive geologic work products

- Reviewing reports for compliance with State of Texas and EPA requirements
- Assuming the duties of the HSC at the direction of the HSC

4.5 SUBCONTRACTORS

Subcontractors will be used for the drilling of soil borings; installation of monitoring wells; and excavation of test pits during the field investigation. In addition, laboratory analyses of all samples collected during the investigation will also be subcontracted to an AFCEE approved laboratory.

Qualified subcontractors will be selected in accordance with AFCEE requirements and HydroGeoLogic Procurement and QA procedures. Subcontractors will meet predetermined qualifications developed by the Project Manager and defined in the procurement bid packages. Each bid submitted will be reviewed for technical, QA, and purchasing requirements. All subcontractors will be required to follow the procedures of the WP, FSP, QAPP, and HSP. Periodic QC inspections of each subcontractor may be performed as specified in the FSP (Section 7.5), QAPP (Section 9.1), and HSP (Section 1.3.2). These inspections will be performed by the QA Manager or his designate as unannounced audits to confirm adherence to the procedures and guidance outlined in the aforementioned documents. Such inspections may relate to health and safety, QAPP requirements, and field standard operating procedures.

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5.0 FIELD OPERATIONS

The overall project field logistics and activities necessary to complete the project sampling objectives described in the work plan are presented in this section. All field work will be conducted in accordance with the site HSP. HydroGeoLogic is the prime contractor for the field investigation. The point-of-contact (POC) at the Base will be Mr. Joseph Dunkle. HydroGeoLogic's Project Geologist/Field Coordinator will be Mr. Michael Rodtang.

5.1 GEOLOGIC STANDARDS

The lithologic descriptions for consolidated materials (igneous, metamorphic, and sedimentary rocks) shall follow the standard professional nomenclature (cf. Tonnissen, A.C., 1983, *Nature of Earth Materials*, 2nd Edition, p. 204-348), with special attention given to describing fractures, vugs, solution cavities and their fillings or coatings, and any other characteristics affecting permeability. Colors shall be designated by the Munsell Color System.

The lithologic descriptions for unconsolidated materials (soils [engineering usage] or deposits) shall use the name of the predominant particle size (e.g., silt, fine sand, etc.). The dimensions of the predominant and secondary sizes shall be recorded using the metric system. The grain size and name of the deposit shall be accompanied by the predominant mineral content, accessory minerals, color, particle angularity, and any other characteristics. The classic deposit descriptions shall include, as a supplement, symbols of the Unified Soil Classification System (USCS). The color descriptions shall be designated by the Munsell Color System.

The sedimentary, igneous, and metamorphic rocks and deposits shall be represented graphically by the patterns shown in Figure 5.1. Columnar sections, well and boring logs, well construction diagrams, cross sections, and three-dimensional (3-D) diagrams shall use these patterns. Supplementary patterns shall follow Swanson, R. G., 1981, *Sample Examination Manual*, American Association of Petroleum Geologists, p IV-41 and 43. Geologic structure symbols shall follow American Geological Institute Data Sheets, 3d Edition, 1989, sheets 3.1 through 3.8.

The scales for maps, cross sections, or 3-D diagrams shall be selected in accordance with the geologic and hydrologic complexity of the area and the purposes of the illustrations. Geophysical logs shall be run at a constant vertical scale of 1 inch equals 20 feet. When geophysical logs are superimposed on geologic logs, cross sections, or 3-D diagrams, the scales shall be the same. If defining geological conditions requires other scales, additional logs at those scales shall be provided.

For orientation, the cross sections shall show the Northern end on the viewer's right. If the line of cross section is predominantly East-West, the Eastern end is on the right. Maps shall be oriented with North toward the top, unless the shape of the area dictates otherwise. Indicate orientation with a North arrow.

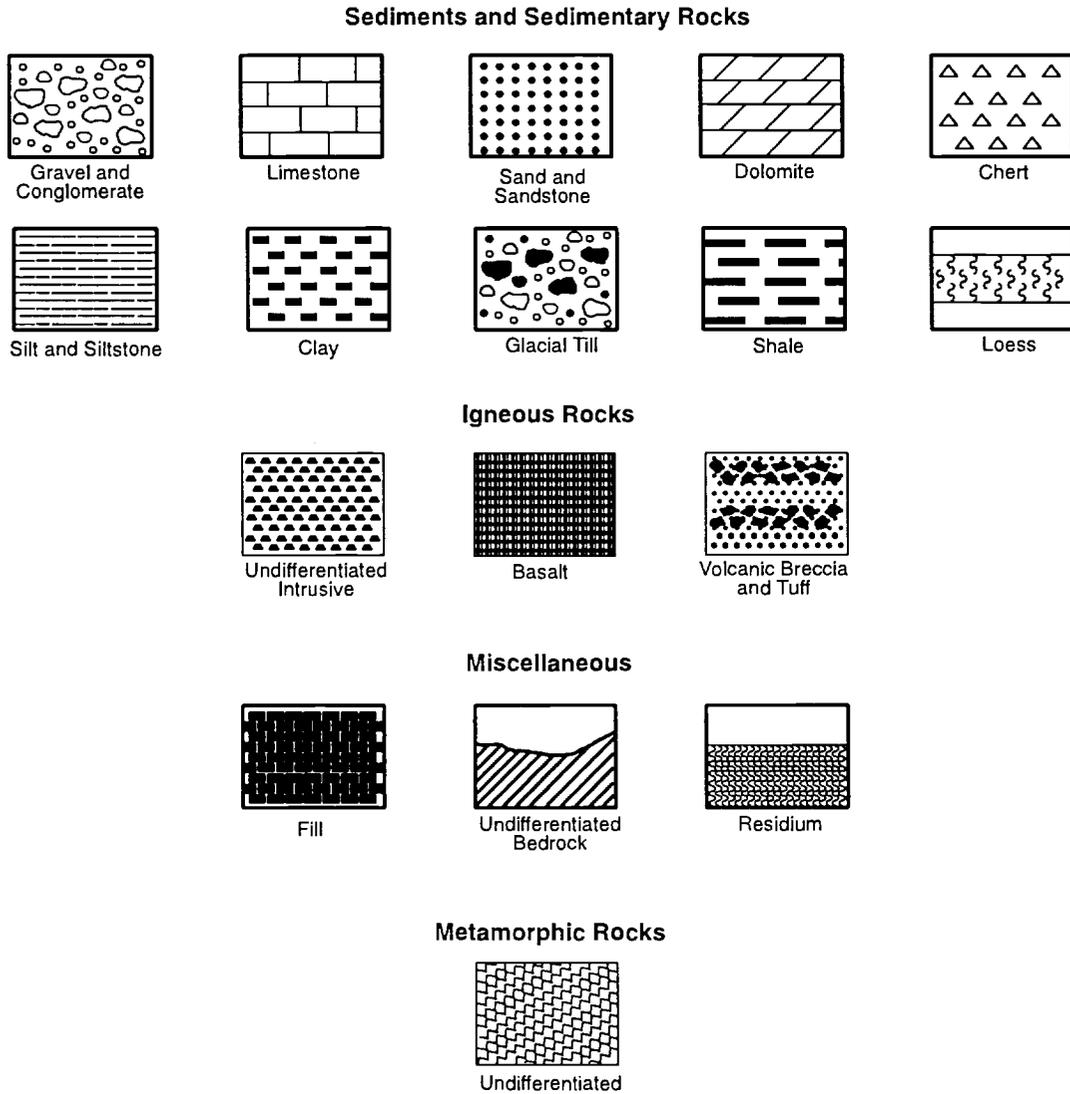


Figure 5.1 Lithologic Patterns for Illustration

5.2 SITE RECONNAISSANCE, PREPARATION, AND RESTORATION PROCEDURES

330185

Areas designated for intrusive sampling shall be surveyed for the presence of underground utilities. Utility locations are determined using existing utility maps, and in the field, are verified using a hand-held magnetometer or utility probe. Prior to commencement of drilling activities, digging permits will be obtained from the Air Force Base Realignment and Closure Agency (AFBRCA) office, located on White Settlement Road. The Base civil engineer will be contacted to verify that selected locations are free of underground utilities. Those locations not clear of underground utilities will be relocated to achieve clearance and verified for clearance a second time. Vehicle access routes to sampling locations shall be determined prior to any field activity.

A centralized decontamination area shall be provided for drilling rigs and equipment. The decontamination area shall be large enough to allow storage of cleaned equipment and materials prior to use, as well as to stage drums of decontamination waste. The decontamination area shall be lined with a heavy gauge plastic sheeting, and designed with a collection system to capture decontamination waters. Solid wastes shall be accumulated in 55-gallon drums and subsequently transported to a waste storage area designated by the Air Force. Smaller decontamination areas for personnel and portable equipment shall be provided as necessary. These locations shall include basins or tubs to capture decontamination fluids, which shall be transferred to a large accumulation tank as necessary. These designated areas of decontamination shall be determined during the pre-construction meeting.

The field office and the primary staging area for field equipment and supplies will be located in the building adjacent to the west side of the Air Force Base Conversion Agency office at 6550 White Settlement Road. This location is in close proximity to SWMU 17 which is under investigation.

Each work site or sampling location shall be returned to its original condition when possible. Efforts shall be made to minimize impacts to work sites and sampling locations, particularly those in or near sensitive environments such as wetlands. Following the completion of work at a site, all drums, trash, and other waste shall be removed. Decontamination and/or purge water and soil cuttings shall be transported to the designated locations as described in Section 5.10. At the completion of field activities, all capital equipment and consumable materials will be removed or turned over to base personnel in accordance with AFCEE procedures. A final site walk will be conducted with the Base representative, at his/her discretion, to ensure that all sampling locations have been restored satisfactorily before final demobilization from the site.

5.3 GEOPHYSICAL SURVEYS

Two geophysical tools, an Electromagnetic Induction (EM) tool and a magnetometer will be used to evaluate the extent of the landfills and any “hot spots” that may be present at SWMU’s 17, 27, 29, 30 and 62. For each SWMU location, the EM survey will be used to initially identify and pin point areas with conductivity contrasts, i.e., “hot spots.” The grid will then be resurveyed, including the “hot spots” using the cesium (Cs) magnetic gradiometer as a confirmatory tool. The data gathered from these surveys will help identify areas of buried wastes and provide indications

on the depths of groundwater, bedrock, and stratigraphy. This information will be used to assure that optimal trenching and soil sampling locations are selected.

5.3.1 General Requirements For Geophysical Surveys

General requirements for all geophysical surveys are: (1) HydroGeoLogic shall provide a professional geologist or engineer to supervise the project, (2) the locations of surface geophysical grid system layouts shall be shown on a site map, (3) final results shall be presented in plain views and cross sections, contours shall be used where appropriate, (4) the interpretation of results shall discuss positive and negative results as well as limitations of the method and data and, (5) the interpretation of the data shall be incorporated into the conceptual site model.

5.3.2 Surface Geophysical Surveys

Surface geophysical techniques include, but are not limited to, ground penetrating radar (GPR), magnetometry, and electromagnetic techniques. Use of any of these techniques is dictated by the project data quality objectives (Section 3.0), and the objectives of these techniques is to locate the boundaries of suspected or known underground metallic objects or volumes of disturbed soil. The areas to be surveyed are described in Section 3.0 and shown on site maps presented in the WP.

Surface geophysical surveys are conducted within predetermined grids defined by transect lines crossing each site or area of interest. The spacing of the grids is determined from the approximate dimensions of the features to be located. Qualified individuals will conduct the surveys and will be supervised by a professional geologist or engineer.

Location and elevation information sufficient to map and assess the survey results shall be recorded. Depending on the level of accuracy and detail required, northing and easting from a surveyed reference point, measurements in a third order survey, depth below ground surface (bgs), and/or professionally surveyed points and transects may be included. Location data, instrument numbers, calibration information, geophysical interpretation, and maps for all geophysical surveys shall be stored in project files.

General requirements for surface geophysical surveys are: (1) HydroGeoLogic will correlate surface survey data (profiles and soundings) with at least one soil boring, well bore, or outcrop at the same site as the survey and, (2) the location and elevation of at least two points of the geophysical survey grid will be surveyed according to the specifications of Section 5.9.

5.3.2.1 Electromagnetic Methods

An electromagnetic survey measures the electrical conductivity of a subsurface volume, which is a function of the soil or rock type, porosity/permeability, and fluid content. The measured values, referred to as terrain conductivity, are obtained without direct ground contact through electromagnetic induction. Data collected during an electromagnetic survey can be used to map the location of buried metallic objects; depth or thickness determinations cannot be made solely by this method. The electromagnetic technique can also detect chemicals or contaminant plumes (e.g., hydrocarbons in high concentrations or other conductive or resistive chemicals).

Geonics' model EM-31 will be used to measure the apparent conductivity of the soil at various depths. The instrument consists of a transmitter coil energized with an alternating current at a 9.9 kiloHertz (kHz) frequency and a receiver coil, separated by a rigid boom. The time-varying magnetic field arising from the alternating current in the transmitter coil induces very small currents into the earth. These currents generate a secondary magnetic field, which is received, together with the primary field, by the receiver coil. The instrument then measures the terrain conductivity by comparing the strength of the two signals.

The EM-31 has an intercoil spacing of 3.7 meters, which yields an effective depth of exploration of about 20 feet. Based on existing site conditions, cultural interference (i.e. utilities, fences, etc.) will be documented during each survey and evaluated as part of the data interpretation. Both quadrature and in-phase channels will be utilized. The quadrature phase channel reads the apparent terrain conductivity of the soil, while the in-phase provides a measure of the terrain magnetic susceptibility. The instrument is calibrated to read terrain conductivity in millimhos per meter. The subsequent readings along the line and station location can be digitally recorded in the field using a portable data logger. This device provides an efficient data interface for computer enhancement and mapping.

The EM-31 survey looks for changes in the terrain conductivity and magnetic susceptibility values as compared with the natural undisturbed soils. This technique has been proven successful in locating buried metallic objects such as pipes, drums, and tanks. Values for buried metallic objects depend upon size and depth of, and distance from the object to the instrument. The presence of subsurface metallic objects near the EM-31 will cause a dramatic change in the instrument readings. Non-metallic objects, such as plumes from petroleum, oils and lubricants (POLs), and chlorinated solvents, can also be detected since they will yield an anomalous low because of their relatively low conductivity.

The EM-31 survey will be utilized to quickly investigate and pin point areas with conductivity contrasts. The EM-31 instrument will be initially calibrated and corrected to zero reading. The DL55/31 Data Logger will be initialized and programmed for the aforementioned survey lines, direction, increment, and reading type. The survey procedure for the EM-31 will be to hand carry the instrument along grid lines with station readings every 20 feet except where surface obstructions may prevent continuous profiling. Section 3.4 further describes the established grid patterns of the survey.

5.3.2.2 Magnetometry

Magnetometer surveys measure variations in the earth's magnetic field. Measurements of the magnetic gradient can be used to locate buried ferrous objects such as tanks, pipelines, and metallic debris.

Magnetometer surveys are conducted using a magnetometer/gradiometer or equivalent equipment. The magnetometer has two sensors and an electronics package and can collect both total field data and vertical gradient data and can discriminate to 0.2 gammas (nT) in a total field of 40,000 to 60,000 g. Magnetic readings are stored in memory with the time of day, station numbers, and line numbers of the readings. A base station for magnetic readings is established at the start of each

day's measurements. Magnetic readings will be collected and recorded in the morning, at noon, and at the end of day to evaluate instrument drift.

The GeoMetrics 858G magnetic gradiometer uses the earth's magnetic field and local variations in the field. The magnetic survey involves the measurement of the earth's magnetic field at various points on the ground surface. Variations in the magnetic susceptibility of the subsurface materials produce anomalies within the earth's magnetic field that can be resolved using a magnetic gradiometer. For the purpose of this project, the magnetic gradiometer will be used to detect ferromagnetic objects, such as drums or tanks, to depths of 10 to 15 feet below the ground surface. For larger objects, or groups of objects, the survey can penetrate to a depth of 25 feet. An added benefit of using the magnetometer is that ferromagnetic objects on the land surface, such as fences and manhole covers, will not create interference i.e., false anomalies with the survey.

Two types of magnetic measurements that can be obtained include a magnetic total field and magnetic vertical gradient. The total field intensity is simply the magnitude of the earth's magnetic field vector. The magnetic vertical gradient is a measure of the difference in the total magnetic field between two sensors set at different fixed heights above the ground. In general, the total field measurements are most suitable for reconnaissance surveys while gradient measurements allow resolution of more complex anomalies.

Magnetic measurements are affected by several sources that interfere with the desired magnetic signal. By using standard surveying techniques, however, the effects of these sources of interference can be removed or corrected from the magnetic data.

The magnetometer will utilize its gradiometer capabilities for geologic reconnaissance to discern between native materials and those that are relict. This will be accomplished by the gradiometer receiving anomalous low readings that will be in response to disturbed soils, i.e., landfill materials. Areas that have not been disturbed will be received and recorded equal to those of normal background levels. These anomalous lows from the gradiometer and data collected from the EM-31 will help to determine the aerial and vertical extent of the landfill.

The magnetometer survey will be conducted to confirm any anomalous areas detected by the EM-31 survey. The magnetometer will be initially calibrated and corrected to a zero reading. As the magnetic survey proceeds, a built-in data logger will record any magnetic variation in the earth's magnetic field, i.e., "hot spots." The surveyor will also have the capability of viewing these variations, on the screen, as they are recorded. The survey procedure for the magnetometer will be the same as for the EM-31, which will be to hand carry the instrument along established grid lines with station readings every 20 feet except where surface obstructions may prevent continuous profiling. Section 3.4 further describes the established grid patterns of the survey.

5.4 BOREHOLE DRILLING, LITHOLOGIC SAMPLING, LOGGING, AND ABANDONMENT

5.4.1 General Drilling Procedures

All drilling activities shall conform with state and local regulations and will be supervised by a professional geologist or engineer. HydroGeoLogic will obtain and pay for all permits, applications, and other documents required by state and local authorities.

The location of all borings will be coordinated, in writing, with the base civil engineer or equivalent before drilling commences. When drilling boreholes through more than one water bearing zone or aquifer, HydroGeoLogic and its subcontractors will take measures to prevent cross-connection or cross-contamination of the zones or aquifers.

The drill rig will be cleaned and decontaminated in accordance with (IAW) the procedure in Section 5.10. The drill rig shall not leak any fluids that may enter the borehole or contaminate equipment placed in the hole. The use of rags or absorbent materials to absorb leaking fluids is unacceptable and thus will not be permitted.

As hollow-stem auger drilling is to be used for this project, drilling fluids shall not be used. A log of drilling activities will be kept in a bound field notebook. Information in the log book will include location, time on site, personnel and equipment present, down time, materials used, samples collected, measurements taken, and any observations or information that would be necessary to reconstruct field activities at a later date. At the end of each day of drilling the drilling supervisor will complete a Log of Daily Time and Materials Form. An example of this form is provided in Appendix D.

HydroGeoLogic will dispose of all trash, waste grout, cuttings, and drilling fluids as coordinated with the base civil engineer or NAS Fort Worth JRB representative.

5.4.2 Sampling and Logging

The lithology in all boreholes will be logged. The boring log form (Appendix D) will be used for recording the lithologic logging information. Information on the boring log sheet includes the borehole location; drilling information; sampling information such as sample intervals, recovery, and blow counts; and sample description information.

Unconsolidated samples for lithologic description will be obtained continuously at 2-foot intervals using split spoon samplers and standard penetration tests. Lithologic descriptions of unconsolidated materials encountered in the boreholes will generally be described in accordance with American Society for Testing and Materials (ASTM) D-2488-90 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) (ASTM, 1990). Descriptive information to be recorded in the field will include: (1) identification of the predominant particles size and range of particle sizes, (2) percent of gravel, sand, fines, or all three, (3) description of grading and sorting of coarse particles, (4) particle angularity and shape, and (5) maximum particle size or dimension.

Plasticity of fines description include: (1) color using Munsell Color System, (2) moisture (dry, wet, or moist), (3) consistency of fine grained soils, (4) structure of consolidated materials, and (4) cementation (weak, moderate, or strong).

Identification of the USCS group symbol will be used. Additional information to be recorded includes the depth to the water table, caving or sloughing of the borehole, changes in drilling rate, depths of laboratory samples, presence of organic materials, presence of fractures or voids in consolidated materials, and other noteworthy observations or conditions, such as the locations of geologic boundaries.

Lithologic descriptions of consolidated materials encountered in the boreholes will generally be described in accordance with Section 5.1. Consolidated samples for lithologic description will be obtained continuously at 2-foot intervals using split spoon samplers and standard penetration tests. All samples will be monitored with an organic vapor monitor (e.g., PID, OVA). The samples shall be handled in such a way as to minimize the loss of volatiles, and these procedures are described in Section 6.0. Cuttings will be examined for their hazardous characteristics. Materials suspected to be hazardous because of abnormal color, odor, or organic vapor monitor readings will be containerized in conformance with RCRA, state, and local requirements.

5.4.3 Abandonment

Boreholes that are not converted to monitor wells will be abandoned in accordance with 30 TAC Chapter 238, Water Well Driller Rules (TNRCC, 1997). Since the borings will not exceed 100 feet, the boring will be plugged to a depth not exceeding two feet below ground surface with a solid column of either cement, or 3/8 inch or larger granular sodium bentonite. The granular bentonite shall be hydrated at frequent intervals while strictly adhering to the manufacturers specifications. The top two feet of each boring will be filled with cement as an atmospheric barrier (TNRCC, 1997).

All abandoned boreholes will be checked 24 to 48 hours after mud/solid bentonite emplacement to determine whether curing is occurring properly. More specific curing specifications may be recommended by the manufacturer and will be followed. If settling has occurred, a sufficient amount of cement will be added to fill the hole to the ground surface. These curing checks and any addition of cement will be recorded in the field log.

5.5 MONITOR WELL CONSTRUCTION

The on-site Project Geologist will supervise the drilling, soil boring, geophysical surveys, lithologic sampling, and monitor well construction and will be a professional geologist or engineer. A Professional Geologist will affix his/her signature and registration/ certification seal to all drilling logs, as-built well construction diagrams, lithologic logs, sampling records, and similar documents. Although floating petroleum products (i.e., light non-aqueous phase liquids, LNAPLs) are not anticipated, shallow monitor wells shall be screened across the water table if they are encountered. The length of the screen will be such that tidal and seasonal water table fluctuations shall not cause water levels to rise above or fall below the screened interval. If dense

the drilling method used for this project), (8) diameters of surface casing, casing type, and methods of installation, (9) depth at which saturated conditions were first encountered, (10) lithologic descriptions and depths of lithologic boundaries, (11) sampling-interval depths, (12) zones of caving or heaving, (14) drilling rate, and (15) drilling rig reactions, such as chatter, rod drops, and bouncing.

In addition to the above, the following information shall be recorded when rock core samples are collected: (1) the depth interval and top and bottom of each core shall be marked on the core box, (2) percentage of core recovered, (3) number of fractures per foot, (4) angle of fractures relative to the core axis, and (5) breaks due to coring and core handling shall be distinguished from naturally occurring fractures.

A standard penetration test shall be performed each time a split spoon sample is taken. The test shall be performed in accordance with ASTM D-1586.

5.5.3 Casing Requirements

The casing requirements that will be followed are: (1) all casing will be new, unused, and decontaminated according to the specifications of Section 5.10, (2) glue will not be used to join casing, and casings will be joined only with compatible welds or couplings that shall not interfere with the planned use of the well, (3) all polyvinyl chloride (PVC) will conform to the ASTM Standard F-480-88A or the National Sanitation Foundation Standard 14 (Plastic Pipe System), (4) all metal casing will be seamless stainless steel casing, and the casing "mill" papers will be included in the appendix of the technical report, (5) the casing will be straight and plumb within the tolerance stated for the borehole, and (6) the driller shall cut a notch in the top of the casing to be used as a measuring point for water levels.

All monitoring wells for this project will be constructed using flush threaded two-inch diameter Schedule 40 PVC casing. The notches cut in the top of the monitoring well casings for water level measuring points will be oriented on the north side of each casing for uniformity.

5.5.4 Well Screen Requirements

AFCEE well screen requirements are: (1) all requirements that apply to casing will also apply to well screen, except for strength requirements, (2) monitor wells will not be screened across more than one water-bearing unit, (3) screens will be factory slotted or wrapped, (4) screen slots will be sized to prevent 90 percent of the filter pack from entering the well, and for wells where no filter pack is used, the screen slot size will be selected to retain 60 to 70 percent of the formation materials opposite the screen, and (5) the bottom of the screen is to be capped, and the cap will be joined to the screen by threads.

The monitoring wells will be constructed using flush-threaded two-inch diameter Schedule 40 PVC casing and screen. The well screen will be 10 feet long with 0.010 inch continuous slotted PVC screen placed in the lowest portion of the alluvial terrace groundwater zone. The bottom of the screen will be capped using a flush threaded PVC cap.

petroleum products (i.e., dense non-aqueous phase liquids [DNAPLs]) are encountered, monitor wells will be screened at the bottom of the aquifer to capture the DNAPL.

5.5.1 Drilling Requirements

All drilling and well installations will conform to state and local regulations, and HydroGeoLogic will obtain and pay for all permits, applications, and other documents required by state and local authorities. The location of all borings will be coordinated in writing with the base civil engineer or equivalent before drilling commences.

The rig will be cleaned and decontaminated according to the guidelines described in Section 5.10. The rig will not leak any fluids that may enter the borehole or contaminate equipment that is placed in the hole. Rags or absorbent materials will not be used to absorb leaking fluids.

HydroGeoLogic and its drilling subcontractors will dispose of all trash, waste grout, cuttings, and drilling fluids as coordinated with the base civil engineer or representative. Monitoring wells will be completed in the alluvial terrace groundwater only, thereby preventing cross-connection or cross-contamination of other water bearing zones or aquifers.

5.5.2 Borehole Requirements

As hollow-stem auger drilling is to be used for this project, the inside diameter of the auger will be at least 4-inches larger than the outside diameter of the casing and well screen.

The completed monitor wells will be sufficiently straight to allow passage of pumps or sampling devices and will be plumb within 1 degree of vertical where the water level is greater than 30 feet below land surface unless otherwise approved by AFCEE. AFCEE may waive a plumbness requirement. Any request for a waiver from straightness or plumbness specifications will be made, in writing, to AFCEE in advance of mobilization for drilling. HydroGeoLogic or its drilling subcontractor will use a single-shot declination tool to demonstrate plumbness. Monitor wells not meeting straightness or plumbness specifications will be redrilled and/or reconstructed.

Formation samples for lithologic description will be obtained continuously at 2-foot sampling intervals. All samples will be monitored with an organic vapor monitor (e.g., PID, OVA). The samples will be handled in such a way as to minimize the loss of volatiles, and these procedures will be described in Section 6.0. Cuttings will be examined for their hazardous characteristics. Materials that are suspected to be hazardous because of abnormal color, odor, or organic vapor monitor readings shall be containerized in conformance with RCRA and the state and local requirements.

The documentation record and forms (Appendix D) will document the following information for each boring: (1) boring or well identification (this identification shall be unique, and HydroGeoLogic will ensure it has not been used previously at the installation.), (2) purpose of the boring (e.g., soil sampling, monitor well), (3) location in relation to an easily identifiable landmark, (4) names of drilling contractor and logger, (5) start and finish dates and times, (6) drilling method, (7) types of drilling fluids and depths at which they were used (not applicable to

5.5.5 Annular Space Requirements

The annular space requirements are the following: (1) the annular space will be filled with a filter pack, a bentonite seal, and casing grout between the well string and the borehole wall, and (2) as the annular space is being filled, the well string will be centered and suspended such that it does not rest on the bottom of the hole, and for wells greater than 50 feet deep, at least two stainless steel centralizers will be used, one at the bottom and one at the top of the screen. Additional centralizers will be used as needed.

5.5.6 Filter Pack Requirements

The filter pack will consist of silica sand or gravel and will extend from the bottom of the hole to at least 2 feet above the top of the well screen. After the filter pack is emplaced, the well will be surged with a surge block for ten minutes. The top of the sand pack will be sounded to verify its depth during placement. Additional filter pack will be emplaced as required to return the level of the pack to 2 feet above the screen. The well will then be surged again for five minutes and additional filter pack will be emplaced as required to bring its level to 2 feet above the screen.

The filter pack material will be clean, inert, and well-rounded and will contain less than 2 percent flat particles. The sand will be certified free of contaminants by vendor or contractor. If decontamination is necessary, the methods shall be approved in writing by AFCEE.

The filter pack will have a grain size distribution and uniformity coefficient compatible with the formation materials and the screen. This will be calculated as described in Chapter 12, Ground Water and Wells, 2nd Edition (Driscoll, 1986). The grain size of the filter pack material will be determined based on existing grain size analysis prior to mobilization to the field. The filter pack will not extend across more than one water-bearing unit. In all wells (deep 1½ inches in diameter to prevent bridging. The tremie pipe will be lifted from the bottom of the hole at the same rate the filter pack is set. HydroGeoLogic will record the volume of the filter pack emplaced in the well. If potable water is necessary to place the filter pack, HydroGeoLogic will obtain prior approval from the regulatory agency providing oversight, and will ensure that no contaminants are introduced into the well.

5.5.7 Bentonite Seal Requirements

The bentonite seal requirements that will be followed are the following: (1) the bentonite seal will consist of at least 2 feet of bentonite between the filter pack and the casing grout, (2) the bentonite will be hydrated before placement and shall be installed by pump tremie methods, and (3) only 100 percent sodium bentonite shall be used.

5.5.8 Casing Grout Requirements

The casing grout requirements are the following: (1) the casing grout will extend from the top of the bentonite seal to ground surface, (2) the grout will be mixed in the following proportions: 94 pounds of neat Type I Portland or American Petroleum Institute Class A cement, not more than 4 pounds of 100 percent sodium bentonite powder, and not more than 8 gallons of potable water,

(3) all grout will be pump tremied using a side-discharge tremie pipe, and pumping will continue until 20 percent of the grout has been returned to the surface, and (4) in wells where the bentonite seal is visible and within 30 feet of the land surface, the 20 percent return is not necessary so long as the tremie pipe is pulled back as the grout is emplaced.

5.5.9 Surface Completion Requirements

For flush-mounted completions, the casing will be cut about three inches below the land surface and provide a water-tight casing cap to prevent surface water from entering the well. To allow for escape of gas, a small diameter (e.g., ¼-inch) vent hole will be placed in the upper portion of the casing, or a ventilated well cap will be used. A freely draining valve box with a locking cover will be placed over the casing. The top of the casing will be at least one foot above the bottom of the box. The valve box lid will be centered in a three-foot diameter, four-inch thick concrete pad that slopes away from the box at ¼ inch per foot. The identity of the well will be permanently marked on the valve box lid and the casing cap. Where heavy traffic may pass over the well or for other reasons, the concrete pad and valve box/lid assembly will be constructed to meet the strength requirements of surrounding surfaces.

When above-ground surface completion is used, the well casing will be extended 2 or 3 feet above land surface. A casing cap will be provided for each well, and the extended casing will be shielded with a steel sleeve that is placed over the casing and cap and seated in a 3-foot by 3-foot by 4-inch concrete surface pad. To allow for escape of gas, a small diameter (e.g., ¼-inch) vent hole will be placed in the well casing, or a ventilated well cap will be used. The concrete surface pad will be reinforced with steel reinforcing bars at least 1/4 inch in diameter. The ground surface will be freed of grass and scoured to a depth of 2 inches before setting the concrete pad. The diameter of the sleeve will be at least 6 inches greater than the diameter of the casing. The pad will be sloped away from the well sleeve. A lockable cap or lid will be installed on the guard pipe. The identity of the well will be permanently marked on the casing cap and the protective sleeve. Three 3-inch diameter concrete-filled steel guard posts, each 5 feet in total length, will be installed radially from each well head. The guard posts will be recessed approximately 2 feet into the ground and set in concrete. The guard posts will not be installed in the concrete pad placed at the well base. The protective sleeve and guard posts will be painted with a color specified by the installation civil engineer.

All wells will be secured as soon as possible after drilling with corrosion-resistant locks for both flush and above-ground surface completions. The locks will either have identical keys or be keyed for opening with one master key. The lock keys will be delivered to the appropriate Air Force personnel following completion of the field effort. A Monitoring Well Construction Form will be completed for each well (Appendix D).

5.6 MONITOR WELL DEVELOPMENT

The monitor well development requirements are: (1) all newly installed monitor wells will be developed no sooner than 24 hours after installation to allow for grout curing, (2) all drilling fluids used during well construction will be removed during development, (3) wells will be developed using surge blocks and bailers or pumps (prior approval for any alternate method will be obtained,

in writing, from AFCEE before well construction begins), and wells will be developed until the turbidity of the well is less than 50 nephelometric turbidity units (NTU) and remains within a 10 NTU range for at least 30 minutes and the stabilization criteria in Section 6.0 are met, (4) discharge water color and volume will be documented, (5) no sediment will remain in the bottom of the well, (6) no detergents, soaps, acids, bleaches, or other additives will be used to develop a well, and (7) all development equipment will be decontaminated according to the specifications of Section 5.10.

