

N83447.AR.000381
NAS FORT WORTH
5090.3a

FINAL 1998 BASEWIDE GROUNDWATER SAMPLING AND ANALYSIS PLAN ANNUAL
REPORT NAS FORT WORTH TX
4/1/1998
HYDROGEOLOGIC



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

**ADMINISTRATIVE RECORD
COVER SHEET**

AR File Number 424



HQ Air Force Center for Environmental Excellence