5.7 ABANDONING MONITOR WELLS

All abandonment of monitor wells, when necessary, shall be performed in accordance with state and local laws and regulations. If slurry is used, a mud balance and/or Marsh Funnel will be used to ensure that the density (lbs/gal) of the abandonment mud mixture conforms with the manufacturer's specification. All abandoned monitor wells will be checked 24 to 48 hours after mud/solid bentonite emplacement to determine whether curing is occurring properly. More specific curing specifications or quality assurance checks may be recommended by the manufacturer and will be followed. Additionally, if significant settling has occurred, a sufficient amount of mud/solid bentonite will be added to attain its initial level. These slurry/solid bentonite curing checks and any addition of mud/solid bentonite will be recorded in the field logs.

5.8 TEST PIT EXCAVATION

A test pit is an opening in soil, unconsolidated deposit, or bedrock having at least one lateral dimension greater than the depth of the opening, which is used for scientific purposes. The location of each test pit will be coordinated in writing with the base civil engineer before digging begins. No personnel, under any circumstance, will enter a test pit for any reason. The excavated material will be screened for volatile organic compounds using an organic vapor analyzer (e.g., PID, OVA). Excavated material will be backfilled immediately after the required information has been recorded unless PID/OVA readings indicate that the soil is excessively contaminated. The first soils taken out of the trench will be inserted last when filling the pit. No test pit will be left open overnight unless adequate safety precautions are employed. Safety precautions may include physical barriers such as snow fencing and may include plywood to cover the pit. Further information on test pit health and safety precautions are described in Section 11.3 of the Health and Safety Plan. In vegetated areas, backfilled test pits will be reseeded with native grasses. In addition to the general information required for all field activities listed in Section 8.0, the following will be recorded for each test pit: (1) the total depth, length, and width, (2) the depth and thickness of distinct soil or lithologic units, (3) a lithologic description of each unit, and (4) a description of any man-made materials or apparent contamination encountered. An example Test Pit Classification Log is included in Appendix D.

Excavation will be completed by using a backhoe/trackerhoe. Decontamination of all equipment will occur after an excavation is completed or daily following the procedures described in Section 5.10. Any shoring that is required will be described and documented.

Three test pits will be excavated at both SWMU 17 and SWMU 62 as part of this work effort and will be completed according to specifications outlined in Section 2.1.2.11 of the AFCEE

Handbook. A backhoe/trackhoe will be used to excavate each test pit to the depth at which virgin soil beneath the debris is reached, the depth at which groundwater is encountered, or 15 feet below grade, whichever occurs first. If groundwater is encountered, excavation activities will be discontinued and the trench backfilled. Each test pit will be approximately 40 feet long with a width of approximately 3 feet (i.e., the width of a backhoe/trackhoe bucket). All excavated material will be used as backfill unless field screening data (PID/OVA readings, color, etc.) indicates that the material is contaminated. If the material is contaminated, it will be containerized and disposed of as investigation derived waste (IDW).

5.9 SURVEYING

All surveying locations of field activities will be measured by a state of Texas certified land surveyor as the distance in feet from a reference location that is tied to the state plane system. The surveys will be third order (cf. Urquhart, L.C., 1962 Civil Engineering Handbook, 4th Edition, p. 96 and 97). An XY-coordinate system will be used to identify locations. The X-coordinate will be the East-West axis; the Y-coordinate will be the North-South axis. The reference location is the origin. All surveyed locations will be reported using the state plane coordinate system. The surveyed control information for all data collection points will be recorded and displayed in a table. The table will give the X and Y coordinates in state plane coordinate values, the ground elevation, and the measuring point elevation if the location is a ground-water monitor well. The elevation of all newly installed wells and piezometers will be surveyed at the water level measuring point (notch) on the riser pipe. The elevation of the ground surface at each water level measuring point will be included in the survey.

The X-Y coordinates for each sample location will be determined to within 0.1 feet and referenced to the State Plane Coordinate System. Vertical control will be to the National Geodetic Vertical Datum (NGVD) and will be within 0.01 feet for all sampling locations.

5.10 EQUIPMENT DECONTAMINATION

All equipment that may directly or indirectly contact samples will be decontaminated in a designated decontamination area. This includes casing, drill bits, auger flights, the portions of drill rigs that stand above boreholes, sampling devices, and instruments, such as slugs and sounders. In addition, HydroGeoLogic and its subcontractors will take care to prevent the sample from coming into contact with potentially contaminating substances, such as tape, oil, engine exhaust, corroded surfaces, and dirt.

The following procedure will be used to decontaminate large pieces of equipment, such as casings, auger flights, pipe and rods, and those portions of the drill rig that may stand directly over a boring or well location or that come into contact with casing, auger flights, pipe, or rods. The external surfaces of equipment will be washed with high-pressure hot water and Alconox, or equivalent laboratory-grade detergent, and if necessary, scrubbed until all visible dirt, grime, grease, oil, loose paint, rust flakes, etc., have been removed. The equipment will then be rinsed with potable water. The inside surfaces of casing, drill rod, and auger flights will also be washed as described.

The following procedure will be used to decontaminate sampling and drilling devices, such as split spoons, bailers, and augers, that can be hand-manipulated. For sampling and smaller drilling devices, the equipment will be scrubbed with a solution of potable water and Alconox, or equivalent laboratory-grade detergent. The equipment will then be rinsed with copious quantities of potable water followed by a rinse with ASTM Type II Reagent Water. High pressure liquid chromatograph-grade water and distilled water purchased in stores are not acceptable substitutes for ASTM Type II Reagent-Grade Water. The equipment will then be rinsed with pesticide-grade methanol followed by a rinse with pesticide-grade hexane. The equipment will then be allowed to air dry on a clean surface or rack, such as Teflon[®], stainless steel, or oil-free aluminum elevated at least 2 feet above ground. If the sampling device will not be used immediately after being decontaminated, it will be wrapped in oil-free aluminum foil, or placed in a closed stainless steel, glass, or Teflon[®] container.

Reagent-Grade II Water, methanol, and hexane will be purchased, stored, and dispensed only in glass, stainless steel, or Teflon[®] containers. These containers will have Teflon[®] caps or cap liners. HydroGeoLogic and its subcontractors will assure that these materials remain free of contaminants. If any question of purity exists, new materials will be used.

All fluids generated during decontamination activities will be placed in 55-gallon drums. All drums will be properly labeled as to content and shall be staged in a central location designated by the Base representative for temporary storage pending removal and disposal.

5.11 WASTE HANDLING

5.11.1 General Waste Handling Procedures

Waste handling will be dealt with on a site-by-site basis. Waste may be classified as noninvestigative waste or investigative waste.

Noninvestigative waste, such as litter and household garbage, will be collected on an as-needed basis to maintain each site in a clean and orderly manner. This waste will be containerized and transported to the designated sanitary landfill or collection bin. Acceptable containers will be sealed boxes or plastic garbage bags.

Waste containers will be labeled with the following information: type of matrix being contained, depth from which matrix was obtained, date matrix was contained, company name and phone number, and whether matrix is considered hazardous or not.

Characterization of IDW will be based on sample analysis obtained during the field investigation. Once the IDW has been characterized, disposal of IDW will be conducted as soon as possible, in a cost effective manner, and within all state and Federal regulations.

Investigation derived waste (IDW) will be properly containerized and temporarily stored at each site, prior to transportation. Depending on the constituents of concern, fencing or other special marking may be required. The number of containers will be estimated on an as-needed basis. Acceptable containers will be sealed in either U.S. Department of Transportation (DOT)-approved

steel 55-gallon drums or small dumping bins with lids. The containers will be transported in such a manner to prevent spillage or particulate loss to the atmosphere. To facilitate handling, the containers will be no more than half full when moved.

The investigative derived waste will be segregated at the site according to matrix (solid or liquid) and as to how it was derived (drill cuttings, drilling fluid, decontamination fluids, and purged groundwater). Each container will be properly labeled with site identification, sampling point, depth, matrix, constituents of concern, and other pertinent information for handling.

Waste generated during the field activities will be handled and disposed in accordance with applicable Federal, state, and local regulations. Disposable materials such as latex gloves, aluminum foil, paper towels, etc., shall be placed and sealed in plastic garbage bags for disposal with sanitary waste from the site. Soil cuttings will be placed in 55-gallon steel open top drums with lids. Development and purge waters evacuated from groundwater monitoring wells and all fluids generated during decontamination activities will be placed in 55-gallon steel drums. Drums will be properly labeled with the appropriate boring or well number, content, and will be staged in a central location designated by the Base representative for temporary storage pending removal and disposal.

5.12 HYDROGEOLOGICAL CONCEPTUAL MODEL

The project geologist or engineer will develop a base and site geological and hydrological conceptual model from pre-existing U.S. Geological Survey (USGS), regional, state, and local studies and information developed during the project. Maps and cross sections will be used to depict the conceptual model. The model will be the basis for evaluating monitoring well and piezometer locations, contaminant distribution (plume delineation), and the closeness of fit to natural conditions of analytical or computer-based numerical models.

The Project Geologist will be responsible for evaluating the fit of analytical or numerical groundwater flow and contaminant transport models to natural site conditions and the model's ability to predict the spatial and temporal distribution of contaminants. The model will consider stratigraphy, geological structure, aquifer homogeneity or heterogeneity, hydraulic conductivity, transmissivity, storativity, and effective porosity. As applicable, the model will consider leakage, dispersivity, and attenuation.

The Project Geologist will evaluate the reliability of predictions resulting from use of the model. Reliability will be based on sufficiency and representativeness of field data, model calibration, degree of change of field data during calibration, and model sensitivity to changes in selected variables. The values assigned to nodes of numerical models and the amount of change of field values will be displayed on maps or cross sections.

5.13 CORRECTIVE ACTION

Table 5.1 contains a summary of field quality control procedures and corrective actions.

Table 5.1
Field Corrective Action Procedures
NAS Fort Worth JRB, Texas

Situation	Calibration	Frequency	Field Objective Affected	Corrective Action Procedure
Equipment malfunction			Equipment is calibrated and operating properly	<ul style="list-style-type: none"> - Notification of site supervisory personnel - Correct problem, recalibrate - Repair or replace malfunctioning parts - Recalibrate and/or replace standards - Document to Project Geologist, Project Manager, and Quality Assurance Manager
PID/OVA	- Calibrated to $\pm 20\%$ of known calibration gas	- Daily		
pH	- Calibrated with two buffer solutions that bracket expected sample pH	- Daily		
SC	- Calibrated with two standards in expected range of sample SC	- Daily		
Temperature	- Calibrate within expected temperature range of samples	- Monthly		
Turbidity	- Calibrate within expected range of sample turbidity	- Daily		
Incorrect sample collection procedures	NA	NA	Samples are taken according to standard operating procedures	<ul style="list-style-type: none"> - Notification of site supervisory personnel - Review of situation and correct procedures - Document to Project Geologist, Project Manager, and Quality Assurance Manager
Insufficient sample volume collection	NA	NA	Sufficient sample volume is provided to maintain sample integrity and so that all required analyses can be conducted	<ul style="list-style-type: none"> - Notification of site supervisory personnel by laboratory manager - Review site affected and impact of samples on site characterization - correct procedures - Document to Project Geologist, Project Manager, and Quality Assurance Manager
Incorrect measurement data collection	NA	NA	Measurements are conducted according to standard operating procedures	<ul style="list-style-type: none"> - Notification of site supervisory personnel - Review of situation and correct procedures - Document to Project Geologist, Project Manager, and Quality Assurance Manager

NA = Not Applicable

6.0 ENVIRONMENTAL SAMPLING

6.1 SAMPLING PROCEDURES

All purging and sampling equipment will be decontaminated according to the specifications in Section 5.10 prior to any sampling activities and will be protected from contamination until ready for use. The construction material of the sampling devices (e.g., plastic, PVC, metal) discussed below will be appropriate for the contaminant of concern and shall not interfere with the chemical analyses being performed.

6.1.1 Groundwater Sampling

6.1.1.1 Monitor Well Sampling

When numerous monitor wells are to be sampled in succession, those wells expected to have low levels of contamination or no contamination will be sampled prior to those wells expected to have higher levels of contamination. This practice will help reduce the potential for cross contamination between wells. All sampling activities will be recorded in the field log book. Additionally, all sampling data will be recorded on a Field Sampling Report form. An example Field Sampling Report form is shown in Appendix D.

Before ground-water sampling begins, wells will be inspected for signs of tampering or other damage. If tampering is suspected, (i.e., casing is damaged, lock or cap is missing) this shall be recorded in the field log book and on the well sampling form, and reported to the Field Coordinator. Wells that are suspected to have been tampered with will not be sampled until the Field Coordinator has discussed the matter with the Project Manager.

Before the start of sampling activities, plastic sheeting will be placed on the ground surrounding the well. The plastic sheeting will be used to provide a clean working area around the well head, and prevent any soil contaminants from contacting sampling equipment. Remove water in the protective casing or in the vaults around the well casing prior to venting and purging. Every time a casing cap is removed to measure water level or collect a sample, the air in the breathing zone will be checked with an organic vapor meter and the air in the well bore shall be checked with an explosimeter. Procedures in the HSP will be followed when high concentrations of organic vapors or explosive gases are detected. Air monitoring data will be recorded on the well sampling form. Purge pump intakes will be equipped with a positive foot check valve to prevent purged water from flowing back into the well. Purging and sampling will be performed in a manner that minimizes aeration in the well bore and the agitation of sediments in the well and formation. Equipment will not be allowed to free-fall into a well.

In addition to the information required in Section 8.0, the following information will be recorded each time a well is purged and sampled: (1) depth to water before and after purging, (2) well bore volume calculation, (3) sounded total depth of the monitor well, (4) the condition of each well, including visual (mirror) survey, (5) the thickness of any nonaqueous layer and, (6) field parameters, such as pH, temperature, specific conductance, and turbidity. This information will be encoded in IRP Information Management System (IRPIMS) files when required.

6.1.1.1.1 Water Level Measurement

An interface probe will be used if a nonconductive floating product layer is suspected in the well. The interface probe will be used to determine the presence of floating product, if any, prior to measurement of the ground-water level. The ground-water level will then be measured to the nearest 0.01 foot using an electric water level indicator. Water levels will be measured from the notch located at the top of the well casing and recorded on the well sampling form. If well casings are not notched, measurements will be taken from the north edge of the top of the well casing, and a notch will be made using a decontaminated metal file.

Following water level measurement, the total depth of the well from the top of the casing will be determined using a weighted tape or electric sounder and recorded on the well sampling form. The water level depth will then be subtracted from the total depth of the well to determine the height of the water column present in the well casing. All water level and total depth measuring devices will be routinely checked with a tape measure to ensure measurements are accurate.

6.1.1.1.2 Purging Prior to Sampling

Purging of monitor wells is performed to evacuate water that has been stagnant in the well and may not be representative of the aquifer. Purging will be accomplished using a low flow pump.

At least three well volumes will be removed from the well before it is sampled. The well bore volume is defined as the volume of submerged casing and screen. One well volume can be calculated using the following equation (reference: Ohio EPA, 1993):

$$V = H \times F$$

where

V = one well volume

H = the difference between the depth of well and depth to water (ft)

F = factor for volume of one foot section of casing (gallons) from Table 6.1

Table 6.1
Volume of Water in One-Foot Section of Well Casing

Diameter of Casing (inches)	F Factor (gallons)
1.5	0.09
2	0.16
3	0.37
4	0.65
6	1.47

F can also be calculated from the formula:

$$F = \Pi (D/2)^2 \times 7.48 \text{ gal/ft}$$

where D = the inside diameter of the well casing (feet) and $\Pi = 3.141593$.

Wells with yields too low to produce three well volumes before the well goes dry shall be purged to dryness.

During purging, the temperature, pH, electrical conductivity (EC), and turbidity will be measured and recorded on the well sampling form after removing each well volume. Water removed from the well during purging will be containerized. Detailed information concerning investigative derived wastes is presented in Section 5.11.

Groundwater samples will be collected from monitoring wells using micropurge techniques. Micropurge is a low flow-rate monitor well purging and sampling method that induces laminar (non turbulent) flow in the immediate vicinity of the sampling pump intake, thus drawing groundwater directly from the sampled aquifer, horizontally through the well screen, and into the sampling device. Low-flow pumping rates associated with the micropurge technique, in the approximate range of 0.2 to 2.0 liters/min, will be used. These low flow rates minimize disturbance in the screened aquifer, resulting in: (1) minimal production of artificial turbidity and oxidation; (2) minimal mixing of chemically distinct zones; (3) minimal loss of volatile organic compounds; and (4) collection of representative samples while minimizing purge volume. Pumps will be placed 1 to 3 feet below water level within the screened interval, or in the most permeable zone in the screened interval (as determined from lithologic logs).

6.1.1.1.3 Sample Collection

Samples will not be taken within 24 hours of monitor well development. Except as noted below, at least three well volumes will be removed from the well before it is sampled.

The sample may be collected after three well volumes have been removed and the temperature, pH, EC, and, turbidity have stabilized. Stabilization shall be defined as follows: temperature $\pm 1^\circ\text{C}$, pH ± 0.1 units, EC ± 5 percent, and turbidity < 10 NTU change between two consecutive readings. If these parameters do not stabilize, the sample shall be collected after three to five well volumes have been removed, and the anomalous parameters shall be brought to the Field Coordinator's attention (per CH2M HILL, Jan 1997). Field equipment will be calibrated IAW the Base-Wide QAPP (CH2M HILL, 1996), Section 6.0, and in Section 7.2 of this FSP.

Micropurge sampling will use small positive-displacement pumps (e.g., bladder pumps). Samples to be analyzed for volatile or gaseous constituents will not be withdrawn with pumps or at flows that degas the samples. Water-quality indicators will be monitored during micropurge (turbidity, dissolved oxygen, specific conductance, temperature, etc.).

For the SWMUs investigated during this RFI, DNAPL are not expected to be encountered. If DNAPL are suspected, however, a bailer shall be lowered to the bottom of the well before

purging, retrieved, and observed for the presence of DNAPL. The preservative hydrochloric acid shall be added to the VOC sample bottle before introducing the sample water. The sample shall be collected from the pump discharge line using a slow, controlled pour down the side of a tilted sample vial to minimize volatilization. The sample vial shall be filled until a meniscus is visible and immediately sealed. When the bottle is capped, it shall be inverted and gently tapped to ensure no air bubbles are present in the vial. If, after the initial filling bubbles are present, the vials shall be discarded and the VOC sampling effort shall be repeated. Refilling of vials will result in loss of preservatives. After the containers are sealed, sample degassing may cause bubbles to form. These bubbles shall be left in the container. These samples shall never be composited, homogenized, or filtered.

Following collection of VOC samples, remaining water samples shall be collected in the following order: SVOCs; pesticides/PCBs; herbicides; and metals.

The pH of preserved samples will be checked in the field by pouring a small amount of the water sample onto pH paper. The paper will not touch the sample inside the container. The pH of acidified VOC samples will not be checked. The preservation checks will be documented in the chain-of-custody forms. One preserved VOC sample per day per sampling crew shall be checked with pH paper. The sole purpose of this sample is to check the pH of VOC samples, it will not be submitted for analysis. Field filtering of metals will not occur.

Required sample containers, preservation methods, volumes and holding times are given in Section 6.2 and Table 6.1. Sampling equipment shall be decontaminated in accordance with Section 5.10 upon completion of sampling activities.

6.1.2 Subsurface Soil Sampling

Soil samples will be collected based on odors, discoloration, organic vapor meter readings and any other field screening method. If no odors, discoloration or organic vapor readings are observed, subsurface samples will be collected directly above the water table surface.

6.1.2.1 Split-Spoon Samples

During monitoring well installation using hollow-stem auger methods, soil samples will be collected using stainless steel, continuous drive, California modified split-spoon samplers, or equivalent. These samplers are 24 inches in length and have an outside diameter (OD) of 3 inches to accommodate four stainless steel/Teflon® sleeves, each of which is 6 inches in length. Soil samples during monitoring well installation will be field screened for VOCs. One surface soil sample and one subsurface sample will be collected from each boring location and submitted to the laboratory for analysis.

Each time a split-spoon sample is taken, a standard penetration test will be performed in accordance with ASTM D-1586 “Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils.” The sample is obtained by driving the sampler a distance of 1 foot into undisturbed soil with a 140-pound hammer free falling a distance of 30 inches. The sampler is first driven 6 inches to seat it in undisturbed soil; then the test is performed. The number of

hammer blows for seating the spoon and making the test are then recorded for each 6 inches of penetration on the drill log (i.e., 5/7/8). The standard penetration test result (N) is obtained by adding the last two figures (i.e., 7+8=15 blows per foot). The sampler is then driven an additional 6 inches to fill the remainder of the split-spoon prior to retrieval.

As soon as the split-spoon is opened, the open ends of the stainless/Teflon® steel sleeves will be monitored for organic vapors using the PID or FID. Air monitoring results will be recorded on the boring log and in the field log book.

Samples for VOC analysis will be collected as an entire stainless steel/Teflon® sleeve sample. Stainless steel/Teflon® rings selected for VOC analysis will be completely filled, if possible, to minimize headspace. Sleeves with large gravel or debris will not be used. Following monitoring for organic vapors, the sleeves will be capped on both ends with Teflon® sheeting and plastic end caps to prevent volatilization. The stainless steel/Teflon® rings will then be affixed with a completed sample label, placed in a zip lock plastic bag and placed in an iced cooler held at a temperature below 4°C.

Samples collected concurrently with VOC samples to be tested for other analytical parameters will be collected by extruding the soil out of the stainless steel/Teflon® sleeves immediately adjacent to (above and below) the VOC sample interval. Soil chemistry samples not being analyzed for VOCs will be placed in 8 or 16-ounce, laboratory cleaned, EPA-approved glass containers with Teflon® lined lids. This will be done using clean stainless steel sampling tools. If soil from several stainless steel/Teflon® rings must be composited to provide sufficient sample volume for a particular analysis, the sample will be composited and homogenized in a stainless steel bowl using a stainless steel trowel or scoop. The sample will then be transferred into the appropriate sample container, sealed, labeled, and placed in an iced cooler held at a temperature below 4°C.

If initial screening results indicate the presence of organic vapors, a headspace analysis will be conducted on remaining portions of the sample.

6.1.2.2 Test Pit Samples

During test pit excavations, soil samples will be collected using the bucket of a rubber-tire backhoe. Soils sampled during these test pits will be field screened for VOCs. One surface soil sample and one subsurface sample will be collected from each pit location and submitted to the laboratory for analysis.

When a sample is obtained using the backhoe bucket, estimates will be made as to the approximate density of the soil. The sample will be obtained by driving the backhoe bucket into undisturbed soil. An area of soil selected for sampling will be identified in the pit and brought to the surface using the backhoe. Samples for VOC analysis will be collected immediately and placed in the proper container for shipment. The volatiles will be allowed to equilibrate inside the sample container for approximately ten minutes before head space analysis is performed. The sample container will then be affixed with a completed sample label, placed in a zip lock plastic bag, and placed in an iced cooler held at a temperature below 4°C.

Samples collected concurrently with VOC samples to be tested for other analytical parameters will be collected from the bucket and placed in the proper containers for analysis. Soil chemistry samples not being analyzed for VOCs will be placed in 8 or 16-ounce, laboratory cleaned, EPA-approved glass containers with Teflon[®] lined lids by using a clean stainless steel sampling tools, sealed, labeled, and placed in an iced cooler held at a temperature below 4°C.

If initial screening results indicate the presence of organic vapors, a headspace analysis will be conducted on remaining portions of the sample.

6.1.3 Surface Soil Sampling

Surface soil samples shall be collected from the land surface to 6 inches below the surface. The sample shall be homogenized and quartered before being containerized. Sample collected for VOC analysis shall be containerized prior to sample homogenization. Stainless steel scoops or trowels, glass jars with Teflon[®] lids or equivalent equipment compatible with the chemical analyses proposed shall be used to collect and store samples. Above ground plant parts and debris will be excluded from the sample.

In addition to records outlined in Section 8.0, record unusual surface conditions that may affect the chemical analyses, such as the following: (1) asphalt chunks that may have been shattered by mowers, thus spreading small fragments of asphalt over the sampling area, (2) distance to roadways, aircraft runways, or taxiways, (3) obvious, deposition of contaminated or clean soil at the site, (4) evidence of dumping or spillage of chemicals, (5) soil discoloration, and/or (6) unusual condition of growing plants, etc.

6.1.4 Surface Water Sampling

Surface water samples will be collected so as to not to cause cross-contamination. At locations where both surface water and sediment samples are collected, the surface water sample will be obtained first. The pH, temperature, and specific conductance, will be measured and recorded at each surface water sampling point. Each sampling location where surface water or sediment samples are collected will be permanently marked (e.g., flagged stake in trench bank) and will be recorded on a project map.

Surface water samples will be taken from each end of the ponded trench at SWMU 27. Water samples will be collected using a beaker when grab samples are required, or using an autosampler (discrete or composite samples) with the inlet line located at the desired sampling depth.

The following records will be maintained in addition to those in Section 8.0, (1) the width and depth of the trench, (2) surface water conditions (e.g., floating oil or debris, gassing), (3) the location of any discharge pipes, sewers and tributaries, and (4) instrument calibration.

6.2 SAMPLE HANDLING

6.2.1 Sample Containers

Sample containers will be provided to field personnel precleaned and treated according to EPA specifications for the methods. No sampling containers will be reused for the sampling events of this RFI. Containers will be stored in clean areas to prevent exposure to fuels, solvents, and other contaminants. Amber glass bottles are used routinely where glass containers are specified in the sampling protocol.

6.2.2 Sample Volumes, Container Types, and Preservation Requirements

Sample volumes, container types, and preservation requirements for the analytical methods performed on AFCEE samples are listed in Table 6.2. Sample holding time tracking begins with the collection of samples and continues until the analysis is complete. Holding times for methods used in this FSP are specified in Table 6.2.

6.2.3 Sample Identification

The following information will be written in the log book and on the sample label when samples are collected for laboratory analysis:

- Project identification (name and number)
- Sample identification number
- Sample location
- Preservatives added
- Date and time of collection
- Requested analytical methods
- Sampler's name

Each sample will be assigned a unique identification number that describes where the sample was collected. The number will consist of a maximum 12 digit alphanumeric code as follows:

xxxxyyyzzaa

where:

xxxx represents the site identification (e.g., LF02, LF06, LF07, LF09, LF10)

yyyy represents the location number (e.g., 01, 02)

zz represents the medium (e.g., GW=ground water, SO=soil, SW=surface water, SD=sediment)

aa represents the sample number for soils and round numbers for groundwater and surface water (e.g., 01, 02, 03, etc.)

For example, the second soil sample of soil boring 02 collected from LF02 will be identified as “LF02-SB02-SO-02”. A duplicate groundwater sample collected from MW04 at LF07 would be identified as “LF07-MW04-GW-52”, and sent to the laboratory as a blind sample. Proper notes will, however, be entered into the field sampling logbook to track this sample as a field duplicate.

QC samples will be identified by use of a similar system of identifiers with a maximum of 10 characters. The QC sampling number system is summarized below:

xyyyyyyyzz

where:

xx represents medium (e.g. ER=equipment rinsate, TB=trip blank, AB=ambient blank)

yyyyyy represents date (day, month, year)

zz represents sample number from 01 to 99

The field coordinator will maintain a list that describes how each QC sample corresponds with specific environmental samples. For instance, each trip blank will be correlated with a particular set of samples shipped to the laboratory, and each rinsate will be correlated to those samples collected by a particular set of decontaminated sampling tools.

Table 6.2
Requirements for Containers, Preservation Techniques,
Sample Volumes, and Holding Times

Name	Analytical Methods	Container ^a	Preservation ^{b,c}	Minimum Sample Volume or Weight	Maximum Holding Time
Metals (except chromium (VI) and mercury)	SW6010A SW6020 and SW-846 AA methods	P, G, T	HNO ₃ to pH < 2, 4°C	500 mL or 8 ounces	180 days (water and soil)
Mercury	SW7470 SW7471	P, G, T	HNO ₃ to pH < 2, 4°C	500 mL or 8 ounces	28 days (water and soil)
Chlorinated herbicides	SW8150B SW8151	G, Teflon-lined cap, T	4°C, pH 5-9	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Organochlorine pesticides and polychlorinated biphenyls (PCBs)	SW8080A, SW8081,	G, Teflon-lined cap, T	4°C, pH 5-9	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Semivolatile organics	SW8270B	G, Teflon-lined cap, T	4°C, 0.008% Na ₂ S ₂ O ₃	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Volatile organics	SW8240B, SW8010B, SW8260A	G, Teflon-lined septum, T	4°C, 0.008% Na ₂ S ₂ O ₃ (HCl to pH < 2 for volatile aromatics by SW8240 and SW8260) ^b	2 x 40 mL or 4 ounces	14 days (water and soil); 7 days if unpreserved by acid

^a Polyethylene (P); glass (G); brass sleeves in the sample barrel, sometimes called California brass (T).

^b No pH adjustment for soil.

^c Preservation with 0.008 percent Na₂S₂O₃ is only required when residual chlorine is present.

6.3 SAMPLE CUSTODY

Procedures to ensure the custody and integrity of the samples begin at the time of sampling and continue through transport, sample receipt, preparation, analysis and storage, data generation and reporting, and sample disposal. Records concerning the custody and condition of the samples are maintained in field and laboratory records.

Chain-of-custody (COC) records will be maintained for all field and field QC samples. A sample is defined as being under a person's custody if any of the following conditions exist: (1) it is in their possession, (2) it is in their view, after being in their possession, (3) it was in their possession and they locked it up or, (4) it is in a designated secure area. All sample containers will be sealed in a manner that will prevent or detect tampering if it occurs. In no instance will tape be used to seal sample containers. Samples will not be packaged with activated carbon. Appendix D contains a sample chain-of-custody form.

The following minimum information concerning the sample will be documented on the COC form (as illustrated in Appendix D):

- Unique sample identification
- Date and time of sample collection
- Source of sample (including name, location, and sample type)
- Designation of MS/MSD
- Preservative used
- Analyses required
- Name of collector(s)
- Pertinent field data (pH, temperature, etc.)
- Serial numbers of custody seals and transportation cases (if used)
- Custody transfer signatures and dates and times of sample transfer from the field to transporters and to the laboratory or laboratories
- Bill of lading or transporter tracking number (if applicable)

All samples will be uniquely identified, labeled, and documented in the field at the time of collection IAW Section 6.2.3 of the FSP. Samples collected in the field will be transported to the laboratory or field testing site as expeditiously as possible. When a 4°C requirement for preserving the sample is indicated, the samples will be packed in ice or chemical refrigerant to keep them cool during collection and transportation. During transit, it is not always possible to rigorously control the temperature of the samples. As a general rule, storage at low temperature is the best way to preserve most samples. A temperature blank (a volatile organics compounds sampling vial filled with water) will be included in every cooler and used to determine the internal temperature of the cooler upon receipt of the cooler at the laboratory.

6.4 FIELD QUALITY CONTROL SAMPLES

Field quality control samples such as blanks and duplicates will be collected as described in the following sections.

6.4.1 Ambient Blank

The ambient blank consists of ASTM Type II reagent grade water poured into a VOC sample vial at the sampling site. It is handled like an environmental sample and transported to the laboratory for analysis. Ambient blanks are prepared only when VOC samples are taken and are analyzed only for VOC analytes.

Ambient blanks are used to assess the potential introduction of contaminants from ambient sources (e.g., active runways, engine test cells, gasoline motors in operation, etc.) to the samples during sample collection. Ambient blanks will be collected downwind of possible VOC sources. One ambient blank will be collected at the beginning of the field investigation. Additional ambient blanks will be collected if site conditions warrant.

6.4.2 Equipment Blank

An equipment blank is a sample of ASTM Type II reagent grade water poured into or over or pumped through the sampling device, collected in a sample container, and transported to the laboratory for analysis. Equipment blanks are used to assess the effectiveness of equipment decontamination procedures. Equipment blanks will be collected immediately after the equipment has been decontaminated. The blank will be analyzed for all laboratory analyses requested for the environmental samples collected at the site. One equipment blank will be collected per day for each type of sampling equipment used.

6.4.3 Trip Blank

The trip blank consists of a VOC sample vial filled in the laboratory with ASTM Type II reagent grade water, transported to the sampling site, handled like an environmental sample and returned to the laboratory for analysis. Trip blanks are not opened in the field. Trip blanks are prepared only when VOC samples are taken and are analyzed only for VOC analytes. Trip blanks are used to assess the potential introduction of contaminants from sample containers or during the transportation and storage procedures. One trip blank will accompany each cooler of samples sent to the laboratory for analysis of VOCs.

6.4.4 Field Duplicates

A field duplicate sample is a second sample collected at the same location as the original sample. Duplicate samples are collected simultaneously or in immediate succession, using identical recovery techniques, and treated in an identical manner during storage, transportation, and analysis. The sample containers are assigned an identification number in the field such that they cannot be identified (blind duplicate) as duplicate samples by laboratory personnel performing the analysis. Specific locations are designated for collection of field duplicate samples prior to the beginning of sample collection.

Duplicate sample results are used to assess precision of the sample collection process. Precision of soil samples to be analyzed for VOCs is assessed from collocated samples because the compositing process required to obtain uniform samples could result in loss of the compounds of

interest. One duplicate sample will be collected for every ten groundwater and surface water samples collected.

6.4.5 Field Replicates

A field replicate sample, also called a split, is a single sample divided into two equal parts for analysis. The sample containers are assigned an identification number in the field such that they cannot be identified as replicate samples by laboratory personnel performing the analysis. Specific locations are designated for collection of field replicate samples prior to the beginning of sample collection. Replicate sample results are used to assess precision. One replicate sample will be collected for every ten soil and sediment samples collected.

7.0 FIELD MEASUREMENTS

7.1 PARAMETERS

7.1.1 Field Screening of Soils

RFI field activities will utilize field screening of soil samples for volatile organic compounds to determine the depth from which the laboratory analytical samples will be collected. During hand auguring, hollow-stem auger drilling, and sediment sampling activities, head space readings will be recorded from collected soils. Headspace analysis will be performed on each lithologic and analytical soil sample collected. A portion of the recovered soil sample will be placed into a quart-size Ziploc-type plastic bag, and the bag will be labeled, sealed, and shaken to mix the sample. The sample will be allowed to volatilize in a shaded area for approximately 15 minutes after which a headspace reading will be taken by punching through the bag with an OVA or PID sampling tip. The OVA or PID shall be calibrated using a standard of known concentration (e.g., isobutylene at 104 parts per million) in accordance with the requirements of the Base-Wide QAPP (CH2M HILL, 1996). The sampling tip will not be placed in the soil, but in the headspace of the bag. A background headspace value will be obtained from empty Ziploc-type plastic bag handled in manner identical to the plastic bag containing the headspace sample. The headspace reading and the background reading will be recorded on the Soil Boring Log.

7.1.2 Field Parameters for Water Samples

Temperature, pH, EC, and turbidity will be measured during monitoring well development and purging. The temperature of each water sample will be measured by either a pH meter/temperature probe, conductivity meter/temperature probe, or a mercury thermometer. This measurement will also be used to calibrate the pH meter.

The pH of each water aliquot will be measured by a portable pH meter. The pH meter will be calibrated with two buffer solutions of the appropriate range for the expected values of pH. The meter will be recalibrated daily. The stability of the calibration will be verified through the analysis of one standard periodically throughout the day as deemed necessary by the Field Coordinator, but at least once every five hours.

The EC of each water sample will be measured with a factory calibrated, portable, field conductivity meter. The instrument will be rinsed with reagent water between each use and the calibration of the probe shall be checked at the beginning and middle of each day using two potassium chloride (KCl) solutions of known conductance values. Calibration records will be maintained on the Calibration Log (Appendix D).

The turbidity of each water aliquot will be measured using a portable nephelometer. Calibration of the instrument is periodically performed at the factory as part of routine maintenance. A standard 0.2 NTU solution will be used to verify the stability of the calibration on a daily basis. All measurements will be recorded on the Well Development Record/Monitor Well Purging Form (Appendix D).

7.2 EQUIPMENT CALIBRATION AND QUALITY CONTROL

Field equipment will be maintained and calibrated to the standards in their respective operations manuals. Equipment failures will be repaired in the field if possible; if not, the instrument will be tagged, removed from use, and returned for repair or replacement. Field equipment will be calibrated daily before the start of sampling activities. Calibration records will be maintained on the Calibration Log (Appendix D). The calibration record will include a unique instrument number (e.g., serial number), standards used, concentrations, and meter readings.

7.3 EQUIPMENT MAINTENANCE AND DECONTAMINATION

7.3.1 Equipment Maintenance

Field equipment will be kept in a controlled storage room and will be decontaminated prior to return to storage; any malfunctions will be reported to the Field Coordinator. The Field Coordinator will initiate actions necessary for the repair or replacement of defective equipment. Equipment maintenance logs are kept updated and on file. Power supplies of battery-powered instruments will be checked daily. Rechargeable instruments will be recharged daily.

7.3.2 Decontamination of Field Instruments

Decontamination of field instruments will be instrument-specific. The probes of the pH, temperature, dissolved oxygen (DO), and specific conductivity meters will be rinsed with reagent grade water before and after each use, and at the end of each day. The measurement vial for the turbidity meter will be rinsed with deionized water before and after each use. No decontamination is required for the organic vapor analyzer.

7.4 FIELD MONITORING MEASUREMENTS

7.4.1 Groundwater Level Measurements

Water-level measurements will be taken in all wells and piezometers to determine the elevation of the water table or piezometric surface at least once within a single 24-hour period. These measurements will be taken after all wells and piezometers have been installed and developed and their water levels have recovered completely. Any conditions that may affect water levels will be recorded in the field log.

Water-level measurements will be taken with electric sounders, air lines, pressure transducers, or water-level recorders (e.g., Stevens recorder). Devices that may alter sample composition will not be used. Pressure gauges, manometers, or equivalent devices will be used for flowing wells to measure the elevation of the piezometric surface. All measuring equipment will be decontaminated according to the specifications in Section 7.3 and 5.10. Groundwater level will be measured to the nearest 0.01 foot.

Static water levels will be measured each time a well is sampled, and before any equipment enters the well. If the casing cap is airtight, time will be allowed prior to measurement for equilibration

of pressures after the cap is removed. Measurements will be repeated until water level is stabilized.

7.4.2 Floating Hydrocarbon Measurements

HydroGeoLogic does not anticipate encountering floating hydrocarbons based on the results from previous sampling events that have occurred at NAS Fort Worth JRB. However, if encountered, the thickness of hydrocarbons floating in monitor wells will be measured with an electronic interface probe. Hydrocarbon detection paste, or any other method that may affect water chemistry, will not be used. When detected, the presence of floating hydrocarbons will be confirmed by withdrawing a sample with a clear, bottom-fill Teflon® bailer.

7.4.3 Groundwater Discharge Measurements

Ground-water discharge measurements will be obtained during monitor well purging. Ground-water discharges may be measured with orifice meters, containers of known volume, in-line meters, flumes, or weirs, following guidelines specified in the Water Measurement Manual, Bureau of Reclamation, 1967. Any measurement device will be calibrated using containers of known volume.

7.5 FIELD PERFORMANCE AND SYSTEM AUDITS

The Project Geologist or a designated representative will conduct weekly informal audits of the field activities. The weekly audit for completeness will include the following items:

- Sample labels
- Chain of custody records
- Field notebooks
- Sampling operations
- Document control

The first three items above will be checked for completeness. Sampling operations will be reviewed to determine if they are performed as stated in the Work Plan or as directed by the Project Geologist. The informal document control audit will consist of checking each document for completeness, including items such as signatures, dates, and project numbers.

An unscheduled systems audit of field operations will be conducted using the project-specific work plan and will be used to review the total data generation. The audit will include on-site review of the field operational system, physical facilities for sampling, and equipment calibrations. A performance audit may be conducted by the Project Manager (PM) and Project Geologist if deemed necessary by the PM, Project Geologist, Lab Coordinator, or Client. The audit may focus on verifying that proper procedures are being followed so that subsequent sample data will be

valid. Prior to the audit, a checklist will be prepared by the PM and Project Geologist that will serve as a guide for the performance audit.

The audit will verify whether or not: 1) collection of samples follows the available written procedures; 2) chain of custody procedures are followed for traceability of samples origin; 3) appropriate QC checks are being made in the field and documented in the field logbook; 4) specified equipment is available, calibrated, and working properly; 5) sampling crews are adequately trained; 6) record-keeping procedures are being followed and appropriate documentation is maintained; and corrective action procedures are followed. An audit report summarizing the results and corrections will be prepared and filed in the project files.

8.0 RECORD KEEPING

HydroGeoLogic will maintain field records sufficient to recreate all sampling and measurement activities and to meet all IRPIMS data loading requirements. The information shall be recorded with indelible ink in a permanently bound notebook with sequentially numbered pages. These records shall be archived in an easily accessible form and made available to the Air Force upon request.

The following information will be recorded for all field activities: (1) location, (2) date and time, (3) identity of people performing activity, and (4) weather conditions. For field measurements: (1) the numerical value and units of each measurement, and (2) the identity of and calibration results for each field instrument, will also be recorded.

The following additional information will be recorded for all sampling activities: (1) sample type and sampling method, (2) the identity of each sample and depth(s), where applicable, from which it was collected, (3) the amount of each sample, (4) sample description (e.g., color, odor, clarity), (5) identification of sampling devices, and (6) identification of conditions that might affect the representativeness of a sample (e.g., refueling operations, damaged casing).

The following section describes the field documentation procedures which will be followed as a means of recording observations and findings during the RFI field investigation. Documentation will include the form of field log books, various sample and calibration forms, site photographs, and drawings/sketches. All documentation will be completed in indelible ink and corrections will be stricken out with a single line and initialed. Examples of field forms are included in Appendix D.

8.1 FIELD LOGBOOK

Logbooks with sequentially numbered pages will be kept at the site during all field activities and will be assigned to each sample team. These logs will be updated continually and will constitute master field investigation documents. Information to be recorded in the logs includes, but is not limited to, the following:

- Project identification
- Field activity subject
- General work activity, work dates, and general time of occurrence
- Unusual events
- Subcontractor progress or problems
- Communication with the client or others
- Weather conditions
- HydroGeoLogic personnel, subcontractors, and visitors on site
- Sample number and time of day for each sample collected for analysis
- Listing by sample number of samples collected during the day, sorted by chain-of-custody record number (compiled at the end of the day)
- Record of telephone call to laboratory informing it of sample shipment

- Accomplishment of decontamination of drilling rig, construction materials, and sampling equipment
- Accomplishment of required calibration checks
- Accomplishment of well point purging, with time and/or volume
- Disposition of purge water, decontamination fluids, and soil cuttings
- Well water levels and field measurements
- Variances from project plans and procedures (details will be recorded in the log book and presented in the RFI)
- Accomplishment of tailgate safety meetings
- Review of project procedures with site personnel
- Head space screening and breathing zone readings
- Accomplishment of decontamination of water sampling equipment
- Photographs taken and identification numbers
- Name and signature of person making logbook entries
- Inspections and results of inspections.

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8.2 FIELD EQUIPMENT LOGBOOK

A field equipment logbook will be kept on site to document the proper use, maintenance, and calibration of field testing equipment. Accompanying the field equipment logbook will be a three-ring binder containing operator manuals, specifications, and calibration requirements and procedures for all field testing equipment. Information to be recorded in the field equipment logbook includes:

- Equipment calibration status
- Equipment decontamination status
- Equipment nonconformance
- Equipment inspection and repair records
- Name and signature of person making entry
- Date of entry
- Name of equipment and its identifying number
- Nature of work conducted
- List or reference of procedures used for calibration or maintenance
- Manufacturer, lot number, and expiration date of calibration standards
- Measurement results.

8.2.1 Sample Collection Log

A sample collection log form (i.e., Field Sampling Report) will be completed for each sample collected during the investigation. An example of the Field Sampling Report Form is included at the end of this section. Information to be included on the form includes:

- Date and time of sample collection
- Sample location
- Sample type (i.e., surface soil, sediment, groundwater, etc.)
- Name of person collecting samples

- Sample volumes and container types.

8.3 REFERENCES

Air Force Center for Environmental Excellence (AFCEE), 1993, Handbook for the Installation Restoration Program (IRP) for Remedial Investigations and Feasibility.

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DRAFT FINAL
QUALITY ASSURANCE PROJECT PLAN ADDENDUM

RCRA FACILITY INVESTIGATION OF LANDFILLS
NAS FORT WORTH JRB, TEXAS

Contract Number F41624-95-D-8005

Prepared for:

U.S. Air Force Center for Environmental Excellence
Brooks AFB, Texas

Prepared by:

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June 1997

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1.0 INTRODUCTION

The following Quality Assurance Project Plan (QAPP) Addendum describes the field parameters to be measured and laboratory parameters to be analyzed. In addition, a list of exceptions to the Basewide QAPP (CH2M HILL, 1996) have been identified and are being requested for permanent variance. The QAPP Addendum is meant to be a supplement to the Basewide QAPP.

1.1 FIELD MEASURED ANALYTICAL PARAMETERS

PID measurements of soil samples and temperature, pH, electrical conductivity, and turbidity measurements of groundwater samples will be made during sampling at Solid Waste Management Units (SWMUs) 17, 27, 29, 30 and 62. Readings will be recorded in the field log book. Section 6.2 of the Basewide QAPP (CH2M HILL, 1996) and Section 7.0 of the FSP describe the calibration and measurement techniques necessary for the instruments.

1.2 SUMMARY OF ANALYTICAL REQUIREMENTS

The analytical methods to be used for the soil and groundwater samples collected at SWMUs 17, 27, 29, 30 and 62 were selected based on past site activities and will provide broad screening of potential contaminants in the initial samples. All initial samples will be analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides/polychlorinated biphenyls (PCBs), herbicides and priority pollutant (PP) metals. Analyses of samples collected to further assess the extent of contamination will generally be limited to the constituents detected in the initial samples. Table 1.1 lists the parameters to be analyzed and the analytical methods for soil, groundwater, and surface water samples collected from the SWMUs. Analytical procedures are defined in Section 7.0 of the Basewide QAPP (CH2M HILL, 1996). The analytical results will be reported to HydroGeoLogic approximately three weeks after sample submittal.

1.3 EXCEPTIONS TO THE BASEWIDE QAPP

The Basewide QAPP (CH2M HILL, 1996) was reviewed by HydroGeoLogic. The following is a list of exceptions which have been identified and are being requested for permanent variance.

1. The laboratory will report a representative method detection limit (MDL) for each method. If multiple instruments are used for any test performed at NAS Fort Worth JRB, the least sensitive MDL for each analyte will be reported.
2. Analyst proficiency will be based on statistically derived limits in effect at the time of the study rather than the QC limits established for this project.
3. A variance is requested to reanalyze the laboratory control sample (LCS) in cases where errors in the analysis, such as improper sample injection, are observed by the analyst or supported by instrument data.

Table 1.1
Analytical Methods
SWMUs 17, 27, 29, 30, and 62
NAS Fort Worth JRB, Carswell, Texas

Parameter	Preparation Method (1)	Analytical Method (1)	Abbreviation
Matrix: Soil			
Volatile Organic Compounds	5030A	8260A	VOCs
Semivolatile Organic Compounds	3550A	8270B	SVOCs
Pesticides/PCBs	3550A	8080A	Pest/PCBs
Herbicides	(2)	8151	Herbs
ICP Metals	3050A	6010A	ICP Metals
Mercury	(2)	7471A	Hg
Matrix: Aqueous			
Volatile Organic Compounds	5030A	8260A	VOCs
Semivolatile Organic Compounds	3520A	8270B	SVOCs
Pesticides/PCBs	3520A	8080A	Pest/PCBs
Herbicides	(2)	8151	Herbs
ICP Metals	3005A	6010A	ICP Metals
Mercury	(2)	7470A	Hg

Notes:

- (1) Preparation and Analytical Methods are from "Test Methods for Evaluating Solid Waste U.S. EPA Office of Solid Waste and Emergency Response", Washington, DC, SW-846 3rd Edition, and its first and second updates.
- (2) Sample preparation is included in the analytical method.
4. The Basewide QAPP requires rejection of all associated compound results if the LCS exhibits a percent recovery which is outside (above or below) control limits. The AFCEE QAPP only requires rejection when the LCS percent recovery is below the control limit and the associated sample result is non-detect. A variance is requested to qualify affected results with a "J" flag, which will eliminate unnecessary rejections.
5. The laboratory will prepare the LCS and matrix spikes/matrix spike duplicates using all target analytes, as required by the Basewide QAPP. However, historical laboratory data indicates these limits cannot be achieved by several compounds. A variance is requested to widen the limits of those compounds. These limits are presented below:

QAPP Table	Method	Analytes	Matrix	AFCEE Limits	Laboratory Limits
7.2.15-2	SW8270B	Benzyl alcohol	Water	35 - 125 (20)	10 - 125 (20)
			Soil	25 - 135 (30)	10 - 135 (30)
		4-Chloroaniline	Water	45 - 136 (20)	10 - 136 (20)
			Soil	35 - 146 (30)	10 - 146 (30)
		Hexachlorocyclopentadiene	Water	41 - 125 (20)	10 - 125 (20)
			Soil	31 - 135 (30)	10 - 135 (30)
		2-Nitroaniline	Water	50 - 125 (20)	10 - 125 (20)
			Soil	40 - 135 (30)	10 - 135 (30)
		Dimethyl phthalate	Water	25 - 175 (20)	10 - 175 (20)
			Soil	25 - 175 (30)	10 - 175 (30)
		3-Nitroaniline	Water	51 - 125 (20)	10 - 125 (20)
			Soil	41 - 135 (30)	10 - 135 (30)
		2,4-Dinitrophenol	Water	30 - 151 (20)	10 - 151 (20)
			Soil	25 - 161 (30)	10 - 161 (30)
		4-Nitrophenol	Water	25 - 131 (20)	10 - 131 (20)
			Soil	25 - 141 (30)	10 - 141 (30)
		Diethyl phthalate	Water	37 - 125 (20)	10 - 125 (20)
			Soil	27 - 135 (30)	10 - 135 (30)
		4-Nitroaniline	Water	40 - 143 (20)	10 - 143 (20)
			Soil	30 - 153 (30)	10 - 153 (30)
3,3'-Dichlorobenzidine	Water	29 - 175 (20)	10 - 175 (20)		
	Soil	25 - 175 (30)	10 - 175 (30)		
Benzoic acid	Water	25 - 162 (20)	10 - 162 (20)		
	Soil	25 - 172 (30)	10 - 172 (30)		
7.2.14-2	SW8260A	2,2-Dichloropropane	Water	75 - 125 (20)	50 - 125 (20)
			Soil	65 - 135 (30)	50 - 135 (30)
		Bromomethane	Water	72 - 125 (20)	50 - 125 (20)
			Soil	62 - 135 (30)	50 - 135 (30)
		Chloroethane	Water	65 - 125 (20)	50 - 125 (20)
			Soil	55 - 135 (30)	50 - 135 (30)
		Chloromethane	Water	75 - 125 (20)	50 - 125 (20)
			Soil	65 - 135 (30)	50 - 135 (30)
		Dichlorodifluoromethane	Water	75 - 125 (20)	50 - 150 (20)
			Soil	65 - 135 (30)	50 - 150 (30)
		Trichlorofluoromethane	Water	67 - 125 (20)	50 - 125 (20)
			Soil	57 - 135 (30)	50 - 135 (30)
7.2.12-2	SW8151	2,4-D	Water	65 - 125 (30)	50 - 125 (30)
			Soil	55 - 135 (50)	50 - 135 (50)
		Dalapon	Water	70 - 125 (30)	50 - 125 (30)
			Soil	60 - 135 (50)	50 - 135 (50)

QAPP Table	Method	Analytes	Matrix	AFCEE Limits	Laboratory Limits
7.2.12-2 (cont.)		Dinoseb	Water	72 - 125 (30)	25 - 125 (30)
			Soil	62 - 135 (50)	25 - 135 (50)
7.2.7-2	SW8080A	α -BHC	Water	75 - 125 (30)	60 - 125 (30)
			Soil	65 - 135 (50)	50 - 135 (50)
		δ -BHC	Water	75 - 126 (30)	60 - 126 (30)
			Soil	65 - 136 (50)	50 - 136 (50)
		γ -BHC	Water	73 - 125 (30)	60 - 125 (30)
			Soil	63 - 135 (50)	50 - 135 (50)
		Endosulfan II	Water	75 - 149 (30)	60 - 149 (30)
			Soil	65 - 169 (50)	50 - 169 (50)
		Endrin aldehyde	Water	75 - 150 (30)	60 - 150 (30)
			Soil	65 - 160 (50)	50 - 160 (50)
		Methoxychlor	Water	73 - 142 (30)	60 - 142 (30)
			Soil	63 - 152 (50)	50 - 152 (50)

Note: The format presented for control limits is: LCL-UCL (RPD).

6. The Basewide QAPP states that "J", "UJ", or "R" flags be applied to sample results affected by matrix spike/matrix spike duplicate (MS/MSD) recoveries and/or relative percent differences (RPDs). The AFCEE QAPP states that an "M" flag be applied to sample results affected by MS/MSDs. In order to remain consistent with previous and ongoing investigations performed at NAS Fort Worth JRB, "J" and "UJ" flags will be applied to samples affected by MS/MSD results. However, a variance is requested to do away with the "R" flag in order to eliminate unnecessary rejections.
7. The prescribed corrective action for surrogate failures is re-preparation and re-analysis of associated samples. Allowance will be made for situations in which there is objective evidence of matrix interference (e.g., earlier analyses, co-eluting compounds shown on chromatograms, or evidence of interfering compounds indicated in other method results). Where such evidence exists, a Non-conformance Memo will be initiated by the laboratory to document the situation, and a decision will be made in consultation with the laboratory, HydroGeoLogic, and if needed, AFCEE.
8. In SW-846, provision is made in Method 8000A for calibration by regression for all compounds analyzed using GC methods. It is requested the laboratory be allowed to employ calibration using regression fits for GC analyses. In those situations where a first-order regression curve is used, the minimum allowed correlation coefficient (r) will be 0.995. For a second- or third-order regression, eight data points will be used and the minimum allowed (r) will be 0.995.

9. Software to generate hardcopy results in the AFCEE forms is not commercially available. For the purposes of this project, Quanterra will work with HydroGeoLogic to develop acceptable hardcopy and electronic data deliverables.
10. The referenced tables identify SW3510B (separatory funnel extraction) and SW3550A (sonication extraction) as the allowable sample preparation methods for water and soil, respectively. The laboratory requests an allowance for the use of SW3520B (continuous liquid-liquid extraction) and SW3540B (soxhlet extraction) for methods SW8080A and SW8270B.
11. A variance is requested for the laboratory to analyze and report alpha- and gamma-chlordane instead of technical-chlordane. Identification of alpha- and gamma-chlordane will provide qualitative analysis since these isomers represent the two largest chromatographic peaks in technical-chlordane. Technical-chlordane would not be found without the presence of either isomer. In the event of alpha- or gamma-chlordane detection, each sample will be assessed for the multi-response pattern of technical chlordane. If the pattern is observed, the system will be calibrated for technical-chlordane and quantitated accordingly. Alpha- and gamma-chlordane will be added to all QC and required to meet the limits defined for other single response peaks.
12. A variance is requested to use the arochlor 1016/1260 mixture as representation of the multi-response analytes (i.e., PCBs and toxaphene) in the LCSs and matrix spikes/matrix spike duplicates.
13. A representative Aroclor mixture (AR 1016/1260) will be used for the initial five-point calibration to allow quantitative analysis of that same mixture in the continuing calibration, LCS and MS/MSD. However, a variance is requested to allow for a single point calibration on the remaining PCBs and toxaphene, and the concentration of these single calibration points will correspond to the AFCEE PQLs. If toxaphene or any of the PCBs are detected, a calibration curve for those compounds will be analyzed, and sample(s) reanalyzed.
14. SW8260A only identifies one ion for the internal standard Chlorobenzene- d_5 (m/z 117). The response of this ion is too strong to properly use for bromoform, one of its assigned target compounds. Therefore, a variance is requested to allow the use of a secondary ion for this internal standard (m/z 119) when quantifying associated compounds.
15. Three xylene isomers (o-, m-, and p-) are listed separately in Table 7.2.14 of the Basewide QAPP. Two of these isomers (m- and p-) co-elute in all capillary column systems, and therefore their results cannot be separated. It is requested the laboratory be allowed to report these isomers as one results.
16. The QAPP states in Section 7 that retention time window studies be required for GC/MS methods. A successful LCS is adequate evidence of retention time control

for GC/MS methods and therefore, a variance is requested that retention time window studies not be assessed for GC/MS methods.

17. A daily calibration verification will be performed, but bracketing CCVs will not be performed for the GC/MS methods. This requirement has been dropped from Version 2.0 of the AFCEE QAPP.
18. Two methylphenol isomers (3- and 4-) co-elute in all capillary column systems and therefore their results cannot be separated. Only 4-methylphenol is listed on the compound list for method SW 8270B. The laboratory requests reporting these two compounds as one result.
19. Several compounds are recognized in SW8270B as possibly requiring special treatment. Because of this, the laboratory requests a ± 30 percent difference criteria be allowed for continuing calibration verification for the following compounds:
 - Benzyl alcohol
 - Hexachlorocyclopentadiene
 - 2,4-Dinitrophenol
 - 4-Nitrophenol
 - 4,6-Dinitro-2-methylphenol
 - 2-Nitroaniline
 - 3-Nitroaniline
 - 4-Chloroaniline
20. A variance is requested for the use of Teflon boiling chips instead of Ottawa sand in the LCSs for metals analysis. Ottawa sand is not recommended for metals analyses due to the presence of trace contaminants.
21. A variance is requested that the continuing calibration acceptance criteria for common ions be ± 10 percent rather than 5 percent. Although ± 5 percent was once the requirement in the EPA Method 300.0, the current version of that method (8/93) and SW9056 (9/94) specify a ± 10 percent CCV requirement.
22. A variance is requested for the PQLs on the compounds/analytes listed below:

Method	Analytes	Matrix	AFCEE PQL	Current MDL	Proposed PQL	TNRCC RRS2	Background Concentration
SW8260A	Methylene chloride	Aqueous	0.3 µg/l	0.67 µg/l	5 µg/l	5 µg/l	NA
	1,1,2,2-Tetrachloroethane	Aqueous	0.4 µg/l	0.48 µg/l	1 µg/l	4.26 µg/l	NA
	1,2,3-Trichlorobenzene	Aqueous	0.3 µg/l	0.66 µg/l	2 µg/l	NA	NA
	Naphthalene	Aqueous	0.4 µg/l	0.46 µg/l	2 µg/l	1,460 µg/l	NA
	3- and 4-Methylphenol	Soil	0.3 µg/l	NA	1 mg/kg	1,830 mg/kg	NA
SW8270B							
	Dinoseb	Aqueous	0.7 µg/l	0.84 µg/l	1 µg/l	NA	NA
SW9056	Sulfate	Aqueous	200 µg/l	270 µg/l	500 µg/l	NA	NA
	Bromide	Aqueous	100 µg/l	100 µg/l	200 µg/l	NA	NA
	Fluoride	Aqueous	200 µg/l	360 µg/l	500 µg/l	NA	NA
	ortho-Phosphate	Aqueous	100 µg/l	92 µg/l	200 µg/l	NA	NA
	Calcium	Aqueous	100 µg/l	NA	1,000 µg/l	NA	2,438,000 µg/l
SW6010A		Soil	10 mg/kg	NA	50 mg/kg	NA	167,788 mg/kg (SS)
							272,000 mg/kg (SB)
	Magnesium	Aqueous	300 µg/l	NA	1,000 µg/l	NA	68,780 µg/l
		Soil	30 mg/kg	NA	50 mg/kg	NA	3,003 mg/kg (SS)
							2,420 mg/kg (SB)
	Sodium	Aqueous	300 µg/l	NA	1,000 µg/l	NA	176,200 µg/l
		Soil	30 mg/kg	NA	50 mg/kg	NA	25,800 mg/kg (SS)
							53,200 mg/kg (SB)

SS - Surface Soil
 SB - Subsurface Soil

Please note the proposed PQLs are either equal to or less than the Texas Natural Resource Conservation Commission (TNRCC), Risk Reduction Standard 2 (RRS2) concentration levels or background levels as reported in the Draft Basewide Background Study (Jacobs Engineering, 1997).

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**DRAFT FINAL
HEALTH AND SAFETY PLAN**

**RCRA FACILITY INVESTIGATION OF LANDFILLS
NAS FORT WORTH JRB, TEXAS**

Contract Number F41624-95-D-8005

Prepared for:

U.S. Air Force Center for Environmental Excellence
Brooks AFB, Texas

Prepared by:

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June 1997

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AFB	Air Force Base
AFCEE	U.S. Air Force Center for Environmental Excellence
ANSI	American National Standards Institute
°C	Celsius
CAFB	Carswell Air Force Base
CFR	Code of Federal Regulations
CIH	Certified Industrial Hygienist
CMS	Corrective Measures Study
COR	Contracting Officer's Representative
CPC	Chemical Protective Clothing
CPR	Cardiopulmonary Resuscitation
dB	decibel
DOT	Department of Transportation
EPA	U.S. Environmental Protection Agency
FAR	Federal Acquisition Regulation
FSP	Field Sampling Plan
HAZWOPER	Hazardous Waste Site Operations
HCS	Hazard Communication Standard
HEPA	High Efficiency Particulate Matter
HSO	Health and Safety Officer
HSP	Health and Safety Plan
JRB	Joint Reserve Base
KCl	Potassium Chloride
LEL	Lower Explosive Limit
LF	Landfill
mg/m ³	milligrams per cubic meter
MSDS	Material Safety Data Sheet
NAS	Naval Air Station
NIOSH	National Institute for Occupational Safety and Health
O ₂	Oxygen
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limit
PID	Photoionization Detector

PM	Project Manager
POC	Point of Contact
PPE	Personal Protective Equipment
PVC	Polyvinyl Chloride
RCO	Responsible Corporate Officer
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SAP	Sampling and Analysis Plan
SOW	Statement of Work
SSO	Site Safety Officer
SWMU	Solid Waste Management Unit
T	Air Temperature
T _{aj}	Adjusted Air Temperature
TLV	Threshold Limit Value
UEL	Upper Explosive Limit
US	United States
USCG	United States Coast Guard
VOC	Volatile Organic Compound
WP	Work Plan

1.0 INTRODUCTION

1.1 PURPOSE

This Health and Safety Plan (HSP) is designed to assign responsibilities, establish personnel protection standards, specify mandatory operating procedures, and provide for emergency contingencies with respect to health and safety issues that may arise while HydroGeoLogic, Inc. (HydroGeoLogic) personnel and subcontractor personnel are engaged in Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) activities at Solid Waste Management Unit (SWMU) 29 (Landfill No. 2 or LF-02), SWMU 62 (Landfill No. 6 or LF-06), SWMU 17 (Landfill No. 7 or LF-07), SWMU 30 (Landfill No. 9 or LF-09), and SWMU 27 (Landfill No. 10 or LF-10) of the Former Carswell Air Force Base (CAFB) now referred to as the Naval Air Station (NAS) Fort Worth Joint Reserve Base (JRB) located in Fort Worth, Texas. The request for RFI activities was identified in the statement of work (SOW) dated January 21, 1997 under the authorization of the U.S. Air Force Center for Environmental Excellence (AFCEE) Contract Number F41624-95-D-8005, Delivery Order Number 0005. This HSP conforms to the requirements of the Occupational Safety and Health Administration (OSHA) Standard 29 CFR 1910 and 1926. Detailed OSHA requirements for hazardous waste operations are contained in OSHA Standard 29 CFR 1910.120 and OSHA Standard 29 CFR 1926.65, "Hazardous Waste Operations and Emergency Response." Additional guidance for hazardous waste operations may be found in the Environmental Protection Agency (EPA) publication, "Standard Operating Safety Guides" (November 1987), the National Institute of Occupational Safety and Health (NIOSH)/OSHA/U.S. Coast Guard (USCG)/EPA publication, "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities" (October 1985), and the Federal Acquisition Regulation (FAR) clause 52.236-13: Accident Prevention.

This HSP is based on available background information regarding possible chemical, physical, and biological hazards that may exist at the site. If more information concerning the nature and/or concentrations of contaminants becomes available, this HSP will be amended accordingly.

1.2 APPLICABILITY

The provisions of the HSP are mandatory for all official visitors, HydroGeoLogic employees, and subcontractors while investigations are being conducted at NAS Fort Worth JRB. These investigations will include: the installation of 6 test pits at SWMUs 17 and 62 with associated surface and subsurface soil sampling; geophysical surveys at SWMUs 17, 27, 29, 30, and 62; completion and sampling of 26 soil borings; the installation of 21 groundwater monitoring wells; and groundwater sampling of newly installed and existing monitoring wells to evaluate the nature and extent of potential contamination associated with each of the SWMUs. Inadequate health and safety precautions on the part of visitors or subcontractors, or the belief that personnel on the site are or may be exposed to an immediate health hazard, can be cause for HydroGeoLogic to suspend on-site activities and require all personnel to evacuate the area of concern.

1.3 PROJECT ORGANIZATION, PERSONNEL, AND RESPONSIBILITIES

This section provides HydroGeoLogic's personnel organization for this project as presented in Figure 4.1 of the Field Sampling Plan (FSP) and establishes the roles and responsibilities of various project personnel in regard to site health and safety. The authority and responsibilities of each HydroGeoLogic individual utilized for this project are presented in the following sections.

1.3.1 Responsible Corporate Officer (RCO)

The RCO for this project will be John Robertson, P.G. (Executive Vice-President). The RCO has authority to direct changes to the Corporate Health and Safety Program and determines and implements personnel disciplinary actions, as required. The RCO's responsibilities for this project include:

- Direct and monitor the implementation of the Corporate Health and Safety Program.
- Advise on health and safety matters.
- Issue directives, advisories, and information to the Health and Safety Officer (HSO).

1.3.2 Health and Safety Officer (HSO)

The HSO for this project will be Christopher Spill. He will be assisted by William Max, Law Engineering's Certified Industrial Hygienist (CIH). The HSO has the authority to:

- Suspend work or otherwise limit exposure to personnel if health and safety plans appear to be unsuitable or inadequate.
- Direct personnel to change work practices if existing practices are deemed to be hazardous to their health and safety.
- Remove personnel from projects if their actions or conditions endanger their health and safety or the health and safety of co-workers.
- Approve the qualifications of employees to work at hazardous waste sites.
- Approve health and safety plans.

The HSO responsibilities for this project will include:

- Interface with Project Manager (PM) in matters of health and safety.
- Keep the RCO and PM informed on the status of the site health and safety plan.
- Develop or review and approve project health and safety plans prior to submittal.

- Conduct staff training and orientation on health and safety related activities.
- Appoint or approve Site Safety Officer (SSO).
- Monitor compliance with health and safety plans and conducts site audits.
- Assist in obtaining required health and safety equipment.
- Approve personnel to work on hazardous waste management projects with regard to medical examinations and health and safety training.
- Maintain records pertaining to medical surveillance, training, fit testing, chemical exposure, and accidents/incidents.
- Provide industrial hygiene/chemical safety guidance.

1.3.3 Project Manager (PM)

The PM for this project will be James Costello, P.G. The PM has the authority to:

- Coordinate with the HSO on health and safety matters.
- Assign HSO-approved SSO to project and, if necessary, assign a suitably qualified replacement.
- Temporarily suspend field activities if health and safety of personnel are endangered, pending an evaluation by the HSO.
- Temporarily suspend an individual from field activities for infractions of the health and safety plan, pending an evaluation by the HSO.

The PM responsibilities for this project will include:

- Assure that the project is performed in a manner consistent with the health and safety program.
- Assure that the project health and safety plan is prepared, approved, and properly implemented.
- Provide the HSO with the information needed to develop health and safety plans.
- Assure that adequate funds are allocated to fully implement project health and safety plans.

1.3.4 Site Safety Officer (SSO)

The Site Safety Officer (SSO) will direct all on-site health and safety training and daily safety inspections. A qualified HydroGeoLogic employee who has performed these functions before will be the designated SSO. The SSO has the authority to temporarily suspend field activities if health and safety of personnel are endangered, pending further consideration by the HSO, and to temporarily suspend an individual from field activities for infractions of the health and safety plan, pending an evaluation by the HSO.

The SSO will report any problems or concern to the HydroGeoLogic HSO. The HSO will also review accident reports and air monitoring data sheets; however, because these reviews are necessarily conducted after the fact, the SSO remains the principal person responsible for on-site safety. At the facilities, the SSO has primary responsibility for:

- Directing health and safety activities on a site.
- Assuring that appropriate personal protective equipment (PPE) is available and properly utilized by HydroGeoLogic personnel, visitors, and subcontractor personnel.
- Assuring that personnel are aware of the provisions of this plan, are instructed in the work practices necessary to ensure safety, and are aware of planned procedures for dealing with emergencies.
- Assuring that personnel are aware of the potential hazards associated with investigation activities.
- Monitoring the safety performance of all personnel to ensure that required work practices are followed.
- Monitoring the physical condition of site workers for heat and cold stress.
- Correcting any work practices or conditions that may result in injury or exposure to hazardous substances.
- Assuring the completion of the site-specific HSP forms presented in Section 14.1 (i.e., Compliance Agreement, Accident/Incident Reports, Site Safety Briefing Form, etc.).
- Assuring that a copy of the HSP is maintained on the site during all investigation activities.
- Assuring that all air monitoring and equipment calibrations required by the HSP are preformed and recorded, and that logs/forms that include these activities are maintained (Section 14.1).
- Assuring that the subcontractor's medical monitoring program is adequate per OSHA Standard 29 CFR 1910.120 and this document.

- Verify OSHA 40-Hour Health and Safety training before admitting official site visitors (Air Force and regulatory representatives) into the exclusion zone and verify medical certification and fit-testing for respirator use when visitors request admittance into a Level C PPE exclusion zone (per OSHA Standard 29 CFR 1910.120).

1.3.5 Project Field Personnel

Personnel working on this project will be approved by the PM and the HSO and will meet the qualifications outlined in OSHA Standard 29 CFR 1910.120 and this HSP. The project personnel involved in on-site investigations and operations are responsible for:

- Taking all reasonable precautions to prevent injury to themselves and to their fellow employees.
- Implementing the HSP and reporting any deviations from the anticipated conditions described in the plans to the SSO.
- Performing only those tasks that they believe they can do safely, and immediately reporting any accidents and/or unsafe conditions to the SSO.

1.3.6 Subcontractor Responsibilities

It is the responsibility of each HydroGeoLogic subcontractor to ensure compliance with all applicable Federal, state, and OSHA regulations including OSHA Standard 29 CFR, Parts 1900 through 1910, Part 1926, and the contents of this HSP. Specifically contained within these OSHA regulations is OSHA Standard 29 CFR 1910.120, which includes requirements for training and medical surveillance for employees engaged in certain hazardous waste operations.

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2.0 SITE DESCRIPTION INFORMATION

A description of the NAS Fort Worth JRB sites under investigation is presented in Section 1.0 of the Work Plan. Please refer to this section for site description information.

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3.0 RCRA FACILITY INVESTIGATION ACTIVITIES

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The RFI activities to be conducted at the NAS Fort Worth JRB over a one month period will include:

- Installation of approximately 6 test pits at SWMUs 17 and 62 requiring a field geologist, field technician, and backhoe subcontractor to characterize surface and subsurface soil and type of wastes associated with the SWMUs.
- Installation of 26 soil boring (21 of the soil borings will be converted to monitoring wells) site-wide requiring a field geologist, field technician, and drilling subcontractor to characterize the soil and groundwater associated with the SWMUs.
- Groundwater sampling at the new well locations and three pre-existing well sites using a submersible pump.
- Geophysical surveys at SWMUs 17, 27, 29, 30, and 62 utilizing a electromagnetic conductivity meter and a magnetometer/gradiometer.
- Surface water and surface soil sampling at SWMU 27.

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4.0 HAZARD ASSESSMENT

This section identifies and evaluates potential site hazards which may be encountered during RFI activities. Control measures, to protect site personnel from these potential hazards, are incorporated throughout this HSP, but are mainly contained in the following sections:

- Section 6.0, Air Monitoring
- Section 7.0, Personal Protective Equipment
- Section 11.0, Standard Work Practices

4.1 CHEMICAL HAZARDS

Based upon the information obtained from previous site investigations (groundwater and soil), the primary chemicals of concern at NAS Fort Worth JRB have been listed in Table 4.1.

The primary concerns from a chemical exposure standpoint are inhalation, ingestion, and absorption by direct skin contact with contaminants in locations expected to be source areas. The specific contaminants, their exposure limits, and recognition qualities are presented in Table 4.1. The acute and chronic symptoms of overexposure to these chemical contaminants and first aid procedures are presented in Table 4.2. If additional contaminants are identified as being present at the NAS Fort Worth JRB, this HSP will be amended accordingly.

4.2 DECONTAMINATION SOLUTIONS AND PRESERVATIVES

Chemicals used to decontaminate sampling equipment and to preserve environmental sampling also present hazards to the project personnel who use them. The chemicals likely to be brought to the site for use in this manner include:

- Nitric Acid
- Hydrochloric Acid
- Methanol
- Hexane

Although overexposure to these chemicals is unlikely, the acute and chronic symptoms and first aid procedures are also presented in Table 4.2.

**Table 4.1
Exposure Limits and Recognition Qualities**

Compound	Permissible Exposure Limit (PEL) ^a	IDLH Level ^b	Recognition Qualities			Odor Warning Concentration (ppm)	LEL ^c (%)	UEL ^d (%)	Ionization Potential (eV)
			Color	Odor	State				
Arsenic Compounds	0.010 mg/m ³	5 mg/m ^{3e}	silver gray to tin-white	odorless	solid	NA	NA	NA	
Lead	0.050 mg/m ³	100 mg/m ³	gray	odorless	solid	NA	NA	NA	
Mercury	0.100 mg/m ³	10 mg/m ³	silver-white	odorless	liquid	NA	NA	NA	
Nitric Acid	2 ppm	25 ppm	colorless, red or yellow	acid, suffocating	liquid	NA	NA	11.95	
Hydrochloric acid	C 5 ppm	50 ppm	colorless to light yellow	irritating	gas	NA	NA	12.74	
Methanol	200 ppm	6000 ppm	colorless	pungent	liquid	100	36.0	10.84	
Hexane	500 ppm	1100 ppm	colorless	gasoline-like	liquid	NA	7.5	10.18	
Benzene	1.0 ppm	500 ppm ^e	colorless to light yellow	aromatic	liquid	1.5 - 5.0	7.8	9.24	
Toluene	200 ppm	500 ppm	colorless	aromatic	liquid	0.17 - 40	7.1	8.82	
Ethylbenzene	100 ppm	800 ppm	colorless	aromatic	liquid	4.7 - 5.0	6.7	8.76	
Total Xylene	100 ppm	900 ppm	colorless	aromatic	liquid	1.0 - 1.5	7.0	8.56	
Trichloroethylene	100 ppm	1000 ppm ^e	colorless	chloroform-like	liquid	28.0	10.5	9.45	
Tetrachloroethylene	100 ppm	150 ppm ^e	colorless	chloroform-like	liquid	27.0	NA	9.32	
Vinyl Chloride	1 ppm	Unknown ^e	colorless	pleasant	liquid or gas	3,000	3.6	9.99	
Chloroethane	1000 ppm	3800 ppm	colorless	ether-like	liquid or gas	NA	3.8	10.97	

Table 4.1 (Cont.)
Exposure Limits and Recognition Qualities

Compound	Permissible Exposure Limit (PEL) ^a	IDLH Level ^b	Recognition Qualities			Odor Warning Concentration (ppm)	LEL ^c (%)	UJEL ^d (%)	Ionization Potential (eV)
			Color	Odor	State				
1,1-Dichloroethane	100 ppm	3000 ppm	colorless	chloroform-like	liquid	NA	5.4	11.4	11.06
bis-(2-ethylhexyl)phthalate	5 mg/m ³	5000 mg/m ³	colorless	slight	liquid	NA	0.3	NA	NA
1,2-Dichloroethene	200 ppm	1000 ppm	colorless	slightly acrid, chloroform-like	liquid	17.0	5.6	12.8	9.65

^a OSHA permissible exposure limit or American Conference of Governmental Industrial Hygienists

^b Threshold Limit Value - Time Weighted Average

^c Immediately Dangerous to Life or Health

^d Lower explosive limit

^e Upper explosive limit

^f Ceiling value, a 15-minute Time Weighted Average that shall not be exceeded at any time during the work day

NA Not Applicable

Table 4.2
Acute And Chronic Effects
Symptoms of Overexposure And First Aid Treatment

Compound	Symptoms of Overexposure	First Aid Treatment
Arsenic	Ulceration of nasal septum; dermatitis; gastrointestinal disturbances; peripheral neuropathy; respiratory irritation; hyperpigmentation of skin; carcinogen	Eye: Irrigate immediately (15 min) Skin: Soap wash immediately Inhalation: Not a inhalation hazard Ingestion: Medical attention immediately
Lead	Weak, lassitude, insomnia; facial pallor; pal eye, anorexia, weight loss, malnutrition; constipation, abdominal pain, colic; anemia; gingival lead line; tremors; paralysis of wrist and ankles; encephalopathy; nephropathy; irritation to eyes; hypotension	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Respiratory support Ingestion: Medical attention immediately
Mercury	Cough, chest pain, dyspnea, bronchitis pneumonitis; tremors, insomnia; irritability, indecision; headache, fatigue, weak; stomatitis, salivation; gastrointestinal disturbance, anorexia, weight loss; proteinuria; irritation of the eyes, skin	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Respiratory support Ingestion: Medical attention immediately
Benzene	Irritation to eyes, nose, respiratory systems; giddiness; headache, nausea, staggered gait; fatigue, anorexia, lassitude; dermatitis; bone marrow depressant/depression; carcinogenic	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Artificial respiration Ingestion: Medical attention immediately; DO NOT INDUCE VOMITING
Toluene	Fatigue, weakness; confusion, euphoria, dizziness, headache; dilated pupils, lacrimation; nervousness, muscle fatigue, insomnia; paresis; dermatitis	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air Ingestion: Medical attention immediately; DO NOT INDUCE VOMITING
Ethylbenzene	Irritation to eyes, mucous membranes; headache; dermatitis; narcosis; coma	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Artificial respiration Ingestion: Medical attention immediately
Xylene	Dizziness, excitement, drowsiness, incoordination, staggering gait; irritation of eyes, nose, throat; corneal vacuolization; anorexia, nausea, vomiting, abdominal pain; dermatitis	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air Ingestion: Medical attention immediately; DO NOT INDUCE VOMITING

**Table 4.2 (Cont.)
Acute and Chronic Effects
Symptoms of Overexposure and First Aid Treatment**

Compound	Symptoms of Overexposure	First Aid Treatment
Trichloroethylene	Headache, vertigo; visual disturbance, tremors, somnolence, nausea, vomiting; irritation of the eyes; dermatitis; cardiac arrhythmias, paresthesia; carcinogen	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Respiratory support Ingestion: Medical attention immediately
Tetrachloroethylene	Irritation of the eyes, nose, throat; nausea; flush face, neck; vertigo, dizziness, incoordination; headache, somnolence; skin erythema; liver damage; carcinogen	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Respiratory support Ingestion: Medical attention immediately
Vinyl Chloride	Weakness; abdominal pain, gastrointestinal bleeding; hepatomegaly; pallor or cyan of extremities; carcinogen	Inhalation: Respiratory support
Chloroethane	Incoordination, inebriate; abdominal cramps; cardiac arrhythmias, cardiac arrest; liver and kidney damage	Eye: Irrigate immediately Skin: Water flush promptly Inhalation: Respiratory support Ingestion: Medical attention immediately
1,1-Dichloroethane	Central nervous system depressant; skin irritant; liver and kidney damage	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Respiratory support Ingestion: Medical attention immediately
1,2-Dichloroethene	Irritation of eyes and respiratory system; central nervous system depressant/depression	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Respiratory support Ingestion: Medical attention immediately
bis-(2-ethylhexyl)phthalate	Irritation of eyes, mucous membranes; carcinogen	Eye: Irrigate immediately Skin: Not a dermal hazard Inhalation: Respiratory support Ingestion: Medical attention immediately
Nitric Acid	Irritation of eyes, mucous membranes, and skin; delayed pulmonary edema, pneumitis, bronchitis; dental erosion	Eye: Irrigate immediately Skin: Water flush immediately Inhalation: Respiratory support Ingestion: Medical attention immediately

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**Table 4.2 (Cont.)
Acute and Chronic Effects
Symptoms of Overexposure and First Aid Treatment**

Compound	Symptoms of Overexposure	First Aid Treatment
Hydrochloric Acid	Inflammation of the nose, throat, laryngeal; cough, burns throat, choking; burns eyes, skin; dermatitis	Eye: Irrigate immediately Skin: Water flush immediately Inhalation: Respiratory support Ingestion: Medical attention immediately
Methanol	Eye irritant, headache, drowsiness; lightheadedness, nausea, vomiting; visual disturbances, blindness	Eye: Irrigate immediately Skin: Water flush immediately Inhalation: Respiratory support Ingestion: Medical attention immediately
Hexane	Light-headedness, nausea, headaches, numbness in extremities, weak muscles, eye irritation, nose irritation, dermatitis, chemical pneumonia, giddiness	Eye: Irrigate immediately Skin: Soap, wash immediately Inhalation: Respiratory support Ingestion: Medical attention immediately

In order to communicate the hazards of these chemicals to site personnel, MSDSs for each of these chemicals will be maintained on site and presented as part of the site-specific training (Section 10.2).

4.3 PHYSICAL HAZARDS

The following section titles identify physical hazards that may be encountered. They include but are not limited to:

- Hot or Cold Work Environments (Stress)
- Noise Hazards
- Materials Handling
- Utility Hazards
- Fall, Trip, and Slip Hazards (Section 11.0)
- Flammable/Explosive Atmospheres (Section 6.0)
- Heavy Equipment/Vehicular Activity (Section 11.0)

Control measures to help protect site personnel from these potential hazards are incorporated in the following subsections and throughout this HSP, specifically Section 11.0, Standard Work Practices, for safety hazards associated with drilling rigs and support vehicles.

4.3.1 Heat Stress

Heat stress can be a problem especially if site activities are required to be performed while wearing PPE in warm, humid weather conditions. The four types of heat illness in increasing order of severity include: heat rash, heat cramps, heat exhaustion, and heat stroke.

- Heat rash may result from continuous exposure to heat or humid air.
- Heat cramps are caused by heavy sweating with inadequate electrolyte replacement. Signs and symptoms include muscle spasms and pain in the hands, feet, and abdomen.
- Heat exhaustion occurs from increased stress on various body organs, including inadequate blood circulation due to cardiovascular insufficiency or dehydration. Signs and symptoms include: pale, cool, and moist skin; heavy sweating; dizziness, fainting and nausea.
- Heat stroke is the most serious form of heat stress. Temperature regulation fails, and the body temperature rises to critical levels. Immediate action must be taken to cool the body before serious injury or death occurs. When heat stroke is suspected, professional medical help must be obtained immediately. Signs and symptoms include: red, hot, and unusually dry skin; lack of or reduced perspiration; dizziness and confusion; strong, rapid pulse; and coma.

Proper training and preventive measures will help avert serious illness and loss of work productivity. Preventing heat stress is particularly important, because once someone suffers from

heat stroke or heat exhaustion, that person may be predisposed to additional injuries. To avoid heat stress, the following steps should be taken:

- Work schedules should be adjusted. The following guidelines of rest and cooling of the body will be followed to minimize the effects of heat stress:
 - If oral temperature exceeds 99.6°F (37.6°C), shorten the next work cycle by one-third without changing the rest period.
 - If oral temperature still exceeds 99.6°F (37.6°C) at the beginning of the next rest period, shorten the following work cycle by one-third.
 - Do not permit a worker to wear a semipermeable or impermeable garment when his/her oral temperature exceeds 100.6°F (38.1°C).

Initially, the frequency of physiological monitoring depends on the air temperature adjusted for solar radiation and the level of physical work (See Table 4.3). The length of the work cycle will be governed by the frequency of the required physiological monitoring.

Table 4.3
Suggested Frequency of Physiological Monitoring for
Fit and Acclimatized Workers

Adjusted Temperature ¹	Normal Work Ensemble ²	Impermeable Ensemble
90°F or above	After each 45 minutes of work	After each 15 minutes of work
87.5° - 90°F	After each 60 minutes of work	After each 30 minutes of work
82.5° - 87.5°F	After each 90 minutes of work	After each 60 minutes of work
77.5° - 82.5°F	After each 120 minutes of work	After each 90 minutes of work
72.5° - 77.5°F	After each 150 minutes of work	After each 120 minutes of work

¹ Calculate the adjusted air temperature (T_a) by using the equation: T_a (°F) = T (°F) + (13 x % sunshine). Measure air temperature (T) with a standard mercury-in-glass thermometer, with the bulb shielded from radiant heat. Estimate percent sunshine by judging what percent time the sun is not covered by clouds that are thick enough to produce a shadow. (100 percent sunshine = no cloud cover and a sharp, distinct shadow; 0 percent sunshine = no shadows)

² A normal work ensemble consists of cotton coveralls or other cotton clothing with long sleeves and pants

Source: NIOSH/OSHA/USCG/EPA, 1985

- Shelter (air-conditioners and other cooling devices, if possible) or shaded areas should be provided to protect personnel during rest periods.
- Worker's body fluids should be maintained at normal levels to ensure that the cardiovascular system functions adequately. Daily fluid intake must approximately equal the amount of water in sweat, which will vary from day to day. The normal thirst mechanism is not sensitive enough to ensure that water intake is sufficient to replace lost sweat. When heavy sweating occurs, the worker should be encouraged to drink more.

Have workers drink fluid (preferably water or diluted drinks) before beginning work. Urge workers to drink a cup or two at each scheduled break. A total of 1 to 1.6 gallons (4 to 6 liters) of fluid per day are recommended, but will depend on actual fluid replacement needs, which will vary depending on the sweat rate.

- The drinking water temperature should be maintained at 50°F to 60°F (10°C to 15.6°C).
- Disposable cups that hold about 16 ounces should be provided.
- Encourage workers to maintain an optimal level of physical fitness. Where indicated, acclimatize workers to site work conditions.
- Train workers to recognize, identify, and treat heat stress.

When heat stress is suspected, the following steps should be taken:

- Get the victim out of the heat
- Loosen tight clothing
- Remove perspiration-soaked clothing
- Apply cool, wet cloths to the skin
- Fan the victim
- If the victim is conscious, give cool water to drink. Do not give electrolyte solutions (i.e., those containing salt) to victims of heat stress because it can cause nausea and vomiting. Only small sips of cool water should be administered to heat stress victims.
- Call for an ambulance if the victim refuses water, vomits, or starts to lose consciousness.

4.3.2 Cold Stress

If site work is to be conducted during the winter, cold stress is a concern to the health and safety of personnel. Especially with regard to the wearing of Tyvek suits because such disposable clothing does not “breathe,” perspiration does not evaporate, and the suits can become wet. Wet clothes combined with cold temperatures can lead to hypothermia. If the air temperature is less than 40°F and an employee perspires, the employee must change to dry clothes.

The following are five degrees of cold stress in increasing order of severity:

- Incipient frostbite is a mild form of cold stress characterized by sudden blanching or whitening of the skin.

- Chilblain is an inflammation of the hands and feet caused by exposure to cold moisture. It is characterized by a recurrent localized itching, swelling, and painful inflammation of the fingers, toes, or ears. Such a sequence produces severe spasms, accompanied by pain.
- Second-degree frostbite is manifested by skin with a white, waxy appearance and the skin is firm to the touch. Individuals with this condition are generally not aware of its seriousness, because the underlying nerves are frozen and unable to transmit signals to warm the body. Immediate first aid and medical treatment are required.
- Third-degree frostbite will appear as blue, blotchy skin. The tissue is cold, pale, and solid. Immediate medical attention is required.
- Hypothermia develops when body temperature falls below a critical level. In extreme cases, cardiac failure and death may occur. Immediate medical attention is warranted when the following symptoms are observed: involuntary shivering, irrational behavior, slurred speech, and sluggishness.

To care for any frostbite, handle the area gently. Never rub an affected area because rubbing causes further damage to soft tissues. Warm the affected area gently by soaking the affected part in water no warmer than 105° F. Keep the frostbitten part in the water until it looks red and feels warm. Loosely bandage the affected area with a dry, sterile dressing. If fingers or toes are frostbitten, place cotton or gauze between them. Do not break any blisters caused by frostbite. Obtain professional medical attention as soon as possible.

To care for hypothermia, start by caring for any life-threatening problems and call for emergency medical assistance. Remove any wet clothing and dry the victim. Warm the body gradually by wrapping the victim in blankets or putting on dry clothing and moving him or her to a warm place. If available, apply heat pads or other heat sources to the body but be sure to keep a barrier, such as a blanket, towel, or clothing, between the heat source and the victim to avoid burning the victim. If the victim is alert, give warm liquids to drink. Do not warm the victim too quickly, such as by immersing the victim in warm water, because rapid rewarming can cause dangerous heart problems. In cases of severe hypothermia when the victim may be unconscious, give rescue breathing when necessary and be prepared to administer cardiopulmonary resuscitation (CPR).

4.3.3 Noise Hazards

The SSO or designee will monitor high noise levels when equipment or machinery (e.g. backhoe, drill rig, etc.) is being used on-site. Field personnel working in areas where noise levels can be expected to reach or exceed 85 decibels (dB) will be issued hearing protection to reduce the level below the 85 dB threshold. Compliance standards for occupational noise exposure are found in 20 CFR 1910.95.

4.3.4 Materials Handling

The most common type of materials handling accident is when fingers or toes of field personnel get caught between two objects. Special precautions must be implemented during the moving,

shifting, or rolling of materials and should never be attempted by a single individual. Workers are required to use proper lifting techniques for handling materials, and oversize or heavy loads require “team lift” procedures.

4.3.5 Utility Hazards

The locations of all underground utilities must be identified and marked prior to initiating any subsurface investigations. In addition, drilling within 20 feet in any direction of overhead powerlines will not be permitted.

4.4 BIOLOGICAL HAZARDS

The biological hazards that could be encountered by site personnel include, but are not limited to, the following:

- Poisonous snakes and spiders
- Stinging insects
- Ticks and chiggers
- Poisonous plants (e.g., poison sumac, poison ivy, poison oak)

Control measures to help protect site personnel from these biological hazards are incorporated in the following sections.

4.4.1 Poisonous Snakes and Spiders

Reactions from a snakebite are aggravated by acute fear and anxiety. Other factors that affect the severity of local and general reaction from a poisonous snakebite include: the amount of venom injected and the speed of absorption of venom into the victim’s circulation; the size of the victim; protection from clothing, including shoes and gloves; quick anti-venom therapy; and location of the bite.

Spiders in the United States are generally harmless, with two notable exceptions: the Black Widow spider (*Latrodectus Mactans*) and the Brown Recluse or violin spider (*Lox Osceles Reclusa*). The symptoms of a Black Widow spider bite are: slight local reaction, severe pain produced by nerve toxin, profuse sweating, nausea, painful cramps in abdominal muscles, and difficulty in breathing and speaking. Victims recover in almost all cases, but an occasional death is reported.

Field personnel should exercise caution when lifting logs, rocks, covers to manholes, sumps, etc.

4.4.1.1 First Aid Procedures (Snakebite)

The objective of first aid is to reduce the circulation of blood through the bite area, to delay absorption of venom, to prevent aggravation of the local wound, and to sustain respiration. Several steps are listed to properly care for a snakebite victim. The most important step is to get the snakebite victim to the hospital quickly. Since all investigation activities will be performed

at NAS Fort Worth JRB, the base hospital will be within reasonable travel time. Meanwhile, take the following first aid measures:

- Keep the victim from moving around.
- Keep the victim as calm as possible and preferably in a lying position.
- Immobilize the bitten extremity and keep it at or below heart level. If the victim can reach a hospital within 4 to 5 hours and if no symptoms develop, no further first aid measures need to be applied.
- If mild-to-moderate symptoms develop, apply a constricting band 2 to 4 inches above the bite, but not around a joint (the elbow, knee, wrist, or ankle) and not around the head, neck, or trunk. The band should be $\frac{3}{4}$ to $1\frac{1}{2}$ inches wide, not thin like a rubber band. The band should be snug but loose enough for a finger to be slipped underneath. Watch for swelling and loosen the band if it becomes too tight, but do not remove it. Periodically check the pulse in the extremity beyond the bite to insure that the blood flow has not stopped.

Several other factors must be considered in cases of snakebite:

- Shock. Keep the victim lying down and comfortable, and maintain his or her body temperature.
- Breathing and heartbeat. If breathing stops, give mouth-to-mouth resuscitation. If breathing stops and there is no pulse, perform CPR if you have been trained to do so.
- Identifying the snake. If you can kill the snake without risk or delay, bring it to the hospital for identification, but exercise extreme caution in handling the snake.
- Cleaning the bitten area. You may wash the bitten area with soap and water and blot it dry with sterile gauze. You may apply dressings and bandages, but only for a short period of time.
- Medicine to relieve pain. Do not give the victim alcohol, sedatives, aspirin, or any medicine containing aspirin. Consult a doctor or other medical personnel for specific medications that may be used.
- Snakebite kits. Keep a kit accessible for all outings in primitive areas or areas known or suspected to snake infested.

It is not recommended that cold compresses, ice, dry ice, chemical ice packs, spray refrigerants, or other methods of cold therapy be used in the first aid treatment of snakebite.

4.4.1.2 General First Aid for Poisonous Insect Bites

For minor bites and stings use cold applications and soothing lotions, such as calamine. For more severe reactions, take the following first aid measures:

- Apply a constricting band above the injection site on the victim's arm or leg (between the site and the heart). Do not apply tightly. You should be able to slip your index finger under the band when it is in place. Give artificial respiration if necessary;
- Keep the affected part below the level of the victim's heart.
- If medical care is ready available, leave the band in place; otherwise, remove it after 30 minutes.
- Apply ice contained in a towel or plastic bag, or cold cloths, to the site of the sting or bite.
- Give home medicine, such as aspirin, for pain.
- If the victim has a history of allergic reactions to insect bites or is subject to attacks of hay fever or asthma, or if he or she is not promptly relieved of symptoms, call a physician or take the victim immediately to the nearest location where medical treatment is available. In a highly sensitive person, do not wait for symptoms to appear, since delay can be fatal.
- In case of a bee sting, remove and discard the stinging apparatus and venom sac.

Workers who have had severe allergic reactions to bee/wasp stings in the past will inform the SSO when they arrive at the site for the first time.

4.4.2 Ticks and Chiggers

Field personnel should be aware of the presence of ticks (i.e., deer tick) and chiggers at the site. Common carriers of ticks and chiggers are the white-footed mouse and white-tailed deer which are prevalent in the area. The deer tick is about the size of a sesame seed, as distinguished from the dog tick, which is significantly larger. The deer tick is principally found along the Atlantic coast, living in grassy and wooded areas, and feeds on mammals such as mice, shrews, birds, raccoons, opossums, deer, and humans. Common diseases caused by ticks are presented in the following subsections.

Removal of ticks is best accomplished using small tweezers. Do not squeeze the tick's body. Grasp it where the mouth parts enter the skin and tug gently, not firmly, until it releases its hold on the skin. Save the tick in a jar labeled with the date, body location of the bite, and the place where it may have been acquired. Wipe the bite thoroughly with an antiseptic. Seek medical attention in the event tick-related disease symptoms develop.

When in an area suspected of harboring ticks (grassy, bushy, or woodland area) the following precautions can minimize the chances of being bitten by a tick:

- Wear long pants and long-sleeved shirts that fit tightly at the ankles and wrists. **330266**
- Wear light colored clothing so ticks can be easily spotted.
- Wearing tick repellents may be useful.
- Inspect clothing frequently while in tick habitat.
- Inspect your head and body thoroughly when you return from the field.
- Remove any attached ticks by tugging with tweezers where the tick's mouth parts enter the skin. Do not squeeze or crush it.

4.4.2.1 Lyme Disease

Lyme disease is an illness caused by a bacterium which may be transmitted by the bite of a tick (*Ixodes Dammini*), commonly referred to as the "Deer Tick". Not all ticks are infected with the bacterium, however. When an infected tick bites, the bacterium is passed into the bloodstream of the host, where it multiplies. The various stages and symptoms of the disease are well recognized and, if detected early, can be treated with antibiotics.

The illness typically occurs in the summer and is characterized by a slowly expanding red rash, which develops a few days to a few weeks after the bite of an infected tick. This may be accompanied by flu-like symptoms along with headache, stiff neck, fever, muscle aches, and/or general malaise. At this stage treatment by a physician is usually effective; but, if left too long, these early symptoms may disappear and more serious problems may follow. The most common late symptom of the untreated disease is arthritis. Other problems which may occur include meningitis and neurological and cardiac abnormalities. It is important to note that some people do not get the characteristic rash but progress directly to the later manifestations. Treatment of later symptoms is more difficult than early symptoms and is not always successful.

4.4.2.2 Rocky Mountain Spotted Fever

In the eastern and southern United States this tickborne disease is transmitted by the infected Dog Tick (*Dermacentor Variabilis*). It is important to note that the Dog Tick is significantly larger than the Deer Tick. Nearly all cases of infection occur in the spring and summer, generally several days after exposure to infected ticks. The onset of illness is abrupt and often accompanied by high fever, headache, chills, and severe weakness. After the fourth day of fever, victims develop a spotted pink rash that usually starts on the hands and feet and gradually extends to most of the body. As with Lyme disease, early detection and treatment significantly reduces the severity of illness. The disease responds to antibiotic therapy with tetracycline or chloramphenicol.

4.4.2.3 Other Diseases

Ticks transmit several other diseases, most of which are rare and occur only in specific areas. Babesiosis occurs mainly in the Cape Cod area and eastern Long Island. Colorado tick fever is similarly regional and occurs only among those who live or work at altitudes above 4,000 feet.

4.4.3 Poisonous Plants

The majority of skin reactions following contact with offending plants are allergic in nature and are characterized by general symptoms of headache and fever, itching, redness, and a rash.

Some of the most common and most severe allergic reactions result from contact with plants of the Poison Ivy group including Poison Ivy, Poison Oak and Poison Sumac. The most distinctive features of Poison Ivy and Poison Oak are their leaves, which are composed of three leaflets each. Both plants also have greenish-white flowers and berries that grow in clusters. Such plants produce a severe rash characterized by redness, blisters, swelling, and intense burning and itching. The victim can also develop a high fever and become very ill. Ordinarily, the rash begins within a few hours after exposure, but it may be delayed for 24 to 48 hours.

4.4.3.1 First Aid Procedure

- Remove contaminated clothing.
- Wash all exposed areas thoroughly with soap and water, followed by rubbing alcohol.
- Apply calamine or other soothing skin lotion if the rash is mild.
- Seek medical advice if a severe reaction occurs, or if there is a known history of previous sensitivity.

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5.0 HAZARD COMMUNICATION

The HydroGeoLogic Hazard Communication Program complies with the OSHA Hazard Communication Standard (HCS) found in OSHA Standard 29 CFR 1910.120 and 1926.59, which applies to any chemical present in the workplace in such a manner that employees may be exposed to under normal conditions of use in a foreseeable emergency. Although waste materials are excluded from the OSHA requirements, decontamination chemicals for sampling equipment or protective clothing and calibration standards require MSDSs.

The principle of communicating the hazards of materials used in the workplace by employees applies to company-wide activities, from informational programs on the conduct of hazardous waste activities to the company's insistence upon adequate health and safety training. It is also important for personnel to have an awareness of client concern for Hazard Communication due to Federal, state, and local regulations directly affecting certain client activities.

In order to comply with the HCS, HydroGeoLogic has determined that:

- All containers of hazardous chemicals must be appropriately labeled or tagged to identify the hazard and provide information on effects and appropriate protective measures.
- Labels, tags, or signs must be properly affixed and visible at all times while a hazard is present and removed promptly when the hazard no longer exists.
- Written information (i.e., MSDSs) on hazardous chemicals in the workplace must be available to employees working with the substances.
- Appropriate MSDSs will be available to any contractor or subcontractor employee working on projects under HydroGeoLogic control.

When investigation results indicate potential imminent health risks to contracted or federal personnel, or the public at large, the contracting officer's representative (COR) and the base point of contact (POC) will be notified as soon as practicable. Written notification and supporting documentation will be provided within three days of finding potential imminent health risks during investigation activities.

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6.0 AIR MONITORING

This section presents requirements for the use of real-time air monitoring instruments during site activities involving potential for exposure to site contaminants. It establishes the types of instruments to be used, the frequency of which they are to be used, techniques for their use, action levels for upgrading/downgrading levels of protection, and methods for instrument maintenance and calibration.

6.1 INSTRUMENTS AND USE

A Photo-ionization Detector (PID) equipped with a lamp appropriate will be utilized for detecting the presence of emissions from chemicals of concern. A Draeger pump and colorimetric tubes will be used to confirm any detections observed with the PID in accordance with Table 6.1. Additionally, LEL/O₂ and methane detectors will be used during certain drilling and excavation activities to detect the presence of flammable/explosive atmospheres. The presence of methane will be monitored during field activities in proximity to SWMUs. Visual observation will be used to detect the presence of airborne particulates.

The PID/Draeger pump will be used throughout the execution of these activities:

- Test pit excavations.
- Soil boring installation.
- Monitoring well installation.
- Soil sampling during drilling activities.
- Well development.
- Groundwater sampling.
- Sampling equipment decontamination/equipment (heavy) decontamination.
- Waste characterization and disposal.

LEL/O₂ and methane detector will be used throughout the execution of these activities if flammable contaminants are anticipated:

- Test pit excavations.
- Soil boring/monitoring well installation.

6.2 AIR MONITORING REQUIREMENTS

6.2.1 Photo-Ionization Detector (PID)

Air monitoring with the PID will be initiated at potential sources of vapor emissions (source monitoring) at specified frequencies. The following potential sources and monitoring frequencies are anticipated:

Bore holes	Every 5-foot depth
Test Pits	Every 5-foot depth and length
Open well heads	Upon initial opening
Environmental sampling	Every sample set
Surface/subsurface soil sampling	Every 5-foot depth
RFI waste characterization	Every container to be sampled

If source monitoring indicates the presence of airborne emissions, air monitoring will then be initiated in the breathing zones of those workers who could be affected by the emissions. Air monitoring will also occur upon the request of site workers who notice unusual site odors or an increase in their intensity. If work is to be performed downwind of a site, air monitoring will be conducted to determine what type, if any, PPE is required to protect workers and to determine the potential for an imminent threat to public health.

The presence of elevated readings in the worker's breathing zone as identified in Table 6.1 require amendments to the HSP before workers are allowed to enter the exclusion zone. Depending on the air monitoring readings, air-purifying respirators may not be acceptable due to the fact that some contaminants of concern have poor warning properties and/or are unable to be filtered from inspired air with chemical cartridges (Table 6.1). Elevated readings will be based on confirmation sampling using a Draeger pump and colorimetric tubes in accordance with Table 6.1.

6.2.2 Draeger Pump and Tubes

A hand operated Draeger pump with colorimetric tubes will be used to confirm the results of PID testing. If the results of the PID tests show concentrations greater than 1.0 ppm above background concentrations in the breathing zone, then the colorimetric tubes will be used to identify the contaminants in the breathing zone. Colorimetric tubes to be utilized in the event of elevated PID readings will include: vinyl chloride, benzene, tetrachloroethylene, and/or trichloroethylene in accordance with Table 6.1.

6.2.3 LEL/O₂ and Methane Detectors

Air monitoring with the LEL/O₂ and methane detectors will be conducted during all drilling and excavation activities within bore holes, test pits, and immediately over drill cuttings at every 5-foot depth interval. If elevated (above background) LEL readings are observed, personnel must be advised of the potential explosive nature of the bore hole and must initiate the use of spark proof tools in accordance with Table 6.1. LEL readings in excess of 10 percent requires cessation of drilling activities or abandonment of the drilling location until readings subside.

6.2.4 Visual Observations

If airborne particulates are observed and air monitoring results warrant as indicated in Table 6.1, personnel must don air-purifying respirators equipped with organic vapor cartridges and high efficiency particulate air (HEPA) filters. If airborne particulates are observed due to intrusive activity at these sites, dust control measures will be implemented.

6.3 MODIFICATION OF AIR MONITORING REQUIREMENTS

The action levels and protection measures presented in Table 6.1 are based upon the assumption that the contaminants listed in Table 4.1 are the only contaminants which pose a reasonable health risk to site workers covered by this HSP. In the event that this assumption is found to be invalid through analysis of samples collected, or by some other means, the action levels will be modified as necessary.

6.4 INSTRUMENT MAINTENANCE AND CALIBRATION

Air monitoring instruments are maintained and prefield-calibrated at the HydroGeoLogic office in Herndon, Virginia. Field maintenance will consist of daily cleaning of the instruments using a damp towel or rag to wipe off the instrument's outer casing, overnight battery recharging, and cleaning or replacing of the lamp whenever calibration cannot be attained. Procedures for accomplishing instrument maintenance is contained in the PID User's Manual which will be provided with each instrument. The User's Manual provided with each instrument will be followed to field calibrate the instruments prior to each day of use under the environmental conditions (temperature and humidity) that sampling will occur. Field equipment will also be calibrated at the end of each day to account for instrument drift and reliability.

6.5 RECORDKEEPING

Instrument calibrations and readings will be recorded on the Air Monitoring Log Sheet provided in Section 14.1 of this HSP. Copies of these log sheets will be maintained on site until field activities covered by this HSP have been completed at which time the log sheets will be transmitted to the HydroGeoLogic HSO and to the project file.

LEL/O₂ and methane readings will not be recorded unless flammable/explosive or oxygen deficient/enriched atmospheres are detected in which case entries will be made in the field log book.

LEL/O₂, methane detector, and the PID will undergo daily operational checks. These checks will be recorded in the field log book and Equipment Calibration Log (Section 14.1).

**Table 6.1
Hazard Monitoring Methods, Action Levels,
and Protection Measures**

Hazard	Monitoring Method	Action Level	Protective Measures	Monitoring Schedule
Toxic Vapors (as identified in Table 4.1)	PID	0.0 to < 1.0 ppm above background based on judgement of SSO	Level D (see Table 7.1)	-continue with regular monitoring of breathing zone
		1.0 ppm above background based on judgement of SSO	Level D (see Table 7.1)	-confirm/deny reading with vinyl chloride and benzene colorimetric tubes. -if confirmed as vinyl chloride and/or benzene, then see vinyl chloride/benzene hazard identified below. -if denied as vinyl chloride and benzene, then continue with regular monitoring of breathing zone.
		≥ 1 ppm to < 25 ppm above background based on judgement of SSO (if denied as vinyl chloride and benzene)	Level D (see Table 7.1)	-confirm/deny reading with tetrachloroethylene and TCE colorimetric tubes. -if confirmed, then see hazard identified below.
		≥ 25 to < 250 ppm above background based on judgement of SSO (if denied as vinyl chloride, benzene, and tetrachloroethylene)	Level C (see Table 7.1)	-continue with regular monitoring of breathing zone. - contact HSO and Project Manager. - continue use of tubes, attempt to identify unknown air contaminants
Vinyl Chloride	Colorimetric Tubes	confirmed 1.0 ppm or greater above background based on judgement of SSO.	Level C (See Table 7.1)	-continue regular monitoring of breathing zone.
Benzene	Colorimetric Tubes	confirmed 1.0 ppm or greater above background based on judgement of SSO.	Level C (See Table 7.1)	-continue regular monitoring of breathing zone.
Tetrachloroethylene	Colorimetric Tubes	confirmed 25 ppm or greater above background based on judgement of SSO.	Level C (See Table 7.1)	-continue regular monitoring of breathing zone.
Trichloroethylene	Colorimetric Tubes	confirmed 50 ppm or greater above background based on judgement of SSO.	Level C (See Table 7.1)	-continue regular monitoring of breathing zone.

**Table 6.1 (Cont.)
Hazard Monitoring Methods, Action Levels,
and Protection Measures**

Hazard	Monitoring Method	Action Level	Protective Measures	Monitoring Schedule
Flammable/Explosive Gases and/or Vapors	LEL/O ₂ and Methane Detector	0.0 to 5.0 percent LEL	-notify sampling team of readings.	-prior to and during sampling activities, monitor all areas suspected of containing flammable/explosive gases and/or vapors.
		5.0 to < 10.0 percent LEL	-use spark proof equipment/tools	-continue with regular monitoring of breathing zone.
		> 10.0 percent LEL	STOP WORK, EVACUATE AREA, NOTIFY PROJECT MANAGER	-continue with regular monitoring of breathing zone. - notify HSO and Project Manager
Toxic Vapors (as identified in Table 4.1) (Cont.)	PID	≥ 250 above background based on judgement of SSO (if denied as all chemicals listed above)	STOP WORK, EVACUATE AREA, NOTIFY PROJECT MANAGER	-requires identification of new chemical hazard and HSP amendments.
Vinyl Chloride	Colorimetric Tubes	confirmed 10 ppm or greater above background based on judgement of SSO.	STOP WORK, EVACUATE AREA, NOTIFY PROJECT MANAGER	- requires HSP amendments
Benzene	Colorimetric Tubes	confirmed 25 ppm or greater above background based on judgement of SSO.	STOP WORK, EVACUATE AREA, NOTIFY PROJECT MANAGER	-requires HSP amendments.

Table 6.1 (Cont.)
Hazard Monitoring Methods, Action Levels,
and Protection Measures

Hazard	Monitoring Method	Action Level	Protective Measures	Monitoring Schedule
Tetrachloroethylene	Colorimetric Tubes	confirmed 250 ppm or greater above background based on judgement of SSO.	STOP WORK, EVACUATE AREA, NOTIFY PROJECT MANAGER	-requires HSP amendments.
Trichloroethylene	Colorimetric Tubes	confirmed 500 ppm or greater above background based on judgement of SSO.	STOP WORK, EVACUATE AREA, NOTIFY PROJECT MANAGER	- requires HSP amendments.

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7.0 PERSONAL PROTECTIVE EQUIPMENT (PPE)

This section presents requirements for the use of personal protective equipment (PPE) for each of the activities being conducted. This section includes anticipated levels of protection for each of the activities, the criteria used for selecting various levels of protection, and criteria for modifying levels of protection based on monitoring instrument readings and personal observations.

7.1 ANTICIPATED LEVELS OF PROTECTION

All work is anticipated to be performed in Level D protection, as defined in Appendix B of OSHA Standard 29 CFR 1910.120. Many activities may require the use of chemical resistant coveralls, gloves, and boot covers as presented in Table 7.1.

The items of PPE anticipated to be used for each activity are presented in Table 7.1. Where overlap in activities occur, the more protective requirement will apply.

Table 7.1
Protective Equipment for On-site Activities

Activity	Level	Protective Equipment
Test Pits MW Installation Groundwater Sampling Surface Soil Sampling Subsurface Soil Sampling	D	<ul style="list-style-type: none"> • Street clothes or overalls (long sleeves) • Impermeable safety boots/shoes (steel toed) • Safety glasses/goggles (if hazard to eyes exists) • Hard hat (if hazard to head exists) • Gloves (nitrile, neoprene)
	D (modified)	<ul style="list-style-type: none"> • Rubber boots; chemically-resistant with steel toe • Gloves (nitrile, neoprene) • Tape for sealing ankle and wrist openings • Hard hat (if hazard to head exists) • Safety glasses/goggles (if hazard to eyes exists) • Uncoated tyvek or equivalent
	C	<ul style="list-style-type: none"> • Coated tyvek or equivalent • Rubber boots; chemically-resistant with steel toe • Rubber boot covers • Latex inner gloves • Tape for sealing ankle and wrist openings • Chemical resistant outer gloves (nitrile, neoprene) • Full-face respirator (organic vapor cartridges) • Additional items may be required (site-specific)

7.2 PPE SELECTION CRITERIA

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Respiratory protection is not anticipated for use during the initial stages of work until detectability of site contaminants with air monitoring instruments warrants the donning of respirator protection in accordance with Table 6.1. See Section 7.3 for modification criteria of respiratory protection. Basic requirements of field personnel prior to using respiratory protection include:

- All field personnel will be medically certified to wear a full face respirator and have the proper fit test documentation within the past 12 months prior to assignment.
- Only NIOSH approved respirators are to be used on site. The respirators are to be properly cleaned, inspected, and maintained prior to and at the conclusion of the work day.
- Cartridges to air-purifying respirators will be disposed of at the end of each work day and when load-up or breakthrough occurs.
- Field personnel will be clean shaven in areas which might prevent the seal of the respirator to the face and contact lenses will not be permitted while wearing a respirator.

Hard hats, safety glasses, and steel-toe work boots were selected as minimum protection to reduce the potential for injury resulting from exposure to the physical hazards associated with onsite investigations.

Boot covers, disposable nitrile gloves, and Tyvek coveralls were selected to minimize contamination of work clothes and to prevent direct skin contact with low level contamination. Nitrile gloves of 11 millimeter thickness or greater were selected for activities that may involve direct contact with appreciable concentrations of contaminants thought to be present as site contaminants.

PVC or Saranex coveralls, hoods, and/or splash shields were selected to prevent saturation of work clothes during activities involving large volumes of liquids and/or saturated soils/equipment.

7.3 PPE MODIFICATION CRITERIA

This section presents criteria for upgrading and downgrading chemical protective clothing (CPC) and/or respiratory protection. Where uncertainties arise, the more protective requirement will apply.

7.3.1 CPC Modification Criteria

Tyvek coveralls and boot covers must be worn anytime there is a reasonable potential for contamination of street clothes.

Disposable nitrile gloves must be worn anytime there is a reasonable potential for contact with unsaturated soils or equipment which may contain trace contamination.

Nitrile gloves (11 mil or greater) must be worn anytime there is a reasonable potential for contact with groundwater, saturated soils, and/or soils producing elevated PID readings.

Polyvinyl chloride (PVC) or Saranex coveralls must be worn anytime there is a reasonable potential for saturation of work clothes.

7.3.2 Respiratory Protection Modification Criteria

Air-purifying respirators must be worn when both of the following criteria exist:

- If dusty conditions become evident and cannot be controlled via other methods (e.g., wetting down areas of concern).
- None of the following are observed (if any are observed, amendments must be made to the HSP before initiating work activities):
 - Elevated PID readings in the worker's breathing zone, including intermittent readings that persist for greater than 15 minutes, in accordance with Table 6.1.
 - Unknown chemical odors present in the work space, including intermittent odors that persist for greater than 15 minutes.
 - Worker complaints of adverse health effects that indicate possible overexposure.

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8.0 DECONTAMINATION

This section describes the steps site personnel will follow to prevent the spread of site contaminants into areas that may affect unprotected, unsuspecting site personnel or the public. It includes requirements for decontamination of personnel, sampling equipment, and augering/drilling equipment.

8.1 PERSONNEL DECONTAMINATION

The decontamination of personnel and their protective clothing will be performed within the decontamination zone. Table 8.1 presents the six stages for decontamination for Modified Level D protection.

Table 8.1
Six stages for Decontamination for Modified Level D Protection

Stage	Procedure
Stage 1: Segregated Equipment Drop	Deposit equipment used on site on plastic drop cloths or in assigned containers with plastic liners.
Stage 2: Boot Cover and Glove Wash	Scrub outer boot covers and gloves with decontamination solution, and rinse with water.
Stage 3: Tape Removal	Remove tape around boots and gloves and deposit in container with plastic liner.
Stage 4: Remove boots, gloves, and disposable clothing	Deposit in appropriate plastic-lined container. Discard disposable clothing.
Stage 5: Field wash	Wash hands and face with soap and water.
Stage 6: Redress	Put on clean clothes.

Wash tubs containing an appropriate decontamination solution and soft-bristle brushes will be used to wash reusable personal protective equipment and boots. Clean water will be used for the final rinse. The choice of decontamination solution is dependent upon the type of materials which must be removed from reuseable protective equipment. Based on the current understanding of potential site contaminants, a detergent and water solution is recommended for general purpose decontamination. Acceptable detergents include laboratory-grade cleaners (e.g., Alconox™, or equivalent), or a high strength consumer detergent such as Liquid Tide™.

Alternative decontamination solutions may be called for if the contaminants encountered are different or in a more concentrated state than anticipated. Alternative solutions include:

1. Dilute acids for removal of basic (caustic) compounds, amines, and hydrazines.
2. Dilute bases (soaps and detergents) for removal of acidic compounds, phenols, thiols and some nitro and sulfonic compounds.
3. Organic solvents for removal of nonpolar compounds (organic).

Gloves and other PPE should be inspected frequently for integrity, and manufacturer's expiration or breakthrough times should be considered if concentrated contaminants are encountered. 330282

The decontamination of personnel and their protective clothing will be performed in 18 stages for Level C protection, if necessary. The 18 stages are presented in Table 8.2 below.

Table 8.2
18 Stages for Decontamination in Level C Protection

Stage	Procedure
Stage 1: Segregated Equipment Drop	Deposit equipment used on site on plastic drop cloths or in different containers with plastic liners. Segregation at the drop reduces the probability of cross-contamination. During hot weather operations, a cool-down station may be set up within this area.
Stage 2: Boot Cover and Glove Wash	Scrub outer boot covers and gloves with decon solution of detergent and water.
Stage 3: Boot Cover and Glove Rinse	Rinse off decon solution from Stage 2 using copious amounts of water.
Stage 4: Tape Removal	Remove tape around boots and gloves and deposit in container with plastic liner.
Stage 5: Boot Cover Removal	Remove boot covers and deposit in container with plastic liner.
Stage 6: Outer Glove Removal	Remove outer gloves and deposit in container with plastic liner.
Stage 7: Suit, Glove, and Boot Wash	Wash splash suit, gloves, and safety boots. Scrub with long-handle scrub brush and decon solution.
Stage 8: Suit, Glove and Boot Rinse	Rinse off decon solution using water. Repeat as many times as necessary.
Stage 9: Canister or Mask Change	Perform last step in the decontamination procedure (if worker is leaving exclusion zone to change canister or mask). Worker's canister is exchanged, new outer gloves and boot covers donned, and joints taped; worker returns to duty.
Stage 10: Safety Boot Removal	Remove safety boots and deposit in container with plastic liner.
Stage 11: Splash Suit Removal	Remove splash suit with assistance of helper. Deposit in container with plastic liner.
Stage 12: Inner Glove Wash	Wash inner gloves with decon solution.
Stage 13: Inner Glove Rinse	Rinse inner gloves with water.

Table 8.2 (Cont.)
18 Stages for Decontamination in Level C Protection

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Stage	Procedure
Stage 14: Face Piece Removal	Remove face piece. Deposit in container with plastic liner. Avoid touching face with fingers. Note: Certain parts of contaminated respirators, such as the harness assembly and leather or cloth components are difficult to decontaminate. If grossly contaminated, they may need to be discarded. Rubber components can be soaked in soap and water and scrubbed with a brush. Use a final rinse of water and allow to air dry before using again. Inspect the respirator for damage and wear before and after each use.
Stage 15: Inner Glove Removal	Remove inner gloves and deposit in lined container.
Stage 16: Inner Clothing Removal	Remove clothing soaked with perspiration and place in lined container. Do not wear inner clothing off site since there is a possibility that small amounts of contaminants might have been transferred when removing the disposal coveralls.
Stage 17: Field Wash	Shower if highly toxic, skin-corrosive, or skin-absorbable materials are known or suspected to be present. Wash hands and face if shower is not available.
Stage 18: Redress	Put on clean clothes.

All decontamination fluids generated will be contained and disposed of as specified in the Work Plan. The decontamination area will be physically identified with rope or flagging and will be sufficiently equipped to be conducive for completion of the stages listed above.

8.1.1 Closure of the Personnel Decontamination Station

All disposable clothing and plastic sheeting used during the operation will be double-bagged and contained on site prior to removal to an approved off-site disposal facility as identified in the Work Plan. Decontamination and rinse solution will be contained on site prior to disposal. Reusable rubber clothing will be dried and prepared for future use. If contamination of non-disposable clothing has occurred, the item will be discarded. All wash tubs, pail containers, etc., will be thoroughly washed, rinsed, and dried prior to removal from the site.

8.1.2 Disposal of Decontamination and Other Wastes

All PPE, polyethylene sheeting and sampling support materials (e.g. paper towels, ziplock bags) will be collected at the end of each work day, placed in plastic trash bags and left at the site overnight. The following day, the air within the plastic trash bag will be tested using the PID. If the air within the bag does not show significant concentrations of organic vapors (greater than 10 ppm above background), the plastic trash bag will be double-bagged and placed in the municipal waste dumpster for disposal.

All other wastes generated during decontamination other than decontamination fluids will be placed into 55-gallon drums; the drums will be fully-opening with a top cover bung (type 17E/H) as identified in the FSP. The drums will be filled partially or completely, depending upon the difficulty of transporting them from the work site. All containers will be numbered and clearly labeled with the boring/well number and date of filling. The mixing of solid and liquid wastes will be avoided. The containers will be stored at a predesignated site for disposal after the analyses of the samples have been obtained.

8.2 EQUIPMENT DECONTAMINATION

All sampling equipment will be decontaminated prior to use, between sampling locations, and at the end of sampling activities to avoid cross-contamination, and to decrease personnel contact with contaminated materials and the probability of removing contamination from the site. The procedures for decontaminating equipment is presented in Section 5.10 of the FSP.

9.0 MEDICAL SURVEILLANCE

9.1 REQUIREMENTS FOR HYDROGEOLOGIC PERSONNEL

All employees involved in field activities will be active participants in the HydroGeoLogic medical surveillance program. All medical examinations and procedures will be performed by or under the supervision of a licensed occupational physician. The examination will include the tests, procedures, and frequencies which comply with the requirements of OSHA Standard 29 CFR 1910.120 (f) and American National Standards Institute (ANSI) Z-88.2 and will be medically qualified to perform hazardous waste site work under respiratory protection. Medical surveillance documents confirming the worker's fitness to perform hazardous waste operations on this project are on file at the HydroGeoLogic headquarters in Herndon, Virginia, and can be made available upon request.

9.2 REQUIREMENTS FOR SUBCONTRACTORS

Subcontractors are also required to obtain a certificate of their ability to perform hazardous waste operations work and to wear respiratory protection. Subcontractors, who have a company medical surveillance program meeting the requirements of the OSHA Standard 29 CFR 1910.120 (f) will be required to submit a letter, on company letterhead, confirming all on-site workers to be utilized for this project are medically qualified to perform the investigation activities. In addition, medical surveillance documents for personnel assigned to this project must be made available upon request.

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10.0 TRAINING REQUIREMENTS

10.1 INITIAL TRAINING

10.1.1 Requirements for HydroGeoLogic Personnel

All investigation personnel to be utilized are currently enrolled in the HydroGeoLogic continuous training program in accordance with OSHA Standard 29 CFR 1910.120. Individuals working on a site have successfully completed an approved 40-hour Hazardous Waste Site Operations (HAZWOPER) Course including 24-hours of actual field experience under the direction of a trained supervisor, and any subsequent annual 8-hour refresher courses. In addition, the on-site field leader will have completed an 8-hour supervisory course. In addition, a majority of HydroGeoLogic field investigation personnel are also current in first aid/CPR training requirements. HydroGeoLogic employee records are on file in the employee's home office in Herndon, Virginia.

10.1.2 Requirements for Subcontractors

All HydroGeoLogic subcontractor personnel must also have completed 40 hours HAZWOPER training course or equivalent work experience as defined in OSHA Standard 29 CFR 1910.120(e) prior to performing work at the site. In addition, subcontractor personnel must also have successfully completed any subsequent annual 8-hour refresher training.

HydroGeoLogic subcontractors must certify that each subcontractor employee, who will perform work at the site, has had training meeting the requirements of OSHA Standard 29 CFR 1910.120(e). This certification can be accomplished by submitting a letter to HydroGeoLogic, on company letterhead, containing such information.

10.1.3 Requirements for Site Visitors

No person will be allowed in the work zones (exclusion and decontamination) unless they have completed the necessary health and safety training as required by OSHA Standard 29 CFR 1910.120(e) and are wearing the necessary protective equipment as required by this HSP.

10.2 SITE-SPECIFIC TRAINING

HydroGeoLogic will provide site-specific training to all HydroGeoLogic employees and subcontractor personnel who will perform work at the site. Daily health and safety meetings will be held prior to beginning field activities to discuss each day's activities, potential hazards, and any new health and safety issues not previously discussed. Any personnel who does not participate in training will not be permitted to perform work at the site. Site-specific training will include:

- The contents of the HSP.
- Names of personnel and alternates responsible for site health and safety.

- Safety, health, and other hazards present on the site.
- Use of personal protective equipment.
- Work practices by which the employees can minimize risks from hazards.
- Safe use of engineering controls and equipment on the site.
- Medical surveillance requirements, including recognition of symptoms and signs which might indicate overexposure to hazards.
- Decontamination procedures.
- Emergency response procedures.

HydroGeoLogic and subcontractor personnel will be required to sign a statement indicating receipt of site-specific training and understanding of site hazards and control measures. This form is presented in Section 14.1.

11.0 STANDARD WORK PRACTICES

All site investigation activities will follow these appropriate Health and Safety Standard Work Practices.

11.1 GENERAL REQUIREMENTS/PROHIBITIONS

- A copy of this HSP will be available on-site for all field personnel, including visitors, to reference during investigation activities.
- No running or horseplay.
- Eating, drinking, chewing gum or tobacco, taking medication, applying cosmetics, and/or smoking are prohibited in the exclusion and decontamination zones, or any location where a possibility for contact with site contaminants exists.
- The required level of PPE must be worn by all on site personnel to include at a minimum steel-toed safety boots, safety glasses, and hard hat, if necessary.
- Upon leaving the exclusion zone, hands and face must be thoroughly washed. Any protective outer clothing is to be decontaminated and removed as specified in this HSP, and left at a designated area prior to entering the clean area.
- Contact with potentially contaminated substances must be avoided. Contact with the ground or with contaminated equipment must also be avoided. Air monitoring equipment must not be placed on potentially contaminated surfaces.
- No facial hair, which interferes with a satisfactory fit of the mask-to-face seal, is permitted on personnel required to wear respiratory protective equipment.
- All personnel must satisfy medical monitoring procedures.
- No flames or open fires will be permitted on site.
- All personnel must be aware of and follow the action levels presented in this HSP for upgrading respiratory protection.
- Any new analytical data must be promptly conveyed via telephone to the project HSO by the laboratory technician or field leader.
- Personnel must develop hand signals with users of heavy equipment (i.e., drillers, geoprobe operators, etc.). Standard hand signals to be used by personnel for nonverbal communication include:

Stop With arm extended to the side and palm down, hold position rigidly.

Hoist	With forearm and forefinger pointing up, move hand in small circle.
Lower	With forearm extended and forefinger pointing down, move hand in a small horizontal circle.
Travel	With palm up, fingers closed, and thumb pointing in the direction of motion, jerk hand horizontally.
Slow Move	Use one hand to give any motion signal, and place the other hand motionless in front of the hand giving the motion signal.
Emergency Stop	With arm extended to the side and palm down, move hand rapidly right and left.

Standard hand signals will be discussed during each daily health and safety meeting when the use of heavy equipment is anticipated.

- A copy of the OSHA "Job Safety and Health Protection" poster must be prominently posted at each site.
- Only equipment which has been approved by the manufacturer may be used in conjunction with site equipment.
- Medicine and alcohol can potentiate the effects from exposure to toxic chemicals. Prescribed drugs should not be taken by personnel on operations where the potential for absorption, inhalation, or ingestion of toxic substances exists unless specifically approved by a qualified physician. Alcoholic beverage intake will not be allowed at anytime, including during breaks.
- No person will enter the exclusion zone alone.
- Safety devices on equipment must be left intact and used as designed.
- Equipment and tools will be kept clean and in good repair and used only for their intended purpose.
- Eye protection must be worn when any hammering or pounding is performed that may product flying particles or slivers.
- Field personnel are not allowed to lift more than 60 pounds. Rules to remember when attempting to lift heavy objects include:
 - Size up the load before trying to lift it, test the weight and get help if needed
 - Bend the knees and look up to keep the neck and back straight
 - Do not twist or turn your body once you have made the lift
 - Make sure you can carry the load where you need to go before lifting it
 - Set the load down properly, lower slowly by bending the knees
 - Always push, not pull, the object when possible

- Heavy lifting (more than 60 pounds per worker) must be accomplished using mechanical lifting equipment. Mechanical lifting equipment that will be available on site will include forklifts, hoists, dollies, backhoe/tracker and other types of equipment that can be easily rented from an off-site location.
- Leather gloves must be worn when handling objects that may produce splinters (e.g., driving wood stakes, handling drill rods/augers).
- No person shall climb the drill mast without the use of ANSI approved fall protection (i.e., approved belts, lanyards, and a fall protection slide rail) or portable ladder which meets the requirements of OSHA standards.
- The SSO must make an entry into the site field logbook at least daily, to include:
 - Weather conditions
 - Site Personnel
 - New arrivals and their clearance for site work
 - Air monitoring data summary
 - Monitoring instrument calibration
 - Indications of inhalation exposure
 - PPE used per task
 - Deviations from HSP
 - Inspection and cleaning of respiratory equipment
 - General health and safety problems/corrective actions
- If personnel note any warning properties of chemicals (irritation, odors, symptoms, etc.) or even remotely suspect the occurrence of exposure, they must immediately notify the SSO for further direction.

11.2 DRILLING ACTIVITIES

Prior to the commencement of drilling activities, all locations will be surveyed and marked for underground utilities. In addition, a hand auger or probe will be used to a depth of three feet to assure the absence of underground utilities at the location of interest. If any uncertainties exist, the location will be moved to an adjacent area.

The following general drilling practices must be adhered to during investigation activities:

- All drilling equipment (i.e., rigging, derrick, hoists, augers, etc.) must be inspected by the drilling crew and SSO prior to starting work. Defective equipment will be removed from service and replaced.
- No drilling within 20 feet in any direction of overhead power lines will be permitted. The locations of all underground utilities must be identified and marked prior to initiating any subsurface activities.

- All drill rigs and other machinery with exposed moving parts must be equipped with an operational emergency stop device. Drillers and geologists must be aware of the location of this device. This device must be tested prior to job initiation, and periodically thereafter. The driller and helper shall not simultaneously handle moving augers or flights unless there is a standby person to activate the emergency stop.
- Prior to raising the mast, the drill rig operator shall ensure that the proper stabilization measures have been taken. The drill rig shall not be moved while the mast is in the raised position.
- The driller must never leave the controls while the tools are rotating unless all personnel are clear of the rotating equipment.
- Drillers must wear hearing protection unless the employer can provide documentation that noise exposures are less than a dose of 50 percent as required by OSHA Standard 29 CFR 1910.95.
- Drilling activities shall immediately cease when inclement weather (e.g., heavy rains, lightning) and high winds occurs at the site. All site personnel should immediately seek shelter.
- To maintain a clean operation, drill cuttings shall be promptly containerized as they are generated. A long-handled shovel or equivalent must be used to clear drill cuttings away from the hole and from rotating tools. Hands and/or feet are not to be used for this purpose.
- A remote sampling device must be used to sample drill cuttings if the tools are rotating. Samplers must not reach into or near the rotating equipment. If personnel must work near any tools, which could rotate, the driller must shut down the rig prior to initiating such work.
- Drillers, helpers, and samplers must secure all loose clothing when in the vicinity of drilling operations.
- Only equipment that has been approved by the manufacturer may be used in conjunction with site equipment and specifically to attach sections of drilling tools together. Pins that protrude from augers shall not be allowed.

A variety of additional work practices (i.e., hoisting, cat line, pipe and auger handling, etc.) are to be adhered to by the drilling crew, which will not be addressed in this HSP. If the on-site field team leader or site supervisor observe any operations or actions that are perceived as threatening to the health and safety of site personnel, drilling operations will be temporarily suspended until a mutual understand of the action(s) in question are addressed and/or corrected.

Soil borings have the potential for releases to the environment and exposure to personnel. Gases and vapors that have a vapor density less than 1.0 are lighter-than-air and tend to migrate upward

in the atmosphere and disperse (i.e., methane). Heavier-than-air gases and vapors tend to stay close to the ground and may migrate to low-lying areas (i.e., hydrogen sulfide). In general, the only containment that can be done for a release to the air is termination of the release at the source, i.e., plug the boring. Depending on the contaminant encountered, it may be necessary to evacuate persons downwind of the area of the release. Emergency response personnel should be notified (Section 13.6) if air concentrations at the perimeter of the exclusion zone exceed threshold limit values (TLVs) or Permissible Exposure Levels (PELs).

11.3 TEST PITS

- Before a sample is collected, the backhoe bucket must be resting on level ground; the sampling person will then make eye contact with the operator, who will use hand signals to notify the sampler it is safe to approach the bucket. No personnel, under any circumstances, will enter a test pit. Personnel must use remote sampling equipment to collect samples from test pits or collect the samples from the backhoe bucket.
- No sampling of drums is to occur during test pit operations without prior approval and written procedures from the HSO.
- Personnel must stand a minimum of two feet from the edge of any test pit and are prohibited from leaning over the edge of any test pits. Unstable pits must be sloped at the sides to prevent cave-ins. Equipment and excavated soil should be kept at least four feet away from the edge of the excavation. The SSO may increase these distances if noncohesive soils (sands and gravels) are encountered.
- Equipment operators will be advised during the daily safety meeting of each worker who will be in the immediate vicinity during excavation of test pits, and the operators will be responsible for visual verification of workers locations before moving equipment.
- Personnel must develop hand signals with the backhoe operator prior to digging.
- If for any reason a pit must be left unattended during working hours, access will be restricted using a visible physical barricade around the workzone and plywood sheeting or equivalent to securely cover the test pit opening. No pits will be left open and unattended overnight under any circumstances without the approval of the COR.
- The backhoe operator will not undermine the excavation.
- Personnel must stand upwind from the test pits and away from the reach of the backhoe, tires, and outrigging.
- The SSO will inspect the test pits for slide or cave-in potential on several occasions during the excavation.
- Test pits will not be left open and unguarded overnight - at the end of each day, any open pit must be completely surrounded by protective fencing.

- Excavation of test pits may results in an unexpected release to the atmosphere.

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Excavations have the potential for release to the atmosphere. Gases and vapors may be lighter-than-air or heavier-than-air. In general, the only containment that can be done for a release to the air is termination of the release at the source, i.e., cover the excavated area with soil. Depending on the nature of the release, it may be necessary to evacuate persons downwind of the area of the release. Emergency response personnel should be notified (Section 13.6) if air concentrations at the perimeter of the exclusion zone exceed TLVs or PELs.

11.4 HOUSEKEEPING

Housekeeping is a very important aspect of an investigation program and will be strongly stressed in all aspects of field work. Good housekeeping plays a key role in occupational health protection and is a way of preventing dispersion of dangerous contaminants. All work areas will be kept as clean as possible at all time and spills will be cleaned up immediately. Housekeeping will be the responsibility of all employees.

HydroGeoLogic will implement a housekeeping program for the field activities to minimize the spread of contamination beyond the work site. The program will include:

- Daily scheduling to police the area of debris including paper products, cans, and other materials brought on site.
- Changing of wash and rinse water for hands, face, and equipment as needed.
- Periodic (daily minimum) removal of all garbage bags and containers used to dispose of food products, plastic inner gloves, and contaminated disposable clothing.

11.5 WORK LIMITATIONS

All investigation activities will be performed during normal daylight hours.

11.6 CONFINED SPACE ENTRY

Site personnel are not to undertake any activity which could be considered a confined-space entry.

11.7 SPILL CONTAINMENT

The procedures defined in this section comprise the spill containment activities in place at the site.

- All drums and containers used during the clean-up will meet the appropriate Department of Transportation (DOT), OSHA, and EPA regulators for the waste that they will contain.
- Drums and containers will be inspected and their integrity assured prior to being moved. Drums or containers that cannot be inspected before being moved because of storage

conditions, will be positioned in an accessible location and inspected prior to further handling.

- Operations on site will be organized so as to minimize the amount of drum or container movement.
- Employees involved in the drum or container operations will be warned of the hazards associated with the containers.
- Where spills, leaks, or ruptures may occur, adequate quantities of spill containment equipment (absorbent, pillows, etc.) will be stationed in the immediate area. The spill containment program must be sufficient to contain and isolate the entire volume of hazardous substances being transferred.
- Drums or containers that cannot be moved without failure, will be emptied into a sound container.
- Fire extinguishing equipment meeting 29 CFR Part 1910. Subpart 1 shall be on hand and ready for use to control fires.

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12.0 SITE CONTROL

12.1 WORK ZONES

Each investigation location will be physically barricaded with rope flagging or caution tape to control entry and exit into and from the area. These barricaded areas will be referred to as the exclusion zones. The exclusion zone will be identified by the site supervisor and consist of a twenty foot radius surrounding the drilling or test pit location. Each person leaving an exclusion zone will proceed directly to the decontamination zone which will be located adjacent to the exclusion zone and also identified by physical barriers. The decontamination zone will consist of a low-lying area covered with a plastic sheeting. At the completion of decontamination procedures at each location, the debris will be enclosed in the plastic sheeting and deposited into 55-gallon type 17 E/H drums for later disposal as identified in the Work Plan and Field Sampling Plan. Only personnel who are cleared by the HydroGeoLogic field leader and SSO will be permitted in the exclusion zones and/or decontamination zones. Clearance for accessing these areas will only be given to personnel who meet the training and medical surveillance requirements of OSHA Standard 29 CFR 1910.120 and are wearing the appropriate PPE required for the work activity.

The support zone, where the administrative, communications, and other support services will be based, will be in a controlled area off the site or on the far end away from site contamination or areas of potential exposure. Only persons and equipment that are free of contamination will be permitted in the support zone.

12.2 ON-SITE/OFF-SITE COMMUNICATIONS

Communications will consist of a centrally located telephone within the designated support zone (i.e., trailer, office) in addition to a mobile phone stationed within the on-site vehicle utilized for transportation. Field personnel may also utilize telephones located at NAS Fort Worth JRB in emergency situations.

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13.0 EMERGENCY RESPONSE

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This HSP has been developed in an attempt to prevent the occurrence of situations that may jeopardize the health and safety of on-site personnel. However, supplemental emergency procedures must be identified in the event that an unforeseen health and safety accident or incident occurs. In general, HydroGeoLogic will evacuate their employees and subcontractors from the workplace if an emergency involving chemical spills, chemical fires, chemical exposure, and/or chemical emissions occurs. For this reason, Emergency Response planning will be in accordance with OSHA Standard 29 CFR 1910.38(a).

13.1 PREPLANNING

Upon initial arrival at the site, the HydroGeoLogic field leader and SSO will visit the AFB's fire department to determine the status of emergency response services. This meeting will include a determination as to the need for further coordination with local rescue and police services.

Another aspect of preplanning for emergencies includes completion of the medical data sheet (Section 14.1). This sheet must be completed by all HydroGeoLogic personnel and subcontractors so that, in the event of personal injury or illness, the examining physician has background information readily available on the injured/ill party.

13.2 EMERGENCY PROCEDURES AND ASSIGNMENTS

Upon notification of a site emergency requiring evacuation, all HydroGeoLogic personnel and subcontractors will proceed directly to the support zone (i.e., trailer, office). If personnel cannot reach the support zone without endangering life or health, an alternate meeting point will be specified by the HydroGeoLogic SSO. Emergency egress routes and meeting points will be discussed at each daily health and safety briefing.

In the event of an emergency, the following procedures will be implemented:

- The site supervisor will evaluate the incident, assess the need for assistance, and call the appropriate contacts, if necessary.
- The site supervisor will act as the point of contact for outside emergency personnel and on site personnel.
- The site supervisor will advise emergency response and emergency room personnel to the types of contamination potentially contacted by injured workers receiving emergency care.
- The site supervisor will ensure that the SSO promptly notifies the HydroGeoLogic PM and HSO of the incident.

13.2.1 Chemical Inhalation

It is not anticipated that chemicals of concern are present at the site in concentrations to cause immediate danger to life and health. However, any field personnel exhibiting or complaining of symptoms of chemical exposure as described in Section 4.1 will be removed from the work zone and transported to the designated medical facility for examination and treatment.

13.2.2 Eye and Skin Contact

Field personnel who have come into contact with contaminants while in the exclusion zone will immediately proceed to the decontamination zone, where an eyewash station will be located. Do not decontaminate prior to using the eyewash. Remove necessary PPE to perform the eyewash procedures. Flush the eye with the clean water for at least 15 minutes and arrange for prompt transport to the designated medical facility.

Unless skin contact with contaminants is severe proceed through the decontamination zone. Field personnel should remove any contaminated PPE and wash the affected area for at least 15 minutes. If the personnel show signs of skin irritation, they will be transported to the designated facility.

13.3 PROCEDURES FOR PERSONNEL REMAINING ON SITE

No HydroGeoLogic or subcontractor personnel will remain on site to operate critical site emergency operations.

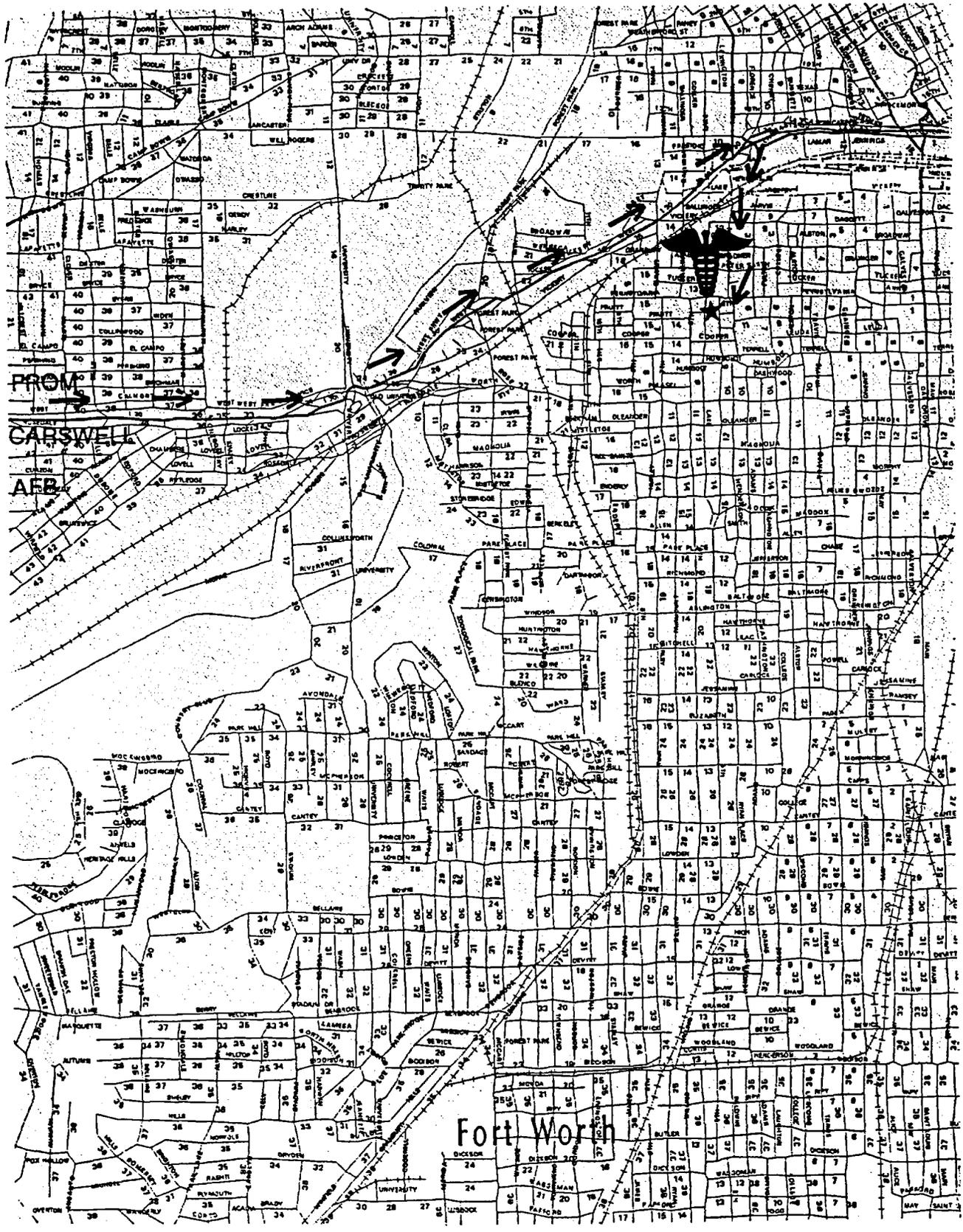
13.4 PROCEDURES TO ACCOUNT FOR SITE PERSONNEL

The HydroGeoLogic and subcontractor work force will be small enough so that accounting for site personnel will not be a problem. The HydroGeoLogic field leader and SSO will ensure that the whereabouts of all personnel are known.

13.5 RESCUE AND MEDICAL DUTIES

Only those persons who have been trained by the American Red Cross, or equivalent, will be permitted to perform rescue, first aid, and/or CPR treatment. Outside emergency services and medical facilities will be the primary providers of such services. At least one person who is currently certified in first aid and CPR will be on-site at all times during field activities. A “physicians approved” first aid kit, an ANSI approved eye wash station, and a Class ABC fire extinguisher will be readily available on site.

Any HydroGeoLogic employee who shows signs of symptoms of overexposure must immediately be examined by a licensed physician. Subcontractor personnel who show signs or symptoms of overexposure will be encouraged to visit a licensed physician as well. Figure 13.1 describes the directions to the nearest medical facility.



Legend

-  HOSPITAL
- 
-  ROUTE TO HOSPITAL

 N

Figure 13.1
Nearest Medical Facility
to NAS Fort Worth JRB

13.6 EMERGENCY COMMUNICATION PROCEDURES, CONTACTS AND PHONE NUMBERS

Persons who observe an emergency situation must immediately notify the HydroGeoLogic field leader and/or SSO. The field leader or SSO will then immediately assess the emergency and appoint someone to telephone appropriate outside emergency services and will coordinate site evacuation. Emergency telephone numbers and directions to the nearest medical facility are included as Table 13.1, a copy of which will be posted at the nearest telephone. In addition, Figure 13.1 illustrates the directions to the nearest medical facility.

13.7 ACCIDENT/INCIDENT FOLLOW-UP AND REPORTING

On receiving a report of incident (or near-incident) occurrence the SSO shall immediately investigate the circumstances and shall make appropriate recommendations to prevent recurrence. The HSO shall also be immediately notified by telephone on occurrence of a serious accident or incident. At his discretion, he may also participate in the investigation.

Details of the incident shall be documented on the Accident/Incident Report form (Section 14.1) within 24 hours of the incident and shall be distributed to the Project Manager, HSO and COR. A copy of this report shall also be sent to the appropriate administrative contact for inclusion into the OSHA Form 101 and 200 log. Incident report forms will be available at the site support facilities.

Table 13.1
Emergency Telephone Numbers, Contacts, and
Directions to Nearest Medical Facility

Key Personnel	Number
James Costello - Project Manager	(703) 736-4507
Christopher Spill - Health and Safety Officer	(703) 736-4529
William Max - CIH (Law Engineering)	(770) 499-6850
John Robertson - Executive Vice President	(703) 736-4560
Alan Flolo - Base Point of Contact (AFBCA)	(817) 731-8973 ext 18
Joseph Dunkle - AFCEE/ERD Contracting Officer's Representative	(210) 536-5290
Emergency Phones Numbers	
Ambulance -	911 or (817) 922-3150
Fire Department -	911 or (817) 246-1741
Poison Control	911 or (800) 441-0040
Hospital - Harris Methodist - Fort Worth 1301 Pennsylvania Avenue	911 or (817) 882-2000
Directions to Nearest Medical Facility (Figure 13.1)	
Exit NAS Fort Worth JRB south toward the East-West Freeway (Interstate 30). Follow signs for I-30 East. Follow I-30 for approximately 7 miles to the exit for Henderson Street. At Henderson Street turn left (south). Follow to Pennsylvania Avenue and turn right (west). Follow one block and turn left (south) onto Fifth Avenue. Emergency entrance is located on the right.	

14.0 DOCUMENTATION AND EQUIPMENT

This section summarizes the documentation and equipment needs for the project as specified in the HSP. Its purpose is to serve as a partial checklist to help ensure all of the necessary resources are available to carry out the requirements of the HSP.

14.1 DOCUMENTATION AND FORMS

The following documents are presented in the following pages for use during site operations:

- Site Safety Briefing Forms
- HSP Compliance Agreement Forms
- HSP Amendments Forms
- Accident/Incident Report Forms
- Personnel Medical Data Sheets
- Equipment Calibration Logs
- Air Monitoring Logs

In addition, the following documentation will be present on-site during site operations:

- Approved HSP (Signed copy)
- OSHA poster
- MSDSs
- Employee training and medical surveillance certificates
- Subcontractor training and medical surveillance certificates

14.2 EMERGENCY, HEALTH AND SAFETY EQUIPMENT

- First aid kit
- Eye wash
- Inner latex or vinyl gloves
- Outer nitrile gloves (disposable and 11 millimeter thickness)
- Boot covers
- Hard hats and safety glasses
- Tyvek
- PVC and/or Saranex (with hoods)
- Decontamination kit
- Fire extinguisher
- Fall protection devices (body harness and lanyard)
- Duct tape
- LEL/O₂ meter
- Methane Detector
- PID

The site supervisor and/or site safety officer shall be responsible for maintaining first aid kits and fire extinguishers at each site where field activities are taking place. The location of first aid kits and fire extinguishers will be discussed during each daily health and safety meeting. 330304

15.0 REFERENCES

Federal Acquisition Regulation, FAR Clause 52.236-13: Accident Prevention.

NIOSH/OSHA/USCG/EPA, "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities," October 1985. (DHHS (NIOSH) Publication No. 85-115); EPA "Standard Operating Safety Guides," June 1992. (NTIS Publication No. 9285.1-03).

Occupational Safety and Health Administration (OSHA) General Industry Standards, 29 CFR 1910, and Construction Industry Standards, 29 CFR 1926; especially 29 CFR 1910.120/29 CFR 1926.65, "Hazardous Waste Site Operations and Emergency Response."

U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health (NIOSH), Pocket Guide to Chemical Hazards, June 1994.

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SITE SAFETY BRIEFING FORM

Project _____
Date _____ Time _____ Job No. _____
Location _____
Type of Work _____

SAFETY TOPICS PRESENTED

Protective Clothing/Equipment _____

Chemical Hazards _____

Physical Hazards _____

Emergency Procedures _____

Hospital/Clinic _____ Phone _____
Hospital Address _____
Special Equipment _____

Other _____

ATTENDEES

Name (Printed)

Signature

_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Meeting Conducted by: _____

Site Safety Officer: _____

HEALTH AND SAFETY PLAN
COMPLIANCE AGREEMENT FORM

PROJECT: RCRA Facility Investigations
CLIENT: U.S. Air Force Center for Environmental Excellence
LOCATION: NAS Fort Worth JRB, Carswell Field, Texas
PROJECT NO: AFC001-0005

I, _____, have received a copy of the Health and Safety Plan for the above-referenced project. I have read the plan, understand it, and agree to comply with all its provisions. I understand that I can be prohibited from working on the project for violating any of the safety requirements specified in the plan.

Signed:

Signature

Date

Company

HEALTH AND SAFETY PLAN AMENDMENTS FORM

Change in field activities or hazards: _____

Proposed Amendments: _____

Proposed by: _____ Date: _____

Approved by: _____

Accented: _____ Declined: _____ Date: _____

Amendment Number: _____

Amendment Effective Date: _____

330310

HYDROGEOLOGIC, INC.
Accident/Incident/Near Miss Investigation Form

Employee's Name: _____
Address: _____
SS# _____
Job Title: _____ Supervisor's Name: _____
Office Location: _____
Location at Time of Incident: _____
Date/Time of Incident: _____

Describe clearly how the accident occurred: _____

Was incident: Physical _____ Chemical _____
Parts of body affected _____ Exposure: Dermal _____
right left Inhalation _____
Ingestion _____

Witnesses: 1) _____ 2) _____

Conditions/acts contributing to this incident _____

Managers must complete this section:
Explain specifically the corrective action you have taken to prevent a recurrence: _____

Did injured go to doctor: _____ Where: _____
When: _____
Did injured go to hospital: _____ Where: _____
When: _____

Signatures:

Employee Reporting Manager Health & Safety Officer

Date Date Date

Accidents must be reported immediately; this form must be completed and returned to the Health and Safety Officer within **24 hours**.

MEDICAL DATA SHEET

This brief Medical Data Sheet will be completed by all onsite personnel and will be kept in the command post during the conduct of site operations. This data sheet will accompany any personnel when medical assistance is needed or if transport to hospital facilities is required.

Project _____

Name _____ Home Telephone _____

Address _____

Age _____ Height _____ Weight _____

Name of Next of Kin _____

Drug or other Allergies _____

Particular Sensitivities _____

Do You Wear Contacts? _____

Provide a Checklist of Previous Illnesses or Exposure to Hazardous Chemicals.

What medications are you presently using? _____

Do you have any medical restrictions? _____

Name, Address, and Phone Number of personal physician: _____

I am the individual described above. I have read and understand this HSP:

Signature

Date

Project _____

HEALTH AND SAFETY/AIR MONITORING LOG

Date: _____ Logged by: _____

Weather: _____

Field Tasks: _____

HydroGeoLogic Personnel (or subs) working on the site (name and affiliation):

HydroGeoLogic Personnel (or subs) working in restricted zone:

HydroGeoLogic Site Visitors:

Air Quality Monitoring Measurements:

<u>Time</u>	<u>Instrument</u>	<u>Parameter</u>	<u>Concentration</u>	<u>Locations</u>
-------------	-------------------	------------------	----------------------	------------------

Background:

Exclusion zone:

Level of PPE: _____

Comments on other safety-related matters:

(including infractions, accidents, injuries, unusual occurrences, physical complaints)

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APPENDIX A

**GROUNDWATER ANALYTICAL RESULTS
JANUARY 1996 QUARTERLY SAMPLING EVENT**

Table A.1 (continued)
 Groundwater Analytical Results
 January 1996 Quarterly Sampling Event
 Law Environmental, Inc.
 NAS Fort Worth JRB, Texas

Parameter ¹	Background Level ²	TNRCC RRS # ³	MW-10 01/15/96	MW-11 01/10/96	MW-12 01/10/96	MW-5 01/15/96	MW-7 01/10/96	MW-8 01/10/96	MW-9 1/10/96	OT-15C 01/12/96	SD13-01 01/15/96	SD13-02 01/11/96	SD13-03 01/11/96	SD13-05 01/12/96	SD13-06 01/12/96	ST14-01 01/11/96	ST14-02 1/13/96	ST14-03 01/12/96	
Ethylbenzene	ND	700	3670	-	-	16.4	-	-	-	-	-	-	-	-	-	-	-	-	-
Xylenes	ND	NA	10300	-	-	2.78	-	-	-	-	-	-	-	-	-	-	-	-	-
Dimethyl Phthalate	ND	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
o-cresol	ND	1830	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
p-cresol	ND	1830	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2-Methylnaphthalene	ND	NA	59.5 JQ	-	-	-	-	-	-	-	13.3	-	-	-	-	-	-	-	-
Naphthalene	ND	1460	598	-	-	7.25 JB	-	-	-	-	1.99 JB	-	1.73 JQ	-	-	-	-	-	-
cis-1,2-Dichloroethene	ND	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	ND	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tetrachloroethene	ND	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trichloroethene	ND	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vinyl Chloride	ND	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Butylbenzyl Phthalate	ND	-	29.4 JQ	1.33 JQ	1.43 JQ	-	2.29 JQ	4.36 JQ	-	15.4	-	-	15.3	7.09 JQ	6.86 JQ	23.0	3.48 JQ	2.96 JQ	-
1,2-Dichlorobenzene	ND	600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bis(2-ethylhexyl) phthalate	ND	6.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isophorone	ND	NA	-	-	-	-	-	-	-	-	-	-	12.9	-	-	-	-	-	-
Phenol	ND	2190	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,1-Dichloroethane	ND	3650	-	-	-	-	-	-	0.517	-	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	ND	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Di-n-Butylphthalate	ND	3650	-	-	-	-	-	-	-	-	-	-	-	0.96 JQ	-	-	-	-	-
Acenaphthalene	ND	3650	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fluorene	ND	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phenanthrene	ND	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dibenzofuran	ND	NA	-	-	-	-	-	-	-	-	-	-	1.52 JQ	-	-	-	-	-	-
Benz[ghi]anthracene	ND	NA	-	-	-	-	-	-	-	-	-	-	-	1.23 JQ	-	-	-	-	-

Parameter ¹	Background Level ²	TNRCC RRS #2 ³	USGS03T 01/10/96	USGS04T 01/11/96	USGS06T 01/14/96	USGS07T 01/13/96	WP07-10B 01/15/96	WP07-10C 01/15/96
<i>Inorganics (mg/L)</i>								
Aluminum	1.332	NA	17.8	12.1	1.35	-	-	-
Arsenic	ND at 0.0049	0.05	-	0.0015	-	-	-	0.0254
Barium	0.587	2	0.186	0.075	0.077	0.132	0.094	0.124
Beryllium	0.0003	0.004	-	-	-	10.1	-	-
Calcium	266.3	NA	247	216	183	329	145	155
Chromium	0.006	0.1	-	-	-	-	-	-
Cobalt	ND at 0.0089	NA	-	-	-	-	-	-
Copper	0.0028	NA	-	0.050	-	-	-	-
Iron	0.2239	NA	44.1	69.1	3.48	12.9	0.723	8.98
Lead	ND at 0.0016	0.015	0.0254	0.0148	-	0.0072	-	-
Magnesium	37.8	NA	14.7	14.6	4.79	8.39	5.91	11.1
Manganese	0.175	NA	2.2	3.02	0.242	0.758	0.063	0.518
Mercury	ND at 0.0001	2	-	-	-	-	-	-
Molybdenum	ND at 0.0144	NA	-	-	-	41.4	-	-
Nickel	0.0204	0.1	-	-	-	-	-	-
Potassium	15.03	NA	5.83	7.67	1.40	3.09	1.23	2.32
Sodium	167.2	NA	33.8	33.6	14.4	-	16.9	43.5
Vanadium	0.123	NA	0.076	0.103	-	-	-	-
Zinc	0.118	NA	0.108	0.067	-	0.027	-	-
<i>Organics (µg/L)</i>								
Bromodichloro-methane	ND	100	-	-	-	-	-	-
Benzene	ND	5	-	-	-	-	-	-
Chlorobenzene	ND	100	-	-	-	-	-	-
Dibromochloro-methane	ND	100	-	-	-	-	-	-
Chloroform	ND	100	-	-	-	0.369 IQ	-	-
Toluene	ND	1000	-	-	-	-	-	-
1,2-Dichloroethane-D4	-	-	-	-	-	-	-	-
Ethylbenzene	ND	700	-	-	-	-	-	-

Parameter ¹	Background Level ²	TNRCC RRS #2 ³	USGS03T 01/10/96	USGS04T 01/11/96	USGS06T 01/14/96	USGS07T 01/13/96	WP07-10B 01/15/96	WP07-10C 01/15/96
Xylenes	ND	NA	-	-	-	-	-	-
Dimethyl Phthalate	ND	NA	-	-	-	-	-	-
o-cresol	ND	1830	-	-	-	-	-	-
p-cresol	ND	1830	-	-	-	-	-	-
2-Methylnaphthalene	ND	NA	-	-	-	-	-	-
Naphthalene	ND	1460	-	-	-	-	-	-
cis-1,2-Dichloroethene	ND	70	-	-	0.509	0.41 JQ	268	193
trans-1,2-Dichloroethene	ND	100	-	-	-	-	-	-
Tetrachloroethene	ND	5	-	-	-	0.18 JQ	-	-
Trichloroethene	ND	5	-	-	10.5	0.718	2550	761
Vinyl Chloride	ND	2	-	-	-	-	-	-
Burylbenzyl Phthalate	ND	-	-	2.8 JQ	-	-	-	41.1
1,2-Dichlorobenzene	ND	600	-	-	-	-	-	-
Bis(2-ethylhexyl) phthalate	ND	6.08	-	-	-	-	-	14.9
Isophorone	ND	NA	-	-	-	-	-	-
Phenol	ND	2190	-	-	-	-	-	-
1,1,-Dichloroethane	ND	3650	-	-	-	0.254 JQ	-	-
1,1-Dichloroethene	ND	7	-	-	-	0.575	-	-
Di-n-Burylphthalate	ND	3650	-	-	-	-	-	-
Acenaphthalene	ND	3650	-	-	-	-	-	-
Fluorene	ND	NA	-	-	-	-	-	-
Phenanthrene	ND	NA	-	-	-	-	-	-
Dibenzofuran	ND	NA	-	-	-	-	-	-
Benz[a]anthracene	ND	NA	-	-	-	-	-	-

Notes:

¹ Source: RI/FIS Stage 2 Final Report (Radian, 1989)

J = Estimated quantitation based upon QC data

JB = Estimated quantitation: possibly biased high or a false positive based upon blank data

JL = Estimated quantitation: possibly biased low or a false negative based upon QC data

JM = Estimated quantitation: possibly biased high based upon QC data

JQ = Estimated quantitation: detected below Practical Quantitation Limit

- = Parameter was not analyzed

² Source: Jacobs Engineering Group, 1997, NAS Fort Worth JRB, Texas Basewide Background Study, Volume 1. ND = Non Detect

³ Risk Reduction Standard #2. Maximum Concentration in Groundwater for residential exposure conditions.

Medium-Specific Concentrations (NA = Not Available), Standards and Criteria for Health Based

Closure/Remediation

(Chapter 335.568 Appendix D) Texas Administrative Code. Environmental Quality Part 1. Texas Natural

Resource Conservation Commission.

Figure A.1
 NAS Fort Worth JRB
 TCE Plume Map
 October/ November 1995

Air Force Center
 For Environmental Excellence
 Brooks AFB, Texas

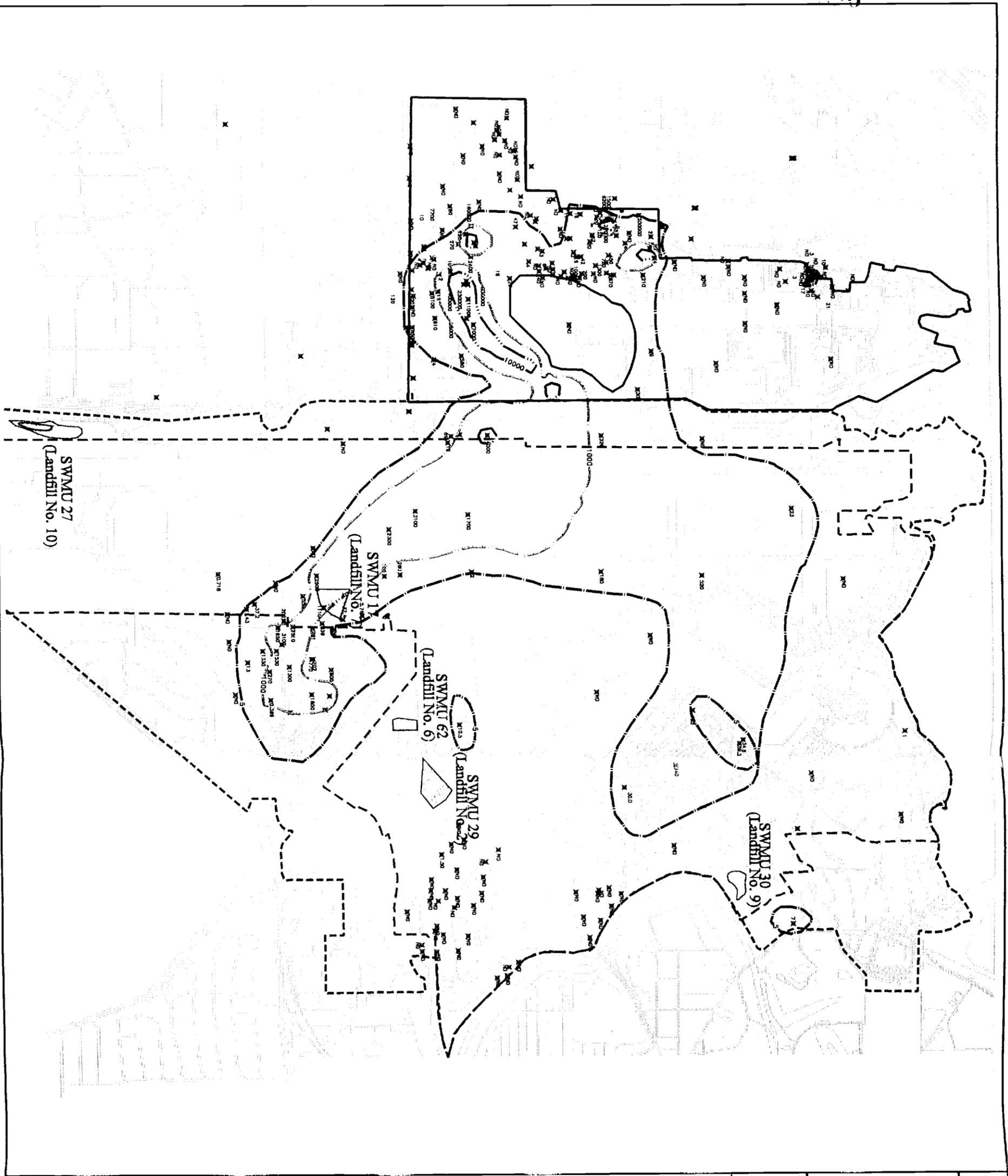
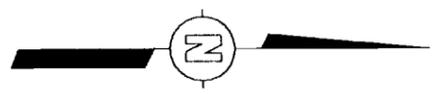
LEGEND

- Former Property Boundary of Carswell AFB
- Property Boundary of AF Plant 4
- Approximate NAS Fort Worth JRB Site Boundary
- SWMUs Locations
- μg/L TCE concentration in μg/L

NOTE:
 Data Source(s): Jacobs, 1996
 LAW, 1996b

Contour Interval Key μg/L TCE

- +10,000
- 1,000-10,000
- 1-1,000
- 0



Drawn By: M. LAWLOR Date: 6/12/97

Checked By: K. HURLEY Date: 6/12/97

Title Name: FIG1-4.DWG

Map Source: JACOBS, 1996

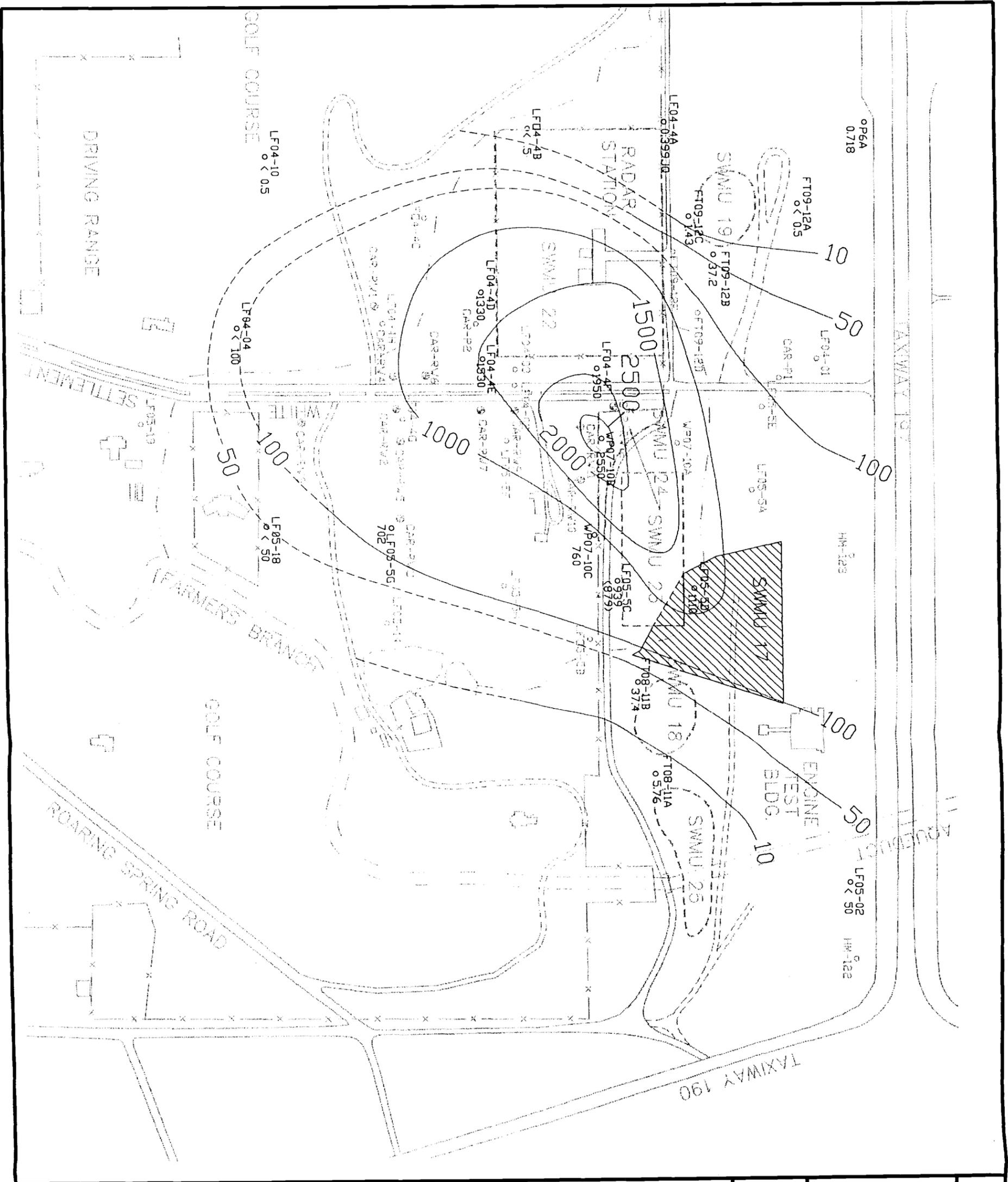
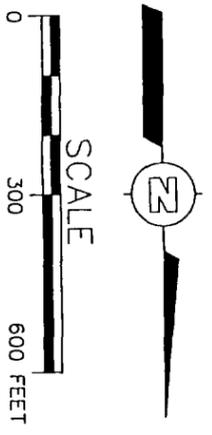


Figure A.2
 Flightline Area
 TCE Plume Map
 (January 1996)

Air Force Center
 For Environmental Excellence
 Brooks AFB, Texas

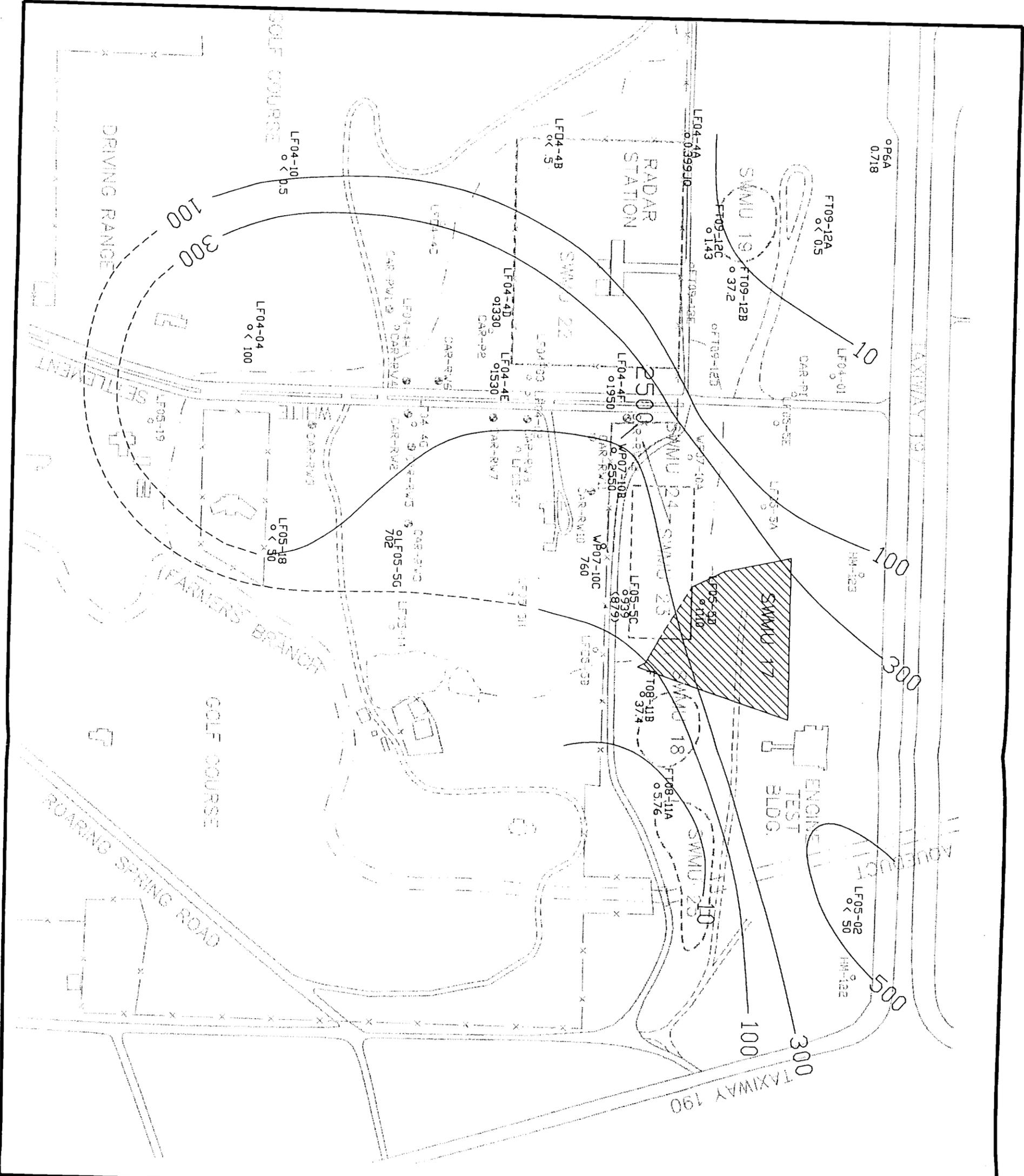
LEGEND

- ROAD
- STREAM
- FENCE
- MONITORING WELL
- RECOVERY WELL LOCATION
- SWMU TO BE INVESTIGATED
- SWMU NOT IN CURRENT RPT/CMS
- TCE CONCENTRATIONS
- ESTIMATED TCE CONCENTRATIONS
- ESTIMATED QUANTITATION DETECTED BELOW THE PRACTICAL QUANTITATION LIMIT



Drawn By:	M. LAWLOR	Date:	6/12/97
Checked By:	K. HURLEY	Date:	6/12/97
Filename:	FIG1-5.DWG		

Map Source:
 JT CORP., 1993



HydroGeologic, Inc.—Draft Final RFI Work Plan
 NAS Fort Worth JRB, Texas

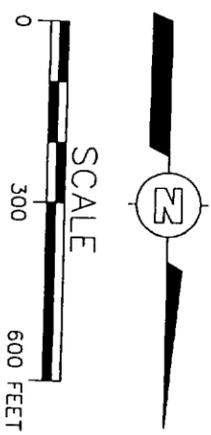
Figure A.3

Flightline Area
 Cis-1, 2 - DCE Plume Map
 (January 1996)

Air Force Center
 For Environmental Excellence
 Brooks AFB, Texas

LEGEND

- == ROAD
- - - STREAM
- - - FENCE
- MONITORING WELL
- RECOVERY WELL LOCATION
- SWMU TO BE INVESTIGATED
- SWMU NOT IN CURRENT RFI/CMS
- CIS-1, 2-DCE CONCENTRATION CONTOUR (µg/L)
- ESTIMATED QUANTITATION DETECTED BELOW THE PRACTICAL QUANTITATION LIMIT

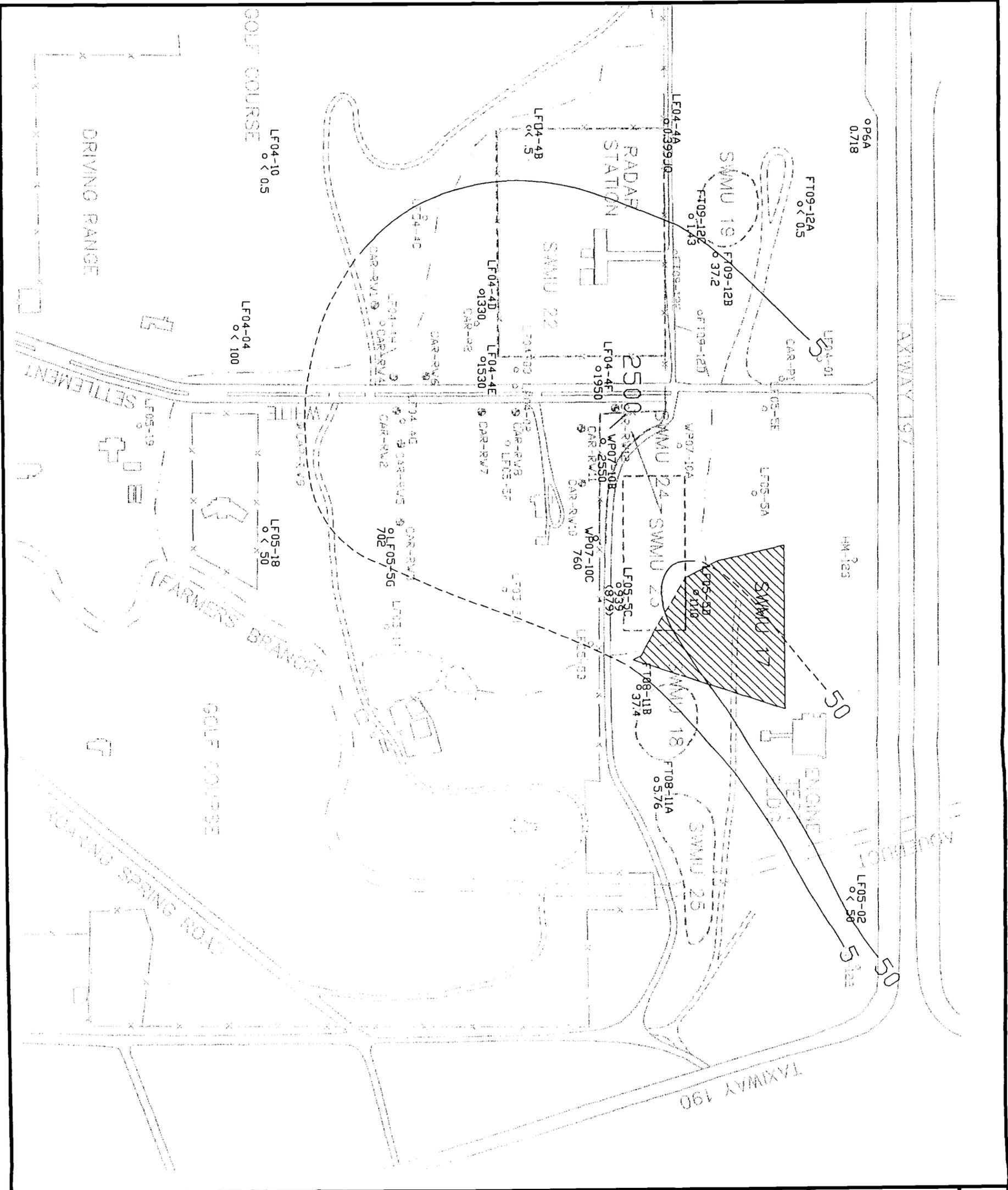


Drawn By: M. LAWLOR Date: 6/12/97

Checked By: K. HURLEY Date: 6/12/97

Filename: FIG1-6-DWG

Map Source:
 IT CORP., 1993



HydroGeologic, Inc. - Draft Final RFI Work Plan
 NAS Fort Worth JRB, Texas

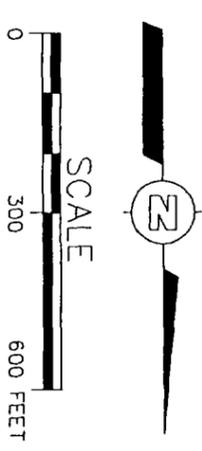
Figure A.4

Flightline Area Trans-1, 2 - DCE Plume Map (January 1996)

Air Force Center
 For Environmental Excellence
 Brooks AFB, Texas

LEGEND

- == ROAD
- - - - - STREAM
- FENCE
- MONITORING WELL
- RECOVERY WELL LOCATION
- SWMU TO BE INVESTIGATED
- ▨ SWMU NOT IN CURRENT RFI/CMS
- TRANS-1, 2 - DCE CONCENTRATIONS CONTOUR (µg/L)
- ESTIMATED TRANS-1, 2 - DCE CONCENTRATIONS DETECTED BELOW THE PRACTICAL QUANTITATION LIMIT



Drawn By: M. LAWLOR Date: 6/12/97

Checked By: K. HURLEY Date: 6/12/97

Filename: FIG1-7.DWG

Map Source:
 IT CORP., 1993

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APPENDIX B
PRELIMINARY IDENTIFIED ARARS

330331

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Table B.1
Preliminary Identified ARARs
NAS Fort Worth JRB, Texas

ARAR Category	Federal Act	Regulation/Standard/Code	Description	Comments
Location Specific	National Environmental Policy Act (NEPA)	40 CFR 1500	Council on environmental quality regulations	Evaluates impacts of remediation on the environment
		40 CFR 6	EPA NEPA regulations	Regulations specific to EPA actions
	32 CFR 989	DOD-Air Force NEPA regulations	Regulations specific to DOD-Air Force actions; the Air Force must evaluate and disclose impacts that will occur as a result of remediation	
	32 CFR 265	DOD-Natural Resources Programs	Regulations pertaining to the protection of cultural resources. Includes Executive Order 11593	
	36 CFR 60, 62, 63, 65, 800	National Historic Preservation Act (1966)	Culture resources regulations	Regulations pertaining to the protection of cultural resources. Includes Executive Order 11593
	36 CFR 296	Archaeological Resources Protection Act (1979)	Cultural resources regulations	Regulations pertaining to the protection of cultural resources. Includes Executive Order 11593
	40 CFR 6.301	Archaeological and Historical Preservation Act (1974)	Cultural resources regulations	Provides for data collection/ preservation listing on the National Registry of National Landmarks, etc. If any building and/or other landmarks/ resources are considered eligible, compliance must be accomplished prior to remediation.
	E.O. 11988 E.O. 11990	Floodplains/Wetlands	Floodplain Management Protection of Wetlands	Executive orders adopted to avoid long and short term impacts associated with wetlands destruction and occupancy and modification of floodplains.

Table B.1 (continued)
 Preliminary Identified ARARs
 NAS Fort Worth JRB, Texas

ARAR Category	Federal Act	Regulation/Standard/Code	Description	Comments
Location Specific (continued)	Migratory Bird Treaty Act	16 U.S.C. 703-712 50 CFR 10, 20, and 21	Regulates the taking of migratory birds	This act prohibits the "taking" of migratory birds without a permit. Accidental killing of birds by pollution from CAF B could be considered "taking".
Action Specific	Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)	40 CFR 300	National oil and hazardous substances pollution contingency plan	Regulations setting forth the procedures for reporting, responsibilities, and planning actions to remediate releases. OSWER Directive 9355.3-01 is applicable.
	Superfund Amendments and Reauthorization Act (SARA)	40 CFR 355, 370, 372	Emergency planning and reporting	Pertains to hazardous and toxic chemical reporting and planning requirements.
	Fish and Wildlife Coordination Act	16 USC 661-666	Requires consultation when Federal department or agency proposes or authorizes any modification of any stream or other water body and adequate provision for protection of fish and wildlife resources.	This requirement would be applicable if modification of Farmers Branch Creek may be required. Consultation with the U.S. Fish and Wildlife Service and the appropriate state agency is required.
	Endangered Species Act	50 CFR 200, 402	Requires action to conserve endangered species within critical habitats upon which endangered species depend; includes consultation with Department of Interior.	This requirement would be most applicable to bird and fish species found in Farmers Branch Creek ecosystems. Consultation with Federal and state agencies can be accomplished simultaneously with requirements under the Fish and Wildlife Coordination Act.

Table B.1 (continued)
 Preliminary Identified ARARs
 NAS Fort Worth JRB, Texas

ARAR Category	Federal Act	Regulation/Standard/Code	Description	Comments
Action Specific (continued)	Clean Water Act (CWA)	33 CFR 322	Structures or work within navigable waters of the United States	May be applicable to Farmers Branch Creek.
		33 CFR 323 33 CFR 328 33 CFR 329	Discharges of dredge or fill material to waters of the United States	May be applicable to Farmers Branch Creek.
		40 CFR 109	Criteria for state, local, and regional oil removal contingency plans	Applicable if oil may be managed or used during remediation due to proximity to Farmers Branch Creek.
		40 CFR 110	Oil discharge	May be applicable if determined that oil has contaminated or may contaminate adjacent water bodies.
		40 CFR 112	Oil pollution prevention	Applicable to prevent oil spills into adjacent water bodies. Requires that persons who may discharge oil in harmful quantities must prepare a Spill Prevention Control and Countermeasure (SPCC) plan (40 CFR 112.1, [b]).
		Texas Administrative Code (TAC), Title 31, Chapter 343	Oil and hazardous substances	Provides for immediate cleanup of hazardous substances without obtaining a permit (Texas Water Code, Chapter 26).
		Texas Water Code, Title 2, Chapter 26, Subchapter G	Oil and hazardous substances spill prevention and control	Also known as Texas Hazardous Substances Spill Prevention and Control Act. Establishes policy to prevent the spill or discharge of hazardous substances into waters of the state of Texas.

Table B.1 (continued)
Preliminary Identified ARARs
NAS Fort Worth JRB, Texas

ARAR Category	Federal Act	Regulation/Standard/Code	Description	Comments
Action Specific (continued)	CWA (continued)	Texas Water Code, Title 2, Chapter 26, Subchapter I	Underground and aboveground storage tanks	Refers to state of Texas Solid Waste Law as related to water quality.
		Natural Resources Code, Title 2, Subtitle 6, Chapter 40	Texas Oil Spill Prevention and Response Act	Established policy for protection of all waters of the state, but focuses on coastal waters.
		TAC, Title 31, Chapter 55	Pollution/fish kill investigations	May be applicable if a fish kill is suspected or confirmed as a result of the release of hazardous substances.
		TAC, Title 31, Chapter 343	Texas oil and hazardous substances regulations	Implements regulations under the Texas Water Code (TWC), Chapter 26, Subchapter G.
		40 CFR 122	Natural Pollutant Discharge Elimination System (NPDES) program	Requires permits for the discharge of pollutants from a point source into waters of the United States.
		40 CFR 125	Criteria and standards for the NPDES	Includes effluent discharge and stormwater discharge.
		TAC, Title 31, Part IX, Chapter 305	Texas consolidated NPDES permit rules	Set standards and requirements for applications, permits, and actions by the Texas Water Commission.
		TAC, Title 31, Part IX, Chapter 315	Texas criteria and standards for the NPDES; pre-treatment regulations	May be applicable depending on selected alternative.

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Table B.1 (continued)
 Preliminary Identified ARARs
 NAS Fort Worth JRB, Texas

ARAR Category	Federal Act	Regulation/Standard/Code	Description	Comments	
Action Specific (continued)	CWA (continued)	TAC, Title 31, Part IX, Chapter 319	General regulations incorporated into permit	Established allowable concentrations of hazardous metals to inland waters. Includes toxic pollutant quality control (319.26) and groundwater protection (319.27).	
		TAC, Title 31, Part IX, Chapter 323	Waste disposal approvals	Applies to the collection of waste in floodplains, and groundwater protection requirements.	
		TAC, Title 31, Chapter 331	Underground injection control	Applies to the injection of chemicals into non-potable aquifers to facilitate remediation.	
	Hazardous Materials Transportation Act (HMTA)	49 CFR 107	Hazardous materials program procedures		
		49 CFR 171, 172, 173, 174, 177	Hazardous materials regulations		Includes general information communication requirements, emergency response information, and carriage by rail and public highway. Carriage by vessel or aircraft is not anticipated.
	Resource Conservation and Recovery Act (RCRA)	40 CFR 241	Land disposal of solid waste		May be applicable to four SWMUs if excavation is required.
		40 CFR 256	State solid waste management plans		May be applicable if excavation of the four SWMUs reclassifies the sites as an "open dump".

Table B.1 (continued)
Preliminary Identified ARARs
NAS Fort Worth JRB, Texas

ARAR Category	Federal Act	Regulation/Standard/Code	Description	Comments
Action Specific (continued)	RCRA (continued)	40 CFR 257	Classification of disposal facilities and practices	May be applicable to the four SWMUs if determined that they pose an adverse environmental or health risk.
		40 CFR 260	Identification and listing of hazardous wastes	Identifies solid waste subject to regulations as hazardous waste.
		40 CFR 262	Hazardous waste generator standards	Waste will be generated as a result of remediation.
		40 CFR 263	Hazardous waste transportation standards	Waste will be transported, including samples, as a result of remediation. Manifests are required
		40 CFR 264	Standards for treatment, storage, and disposal (TSD) facilities	Waste may be stored on-site during remediation.
		40 CFR 265	Interim status standards	May be applicable if CAFB is required to be a RCRA permitted facility.
		40 CFR 266	Management of specific wastes	
		40 CFR 268	Land disposal restrictions (LDRs)	Identifies wastes restricted from land disposal unless specific exemptions exist. Applicable to several contaminants of concern.
		40 CFR 270	Hazardous waste permit program	May be applicable if CAFB is required to be a RCRA permitted facility.
		40 CFR 280	Underground storage tank regulations	Applies to owners/operators of underground storage tanks.

Table B.1 (continued)
Preliminary Identified ARARs
NAS Fort Worth JRB, Texas

ARAR Category	Federal Act	Regulation/Standard/Code	Description	Comments
Action Specific (continued)	RCRA (continued)	Texas Solid Waste Disposal Act	Texas civil statutes Public Article 4477-7	Includes implementation of the Federal Resource Conservation and Recovery Act.
		Texas Underground Storage Tanks Act	Texas water code, Title 2, Chapter 26	Includes underground and aboveground storage tanks. Aboveground tanks pertain only to petroleum products.
		TAC, Title 31, Part IX, Chapter 334	Underground Storage Tank Rules	Applicable to underground storage tanks storing hazardous or petroleum products, and aboveground storage tanks containing petroleum.
		TAC, Title 31, Part IX, Chapter 330	Solid waste management regulations	Includes regulation of both hazardous and non-hazardous waste; however, targets municipal solid waste disposal.
		TAC, Title 31, Chapter 335	Texas industrial waste management regulations	Regulates the management and control of municipal hazardous waste and industrial wastes. Includes generators, transporters, and owners/operators of TSD facilities.
		TAC, Title 31, Chapter 330	Disposal of lead acid batteries	May be applicable if batteries are disposed in any of the four SWMUs.
		29 CFR 1900	Implementation of OSHA	Address standard safety practices including personal protective equipment.
Chemical Specific	CWA	40 CFR 129	Toxic pollutant effluent standards	Applicable if any toxic pollutants listed at 129.4 (including PCBs) are discovered.
		TAC, Title 31, Chapter 314	Texas toxic pollutant effluent standards	Adopts 40 CFR 129, by reference.

Table B.1 (continued)
Preliminary Identified ARARs
NAS Fort Worth JRB, Texas

ARAR Category	Federal Act	Regulation/Standard/Code	Description	Comments
Chemical Specific (continued)	CWA (continued)	40 CFR 130	Water quality planning and management	Water quality planning, management, and program implementation.
		40 CFR 131	Water quality standards	Procedures for development, review, and approval of state water quality standards.
		TAC, Title 31, Chapter 307	Texas surface water quality standards	Standards of the state to maintain the quality water consistent with public health and enjoyment.
	Safe Drinking Water Act (SDWA)	TAC, Title 31, Chapter 311	Watershed protection	Includes Lake Worth regarding wastewater disposal and effluent requirements.
		40 CFR 141, 143	National primary and secondary drinking water standards	Establishes maximum contaminant levels (MCLs) for organics, inorganics, radioactivity, and turbidity. The standards also serve as groundwater cleanup standards at RCRA sites. Trichloroethene is the primary contaminants of concern.
		TAC, Title 31, Part IX, Chapter 290	Texas drinking water standards	Essentially adopts 40 CFR 141, 143, and establishes standards for bacteriological, chemical, and radiological quality.
		40 CFR 50	National primary and secondary ambient air quality standards	Establishes standards for sulfur oxides, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead.
	Clean Air Act (CAA)	40 CFR 52 Subpart 55	Texas state implementation plan	Incorporates and cites revisions to Texas' 1972 original submittal of a state implementation plan.

Table B.1 (continued)
Preliminary Identified ARARs
NAS Fort Worth JRB, Texas

ARAR Category	Federal Act	Regulation/Standard/Code	Description	Comments
Chemical Specific (continued)	CAA (continued)	Texas CAA	Abatement of air pollution and contaminants	Includes dust, smoke, particulate matter, fumes, gas, vapor, odor produced by processes other than natural.
		TAC, Title 31, Part III, Chapter 101	Texas Air Pollution control regulations: General Provisions	Implements the Texas CAA.
			Section 101.4 Nuisance	Requires that air pollutants can not be discharged that may be adverse to, or may be injurious to humans, animals, vegetation, and property.
			Section 101.20 and 101.21	Compliance with National Standards
			Visible emissions and particulate matter	Includes incineration of hazardous waste.
			Section 111.145	Dust control required for land clearing, construction, etc., if more than one area.
			National Emission Standards for Hazardous Air Pollutants (NESHAPS)	Possible applicable due to trichloroethane.
			TAC, Title 31, Part III, Chapter 115	Control of air pollution for volatile organic compounds

Table B.1 (continued)
Preliminary Identified ARARs
NAS Fort Worth JRB, Texas

ARAR Category	Federal Act	Regulation/ Standard/Code	Description	Comments
Chemical Specific (continued)	CAA (continued)	TAC, Title 31, Part III, Chapter 120	Control of air pollution from hazardous waste or solid waste sites	Applies to all hazardous waste facilities required to obtain a permit pursuant to the Texas Solid Waste Disposal Act.
	Toxic Substances Control Act (TSCA)	40 CFR 761 40 CFR 763	Regulation of PCBs Regulation of Asbestos	Applicable if PCBs discovered. Applicable if asbestos containing materials are included in remediation.

Source: Rust Geotech, 1995

APPENDIX C
SUMMARY OF BACKGROUND VALUES
(JACOBS, 1997)

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Table C.1
 Summary of Background Values for Surface Soil
 NAS Fort Worth JRB, Texas

Analyte	% Non-detects	Detects/ Total	W (crit)	W (log)	W (raw)	Min	Max	Mean	Standard Deviation	UTL _{95,95}	Outlier?
Aluminum	0.0%	30 / 30	0.927	0.896 Accept	0.960 Accept	1790	19900	10775	5072	22035	No
Antimony	80.0%	6 / 30	-----	----	----	<0.215	0.56	nc	nc	0.56	----
Arsenic	0.0%	30 / 30	0.927	0.851 Reject	0.959 Accept	1.23	5.88	3.504	1.059	5.855	No
Barium	0.0%	30 / 30	0.927	0.810 Reject	0.281 Reject	24.9	1980	145.3	349.3	233.0	Yes
Beryllium	0.0%	30 / 30	0.927	0.808 Reject	0.911 Reject	0.164	1.02	0.6552	0.2432	1.0200	No
Calcium	0.0%	30 / 30	0.927	0.969 Accept	0.687 Reject	418	111000	20991	28270	167788	No
Cadmium	6.7%	28 / 30	0.927	0.928 Accept	0.809 Reject	0.054	0.625	0.2118	0.1119	0.5562	No
Chromium	0.0%	30 / 30	0.927	0.952 Accept	0.965 Accept	5.06	20.1	11.73	4.203	21.056	No
Cobalt	0.0%	30 / 30	0.927	0.961 Accept	0.953 Accept	1.54	10.2	4.751	1.851	11.050	No
Copper	0.0%	30 / 30	0.927	0.909 Reject	0.964 Accept	4.44	16.7	10.77	2.974	17.373	No
Iron	0.0%	30 / 30	0.927	0.879 Reject	0.946 Accept	3460	15500	10199	3386	17717	No
Lead	0.0%	30 / 30	0.927	0.927 Reject	0.750 Reject	6.08	40.5	14.59	6.628	30.97	Yes
Magnesium	0.0%	30 / 30	0.927	0.830 Reject	0.968 Accept	112	2830	1369	736	3003	No
Manganese	0.0%	30 / 30	0.927	0.923 Reject	0.624 Reject	132	1420	336.8	237.9	849.1	Yes
Mercury	93.3%	2 / 30	----	----	----	<0.031	0.14	nc	nc	0.14	----
Molybdenum	80.0%	6 / 30	----	----	----	<0.657	1.460	nc	nc	1.460	----
Nickel	0.0%	30 / 30	0.927	0.856 Reject	0.918 Reject	3.74	14.6	9.746	3.276	14.6	No
Potassium	0.0%	30 / 30	0.927	0.963 Accept	0.950 Accept	434	2790	1253	489.1	2895	No
Selenium	40.0%	18 / 30	0.927	0.857 Reject	0.840 Reject	0.059	0.637	0.212	0.1606	0.9072	No
Silver	3.3%	29 / 30	0.927	0.918 Reject	0.821 Reject	<0.025	0.213	0.0701	0.0352	0.213	No

Table C.1 (continued)
Summary of Background Values for Surface Soil
NAS Fort Worth JRB, Texas

Analyte	% Non-detects	Detects/ Total	W (crit)	W (log)	W (raw)	Min	Max	Mean	Standard Deviation	UTL _{95,95}	Outlier?
Sodium	3.3%	29 / 30	0.927	0.723 Reject	0.467 Reject	<2.57	37300	3482	8804	25800	Yes
Thallium	16.7%	25 / 30	0.927	0.683 Reject	0.857 Reject	0.555	107	35.54	24.89	63.9	Yes
Vanadium	0.0%	30 / 30	0.927	0.884 Reject	0.966 Accept	5.82	48.5	23.89	10.08	46.26	No
Zinc	0.0%	30 / 30	0.927	0.819 Reject	0.488 Reject	13.3	124	29.30	18.96	38.8	Yes

Notes:

All units are in milligrams per kilogram (mg/kg).

---- = not applicable

nc = not calculated

ND = not detected

UTL_{95,95} = Upper Tolerance Level (95% confidence and 95% coverage)

Outlier? = Result of test to determine if the maximum value is a potential outlier.

W (crit) = Shapiro-Wilk critical value

W (log) = calculated W using log-transformed data and result when compared to W (crit)

W (raw) = calculated W using raw data and result when compared to W (crit)

Source: Draft Basewide Background Summary (Jacobs, 1997)

Table C.2
Summary of Background Values for Subsurface Soil
NAS Fort Worth JRB, Texas

Analyte	% Non-detects	Detects/ Total	W (crit)	W (log)	W (raw)	Min	Max	Mean	Standard Deviation	UTL _{95,95}	Outlier?
Aluminum	0.0%	30 / 30	0.927	0.960 Accept	0.955 Accept	3780	17700	9905	3277	17180	No
Antimony	80.0%	6 / 30	0.927	----	----	<0.21	0.712	nc	nc	0.712	----
Arsenic	0.0%	30 / 30	0.927	0.963 Accept	0.942 Accept	1.42	5.31	3.0317	1.1266	5.533	No
Barium	0.0%	30 / 30	0.927	0.922 Reject	0.974 Accept	16.4	127	65.83	28.03	128.1	No
Beryllium	0.0%	30 / 30	0.927	0.966 Accept	0.969 Accept	0.208	1.07	0.5629	0.1776	0.957	No
Calcium	0.0%	30 / 30	0.927	0.733 Reject	0.853 Reject	751	347000	91395	76216	272000	Yes
Cadmium	33.3%	20 / 30	0.927	0.829 Reject	0.390 Reject	0.055	1.48	0.1754	0.2540	0.5891	Yes
Chromium	0.0%	30 / 30	0.927	0.937 Accept	0.847 Reject	5.77	17.90	9.494	2.766	16.31	No
Cobalt	10.0%	27 / 30	0.927	0.762 Reject	0.954 Accept	0.4395	5.5	3.181	1.356	6.191	No
Copper	0.0%	30 / 30	0.927	0.848 Reject	0.952 Accept	2.61	13.30	8.119	2.524	13.72	No
Iron	0.0%	30 / 30	0.927	0.936 Accept	0.941 Accept	3840	16900	9185	2720	15224	No
Lead	6.7%	28 / 30	0.927	0.746 Reject	0.949 Accept	0.073	14.3	5.280	3.325	12.66	No
Magnesium	0.0%	30 / 30	0.927	0.697 Reject	0.843 Reject	292	2420	1569	582.1	2420	No
Manganese	0.0%	30 / 30	0.927	0.904 Reject	0.964 Accept	28.7	317	169.6	82.03	351.7	No
Mercury	100.0%	0 / 30	0.927	----	----	<0.03	<0.035	nc	nc	ND at 0.035	----
Molybdenum	80.0%	6 / 30	0.927	----	----	<0.638	1.930	nc	nc	1.930	----
Nickel	0.0%	30 / 30	0.927	0.959 Accept	0.837 Reject	4.17	22.1	9.166	3.862	19.76	Bi
Potassium	0.0%	30 / 30	0.927	0.909 Reject	0.977 Accept	271	1900	1000	322.8	1717	No
Selenium	80.0%	6 / 30	0.927	----	----	<0.12	0.3130	nc	nc	0.3130	----
Silver	33.3%	20 / 20	0.927	0.862 Reject	0.847 Reject	<0.021	0.0928	0.0354	0.0273	0.1277	No

Table C.2 (continued)
Summary of Background Values for Subsurface Soil
NAS Fort Worth JRB, Texas

Analyte	% Non-detects	Detects/ Total	W (crit)	W (log)	W (raw)	Min	Max	Mean	Standard Deviation	UTL _{95,95}	Outlier?
Sodium	10.0%	27 / 30	0.927	0.898 Reject	0.426 Reject	1.1	53200	4225	11762	53200	No
Thallium	13.3%	26 / 30	0.927	0.630 Reject	0.858 Reject	0.575	65.4	34.74	19.84	65.4	No
Vanadium	0.0%	30 / 30	0.927	0.980 Accept	0.926 Reject	9.7	37.8	20.33	6.245	37.39	No
Zinc	0.0%	30 / 30	0.927	0.851 Reject	0.963 Accept	5.9	31	18.70	5.663	31.27	No

Notes:

All units are in milligrams per kilogram (mg/kg).

---- = not applicable

nc = not calculated

ND = not detected

UTL_{95,95} = Upper Tolerance Level (95% confidence and 95% coverage)

Outlier? = Result of test to determine if the maximum value is a potential outlier.

W (crit) = Shapiro-Wilk critical value

W (log) = calculated W using log-transformed data and result when compared to W (crit)

W (raw) = calculated W using raw data and result when compared to W (crit)

Source: Draft Basewide Background Summary (Jacobs, 1997)

Table C.3
Summary of Background Values for Low-Stress Groundwater Samples
NAS Fort Worth JRB, Texas

Analyte	% Non-defects	Defects/ Total	W (crit)	W (log)	W (raw)	Min	Max	Mean	Standard Deviation	UTL _{95,95}	Outlier?
Aluminum	25.0%	9 / 12	0.859	0.930 Accept	0.505 Reject	0.052	0.472	0.0754	0.1910	1.332	No
Antimony	100.0%	0 / 12	0.859	----	----	<0.002	<0.002	nc	nc	ND at 0.002	----
Arsenic	100.0%	0 / 12	0.859	----	----	<0.0049	<0.0049	nc	nc	ND at 0.0049	----
Barium	0.0%	12 / 12	0.859	0.887 Accept	0.647 Reject	0.052	0.472	0.135	0.114	0.587	Yes
Beryllium	91.7%	1 / 12	0.859	----	----	<0.0003	0.0003	nc	nc	0.0003	----
Calcium	0.0%	12 / 12	0.859	0.855 Reject	0.905 Accept	56.5	193	141.7	45.5	266.3	No
Cadmium	100.0%	0 / 12	0.859	----	----	<0.0005	<0.0005	nc	nc	ND at 0.0005	----
Chromium	91.7%	1 / 12	0.859	----	----	<0.0053	0.0064	nc	nc	0.006	----
Cobalt	100.0%	0 / 12	0.859	----	----	<0.0089	<0.0089	nc	nc	ND at 0.0089	----
Copper	91.7%	1 / 12	0.859	----	----	<0.0008	0.0028	nc	nc	0.0028	----
Iron	0.0%	12 / 12	0.859	0.874 Accept	0.872 Accept	0.0049	0.072	0.0253	0.0194	0.2239	No
Lead	100.0%	0 / 12	0.859	----	----	<0.0016	<0.0016	nc	nc	ND at 0.0016	----
Magnesium	0.0%	12 / 12	0.859	0.839 Reject	0.639 Reject	2.76	37.8	10.32	10.49	37.80	No
Manganese	0.0%	12 / 12	0.859	0.820 Reject	0.376 Reject	0.0019	2.86	0.2713	0.8177	0.175	Yes
Mercury	100.0%	0 / 12	0.859	----	----	<0.0001	<0.0001	nc	nc	ND at 0.0001	----
Molybdenum	100.0%	0 / 12	0.859	----	----	<0.0144	<0.0144	nc	nc	ND at 0.0144	----
Nickel	75.0%	3 / 12	0.859	----	----	<0.002	0.0204	nc	nc	0.0204	----
Potassium	33.3%	8 / 12	0.859	0.890 Accept	0.665 Reject	0.233	5.55	1.277	2.079	15.03	No
Selenium	25.0%	9 / 12	0.859	0.823 Reject	0.882 Accept	0.00055	0.0046	0.0021	0.0012	0.0077	No
Silver	91.7%	1 / 12	0.859	----	----	<0.0002	0.0002	nc	nc	0.0002	----

Table C.3 (continued)
Summary of Background Values for Low-Stress Groundwater Samples
NAS Fort Worth JRB, Texas

Analyte	% Non-detects	Detects/ Total	W (crit)	W (log)	W (raw)	Min	Max	Mean	Standard Deviation	UTL _{95,95}	Outlier?
Sodium	0.0%	12 / 12	0.859	0.885 Accept	0.519 Reject	6.17	144	28.76	37.05	167.2	Yes
Thallium	100.0%	0 / 12	0.859	----	----	<0.0632	<0.0632	nc	nc	ND at 0.0632	----
Vanadium	18.2%	9 / 11	0.859	0.893 Accept	0.863 Accept	<0.0029	0.0074	0.0034	0.0018	0.0123	No
Zinc	36.4%	7 / 11	0.859	0.877 Accept	0.622 Reject	0.00195	0.0487	0.0101	0.0170	0.1180	No

Notes:

All units are in milligrams per liter (mg/L).

---- = not applicable

nc = not calculated

ND = not detected

UTL_{95,95} = Upper Tolerance Level (95% confidence and 95% coverage)

Outlier? = Result of test to determine if the maximum value is a potential outlier.

W (crit) = Shapiro-Wilk critical value

W (log) = calculated W using log-transformed data and result when compared to W (crit)

W (raw) = calculated W using raw data and result when compared to W (crit)

Source: Draft Basewide Background Summary (Jacobs, 1997)

Table C.4
Summary of Background Values for Unfiltered Groundwater Samples
NAS Fort Worth JRB, Texas

Analyte	% Non-detects	Detects/ Total	W (crit)	W (log)	W (raw)	Min	Max	Mean	Standard Deviation	UTL _{95.95}	Outlier?
Aluminum	0.0%	12 / 12	0.859	0.950 Accept	0.779 Reject	0.0699	2.45	0.8072	0.8586	11.07	No
Antimony	91.7%	1 / 12	0.859	----	----	<0.002	0.0024	nc	nc	0.0024	----
Arsenic	91.7%	1 / 12	0.859	----	----	<0.0049	0.0067	nc	nc	0.0067	----
Barium	0.0%	12 / 12	0.859	0.982 Accept	0.882 Accept	0.0358	0.513	0.1931	0.1362	1.133	No
Beryllium	66.7%	4 / 12	0.859	----	----	<0.003	0.0019	nc	nc	0.0019	----
Calcium	0.0%	12 / 12	0.859	0.916 Accept	0.806 Reject	102	881	406.6	300.8	2438	No
Cadmium	66.7%	4 / 12	0.859	----	----	<0.0005	0.0016	nc	nc	0.0016	----
Chromium	58.3%	5 / 12	0.859	----	----	<0.0053	0.0136	nc	nc	0.0136	----
Cobalt	91.7%	1 / 12	0.859	----	----	<0.0089	0.01	nc	nc	0.01	----
Copper	50.0%	6 / 12	0.859	----	----	<0.0008	0.0101	nc	nc	0.0101	----
Iron	0.0%	12 / 12	0.859	0.984 Accept	0.828 Reject	0.0768	2.64	0.7838	0.7026	7.234	No
Lead	100.0%	0 / 12	0.859	----	----	<0.0016	<0.0016	nc	nc	ND at 0.0016	----
Magnesium	0.0%	12 / 12	0.859	0.905 Accept	0.735 Reject	3.79	35.6	11.91	10.65	68.78	No
Manganese	0.0%	12 / 12	0.859	0.958 Accept	0.863 Accept	0.0393	2.17	0.7055	0.6592	10.57	No
Mercury	100.0%	0 / 12	0.859	----	----	<0.0001	<0.0001	nc	nc	ND at 0.0001	----
Molybdenum	100.0%	0 / 12	0.859	----	----	<0.0144	<0.0144	nc	nc	ND at 0.0144	----
Nickel	0.0%	12 / 12	0.859	0.92 Accept	0.78 Reject	0.0022	0.0203	0.0068	0.0055	0.0364	No
Potassium	50.0%	6 / 12	0.859	----	----	<0.466	3.9	nc	nc	3.9	----
Selenium	16.7%	10 / 12	0.859	0.891 Accept	0.851 Reject	<0.0011	0.0042	0.0018	0.0009	0.0072	No
Silver	91.7%	1 / 12	0.859	----	----	<0.0002	0.0003	nc	nc	0.0003	----

Table C.4 (continued)
Summary of Background Values for Unfiltered Groundwater Samples
NAS Fort Worth JRB, Texas

Analyte	% Non-detects	Detects/ Total	W (crit)	W (log)	W (raw)	Min	Max	Mean	Standard Deviation	UTL _{95,95}	Outlier?
Sodium	0.0%	12 / 12	0.859	0.960 Accept	0.630 Reject	1.96	91.5	20.24	23.68	176.2	No
Thallium	100.0%	0 / 12	0.859	-----	-----	<0.0632	<0.0632	nc	nc	ND at 0.0632	----
Vanadium	9.1%	10 / 11	0.859	0.943 Accept	0.920 Accept	0.00145	0.0247	0.0093	0.0066	0.0653	No
Zinc	9.1%	10 / 11	0.859	0.964 Accept	0.874 Accept	0.00195	0.0307	0.0107	0.0082	0.0682	No

Notes:

All units are in milligrams per kilogram (mg/kg).

----- = not applicable

nc = not calculated

ND = not detected

UTL_{95,95} = Upper Tolerance Level (95% confidence and 95% coverage)

Outlier? = Result of test to determine if the maximum value is a potential outlier.

W (crit) = Shapiro-Wilk critical value

W (log) = calculated W using log-transformed data and result when compared to W (crit)

W (raw) = calculated W using raw data and result when compared to W (crit)

Source: Draft Basewide Background Summary (Jacobs, 1997)

330350

Table C.5
Summary of Background Values for Surface Water
Naval Air Station Fort Worth

Analyte	% Non-defects	Detects/ Total	W (crit)	W (log)	W (raw)	Min	Max	Mean	Standard Deviation	UTL _{95,95}	Outlier?
Aluminum	0.0%	8 / 8	0.818	0.848 Accept	0.729 Reject	0.0509	0.178	0.0842	0.0410	0.2716	Yes
Antimony	75.0%	2 / 8	0.818	----	----	<0.002	0.0031	nc	nc	0.0031	----
Arsenic	100.0%	0 / 8	0.818	----	----	<0.0049	<0.0049	nc	nc	ND at 0.0049	----
Barium	0.0%	8 / 8	0.818	0.957 Accept	0.928 Accept	0.0759	0.124	0.0953	0.0146	0.151	No
Beryllium	100.0%	0 / 8	0.818	----	----	<0.0003	<0.0003	nc	nc	ND at 0.0003	----
Calcium	0.0%	8 / 8	0.818	0.908 Accept	0.879 Accept	84.1	118	96.01	10.61	133.7	No
Cadmium	87.5%	1 / 8	0.818	----	----	<0.0005	0.0005	nc	nc	ND at 0.0005	----
Chromium	62.5%	3 / 8	0.818	----	----	<0.0053	0.0078	nc	nc	0.0078	----
Cobalt	100.0%	0 / 8	0.818	----	----	<0.0089	<0.0089	nc	nc	ND at 0.0089	----
Copper	25.0%	6 / 8	0.818	0.566 Reject	0.566 Reject	<0.0004	0.0101	0.0077	0.0045	0.0101	No
Iron	0.0%	8 / 8	0.818	0.930 Accept	0.989 Accept	0.0221	0.223	0.1128	0.0633	0.9208	No
Lead	100.0%	0 / 8	0.818	----	----	<0.0016	<0.0016	nc	nc	ND at 0.0016	----
Magnesium	0.0%	8 / 8	0.818	0.993 Accept	0.976 Accept	2.07	5.52	3.58	1.114	9.353	No
Manganese	0.0%	8 / 8	0.818	0.937 Accept	0.864 Accept	0.0038	0.0716	0.0251	0.0218	0.4193	No
Mercury	87.5%	1 / 8	0.818	----	----	<0.0001	0.0001	nc	nc	0.0001	----
Molybdenum	100.0%	0 / 8	0.818	----	----	<0.0144	<0.0144	nc	nc	ND at 0.0144	----
Nickel	87.5%	1 / 8	0.818	----	----	<0.0002	0.0178	nc	nc	0.0178	----
Potassium	0.0%	8 / 8	0.818	0.893 Accept	0.924 Accept	2.06	3.93	3.001	0.6836	6.347	No
Selenium	25.0%	6 / 8	0.818	0.689 Reject	0.779 Reject	0.00055	0.0025	0.0018	0.0008	0.0115	No
Silver	75.0%	2 / 8	0.818	----	----	<0.0002	0.0003	nc	nc	0.0003	----

Table C.5 (continued)
Summary of Background Values for Surface Water
Naval Air Station Fort Worth

Analyte	% Non-detects	Detects/Total	W (crit)	W (log)	W (raw)	Min	Max	Mean	Standard Deviation	UTL _{95,95}	Outlier?
Sodium	0.0%	8 / 8	0.818	0.959 Accept	0.943 Accept	19.3	32.9	25.74	4.752	45.46	No
Thallium	100.0%	0 / 8	0.818	-----	-----	<0.0632	<0.0632	nc	nc	ND at 0.0632	----
Vanadium	25.0%	6 / 8	0.818	0.882 Accept	0.941 Accept	<0.0029 7	0.0058	nc	nc	0.0159	----
Zinc	75.0%	2 / 8	0.818	-----	-----	<0.0039	0.0122	nc	nc	0.0122	No

Notes:

All units are in milligrams per liter (mg/L).

- = not applicable
- nc = not calculated
- ND = not detected
- UTL_{95,95} = Upper Tolerance Level (95% confidence and 95% coverage)
- Outlier? = Result of test to determine if the maximum value is a potential outlier.
- W (crit) = Shapiro-Wilk critical value
- W (log) = calculated W using log-transformed data and result when compared to W (crit)
- W (raw) = calculated W using raw data and result when compared to W (crit)

Source: Draft Basewide Background Summary (Jacobs, 1997)

Table C.6
 Summary of Background Values for Stream Sediment Samples
 Naval Air Station Fort Worth

Analyte	% Non-defects	Detects/Total	W (crit)	W (log)	W (raw)	Min	Max	Mean	Standard Deviation	UTL _{95,95}	Outlier?
Aluminum	0.0%	8 / 8	0.818	0.892 Accept	0.924 Accept	2280	9240	5540	2679	28767	No
Antimony	87.5%	1 / 8	0.818	----	----	<0.244	0.33	nc	nc	0.33	----
Arsenic	0.0%	8 / 8	0.818	0.951 Accept	0.925 Accept	2.85	5.27	3.7488	0.7848	0.7018	No
Barium	0.0%	8 / 8	0.818	0.920 Accept	0.918 Accept	21.9	76.8	48.03	19.60	180.4	No
Beryllium	0.0%	8 / 8	0.818	0.912 Accept	0.912 Accept	0.194	0.557	0.3734	0.1336	1.189	No
Calcium	0.0%	8 / 8	0.818	0.877 Accept	0.928 Accept	75100	189000	139888	35825	337544	No
Cadmium	0.0%	8 / 8	0.818	0.859 Accept	0.866 Accept	0.152	0.292	0.2164	0.0588	0.5071	No
Chromium	0.0%	8 / 8	0.818	0.869 Accept	0.885 Accept	4.81	9.59	7.546	1.840	17.0	No
Cobalt	0.0%	8 / 8	0.818	0.882 Accept	0.872 Accept	1.59	3.43	2.51	0.7757	6.651	No
Copper	0.0%	8 / 8	0.818	0.961 Accept	0.953 Accept	4.28	11.7	7.428	2.627	22.18	No
Iron	0.0%	8 / 8	0.818	0.807 Reject	0.832 Accept	5030	8080	6923	1184	10696	No
Lead	0.0%	8 / 8	0.818	0.956 Accept	0.818 Reject	2.21	26.9	9.1	8.330	104.1	No
Magnesium	0.0%	8 / 8	0.818	0.912 Accept	0.938 Accept	1450	2140	1876	221.7	2772	No
Manganese	0.0%	8 / 8	0.818	0.840 Accept	0.743 Reject	143	362	198.4	71.16	491.3	Yes
Mercury	87.5%	1 / 8	0.818	----	----	<0.037	0.0360	nc	nc	0.0360	----
Molybdenum	12.5%	7 / 8	0.818	0.894 Accept	0.963 Accept	0.4355	2.68	1.659	0.7692	9.693	No
Nickel	0.0%	8 / 8	0.818	0.937 Accept	0.958 Accept	5.55	12	9.0475	2.147	19.76	No
Potassium	0.0%	8 / 8	0.818	0.904 Accept	0.929 Accept	386	1300	788.4	340	3227	No
Selenium	87.5%	1 / 8	0.818	----	----	<0.134	0.214	nc	nc	0.214	----
Silver	0.0%	8 / 8	0.818	0.965 Accept	0.888 Accept	0.0311	0.0929	0.0532	0.0188	0.144	No

Table C.6 (continued)
Summary of Background Values for Stream Sediment Samples
Naval Air Station Fort Worth

Analyte	% Non-detects	Detects/ Total	W (crit)	W (log)	W (raw)	Min	Max	Mean	Standard Deviation	UTL _{95,95}	Outlier?
Sodium	75.0%	2 / 8	0.818	-----	-----	<2.44	6.07	nc	nc	6.07	-----
Thallium	0.0%	8 / 8	0.818	0.912 Accept	0.936 Accept	22.2	43.4	33.41	7.443	69.74	No
Vanadium	0.0%	8 / 8	0.818	0.902 Accept	0.896 Accept	15.4	24.1	19.26	3.206	32.26	No
Zinc	0.0%	8 / 8	0.818	0.971 Accept	0.853 Accept	11.3	53.9	25.48	13.11	101.3	No

Notes:

All units are in milligrams per kilogram (mg/kg).

- = not applicable
- nc = not calculated
- ND = not detected
- UTL_{95,95} = Upper Tolerance Level (95% confidence and 95% coverage)
- Outlier? = Result of test to determine if the maximum value is a potential outlier.
- W (crit) = Shapiro-Wilk critical value
- W (log) = calculated W using log-transformed data and result when compared to W (crit)
- W (raw) = calculated W using raw data and result when compared to W (crit)

Source: Draft Basewide Background Summary (Jacobs, 1997)

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APPENDIX D
FIELD FORMS



LOG OF DAILY TIME AND MATERIALS

330350

Project Name: _____

Project Number: _____

Subcontractor: _____

Boring or Well No: _____

Date: _____

ITEM	NO. UNITS
Drilling /ft	
_____-inch augerhole	/ft
_____-inch mud rotary hole	/ft
_____-inch air rotary	/ft
Split spoon samples	
Shelby tube samples	
_____-rock coring	/ft
Driven casing ____-inch	/ft
Well Materials	
_____-inch stainless steel riser pipe	/ft
_____-inch stainless steel screen	/ft
_____-inch PVC riser pipe	/ft
_____-inch PVC screen	/ft
Couplings	
Bottom caps	
Top caps	
Protective casings /w locking caps	
Well installation	/ft
Revert (bags)	
Bentonite powder (bags)	
Bentonite pellets (buckets)	
Sand (bags)	
Cement (bags)	
Other Charges	
Standby	/hr
Decontamination	/hr
Well development	/hr
Spoil Disposal (barrels)	

Other _____

HydroGeoLogic Site Representative: _____

Subcontractor Site Representative: _____



BORING LOG

Borehole ID: _____
 Sheet: **330357**

				Location						
Project Name		Project Number		LTCCODE (IRPIMS)		Site ID	LPRCODE (IRPIMS)			
Drilling Company		Driller		Ground Elevation		Total Drilled Depth				
Drilling Equipment	Drilling Method	Borehole Diameter	Date/Time Drilling Started		Date/Time Total Depth Reached					
Type of Sampling Device				Water Level (bgs)						
				First		Final				
Sample Hammer				Hydrogeologist		Checked by/Date				
Type	Driving Wt.	Drop								
Location Description (include sketch in field logbook)										
Depth	Interval	Recovery	Blow Counts	Description <small>(Include lithology, grain size, sorting, angularity, Munsell color name & notation, mineralogy, bedding, plasticity, density, consistency, etc., as applicable)</small>			USCS Symbol	Lithology	Water Content	Remarks <small>(Include all sample types & depth, odor, organic vapor measurements, etc.)</small>



WELL CONSTRUCTION DETAILS AND ABANDONMENT FORM

33035

FIELD REPRESENTATIVE: _____ TYPE OF FILTER PACK: _____

DRILLING CONTRACTOR: _____ GRADIATION: _____
AMOUNT OF FILTER PACK USED: _____

DRILLING TECHNIQUE: _____ TYPE OF BENTONITE: _____

AUGER SIZE AND TYPE: _____ AMOUNT BENTONITE USED: _____

BOREHOLE IDENTIFICATION: _____ TYPE OF CEMENT: _____

BOREHOLE DIAMETER: _____ AMOUNT CEMENT USED: _____

WELL IDENTIFICATION: _____ GROUT MATERIALS USED: _____

WELL CONSTRUCTION START DATE: _____

WELL CONSTRUCTION COMPLETE DATE: _____ DIMENSIONS OF SECURITY CASING: _____

SCREEN MATERIAL: _____ TYPE OF WELL CAP: _____

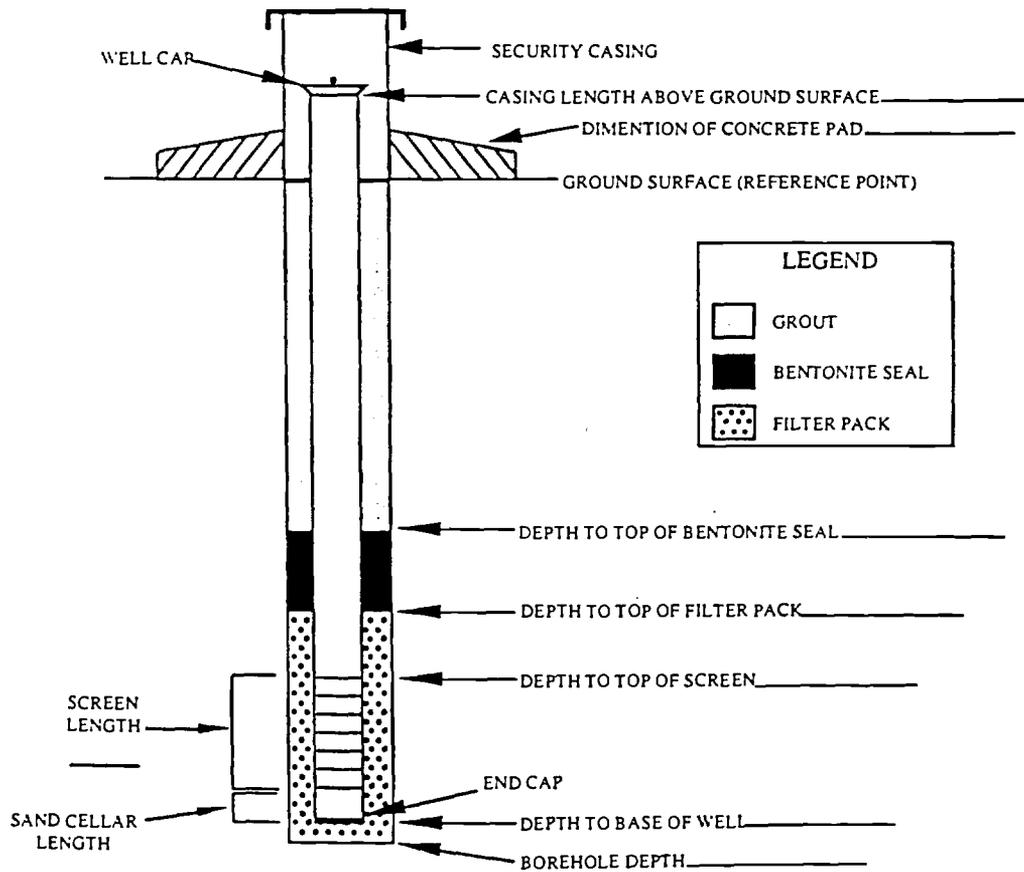
SCREEN DIAMETER: _____ TYPE OF END CAP: _____

STRATUM-SCREENED INTERVAL (FT): _____

CASING MATERIAL: _____ COMMENTS: _____

CASING DIAMETER: _____

SPECIAL CONDITIONS
(describe and draw)



NOT TO SCALE

INSTALLED BY: _____ INSTALLATION OBSERVED BY: _____

DISCREPANCIES: _____



FIELD SAMPLING REPORT

330364

LOCATION: _____ PROJECT: _____

SITE: _____

SAMPLE INFORMATION

MATRIX _____ SAMPLE ID: _____

SAMPLING METHOD _____ DUP./REP. OF: _____

BEGINNING DEPTH _____ MATRIX SPIKE/MATRIX SPIKE DUPLICATE
YES () NO ()

END DEPTH _____

GRAB () COMPOSITE () DATE: _____ TIME: _____

CONTAINER		PRESERVATIVE/ PREPARATION	EXTRACTION METHOD	ANALYTICAL METHOD	ANALYSIS
SIZE/TYPE	#				

NOTABLE OBSERVATIONS

PID READINGS	SAMPLE CHARACTERISTICS	MISCELLANEOUS
1st	COLOR: _____	
2nd	ODOR: _____	
	OTHER: _____	

GENERAL INFORMATION

WEATHER: SUN/CLEAR _____ OVERCAST/RAIN _____ WIND DIRECTION _____ AMBIENT TEMP _____

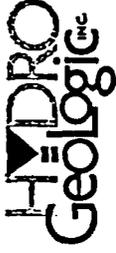
SHIPMENT VIA: FED-X _____ HAND DELIVER _____ COURIER _____ OTHER _____

SHIPPED TO: _____

COMMENTS: _____

SAMPLER: _____ OBSERVER: _____

MATRIX TYPE CODES	SAMPLING METHOD CODES
DC=DRILL CUTTINGS	B=BAILER
WG=GROUND WATER	BR=BRASS RING
LH=HAZARDOUS LIQUID WASTE	CS=COMPOSITE SAMPLE
SH=HAZARDOUS SOLID WASTE	C=CONTINUOUS FLIGHT AUGER
SE=SEDIMENT	DT=DRIVEN TUBE
SL=SLUDGE	W=SWABWIPE
SO=SOIL	G=GRAB
GS=SOIL GAS	HA=HAND AUGER
WS=SURFACE WATER	H=HOLLOW STEM AUGER
SW=SWABWIPE	HP=HYDRO PUNCH
	SS=SPLIT SPOON
	SP=SUBMERSIBLE PUMP



1155 Herndon Parkway
 Suite 900
 Herndon, VA 20170

CHAIN OF CUSTODY RECORD

Client: _____		MATRIX SOIL WATER OTHER TOTAL NO. OF CONTAINERS		ANALYSIS REQUIRED		APPLICABLE REGULATION <input type="checkbox"/> RCRA <input type="checkbox"/> ECRA <input type="checkbox"/> CERCLA <input type="checkbox"/> NPDES <input type="checkbox"/> CWA <input type="checkbox"/> SDWA <input type="checkbox"/> OTHER			
Project Name/No.: _____									
Project Manager: _____		COMPOSITE		REMARKS OR SAMPLE LOCATION					
Sampler: _____		GRAB							
Phone: (703) 478-5186 Fax: (703) 471-4180		DATE COLL.	TIME COLL.						
SAMPLE IDENTIFICATION									
Special Instructions									
Possible Hazard Identification <input type="checkbox"/> Non-Hazard <input type="checkbox"/> Flammable <input type="checkbox"/> Skin Irritant <input type="checkbox"/> Poison B <input type="checkbox"/> Unknown		Sample Disposal <input type="checkbox"/> Return to Client <input type="checkbox"/> Disposal by Lab <input type="checkbox"/> Archive for _____ Months		Project Specific (specify)					
Turn Around Time Required <input type="checkbox"/> Normal <input type="checkbox"/> Rush		QC Level <input type="checkbox"/> I. <input type="checkbox"/> II. <input type="checkbox"/> III.		1. Received by		Date	Time		
1. Relinquished by				2. Received by		Date	Time		
2. Relinquished by				3. Received by		Date	Time		
3. Relinquished by						Date	Time		
Comments									

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FINAL PAGE

ADMINISTRATIVE RECORD

FINAL PAGE

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ADMINISTRATIVE RECORD

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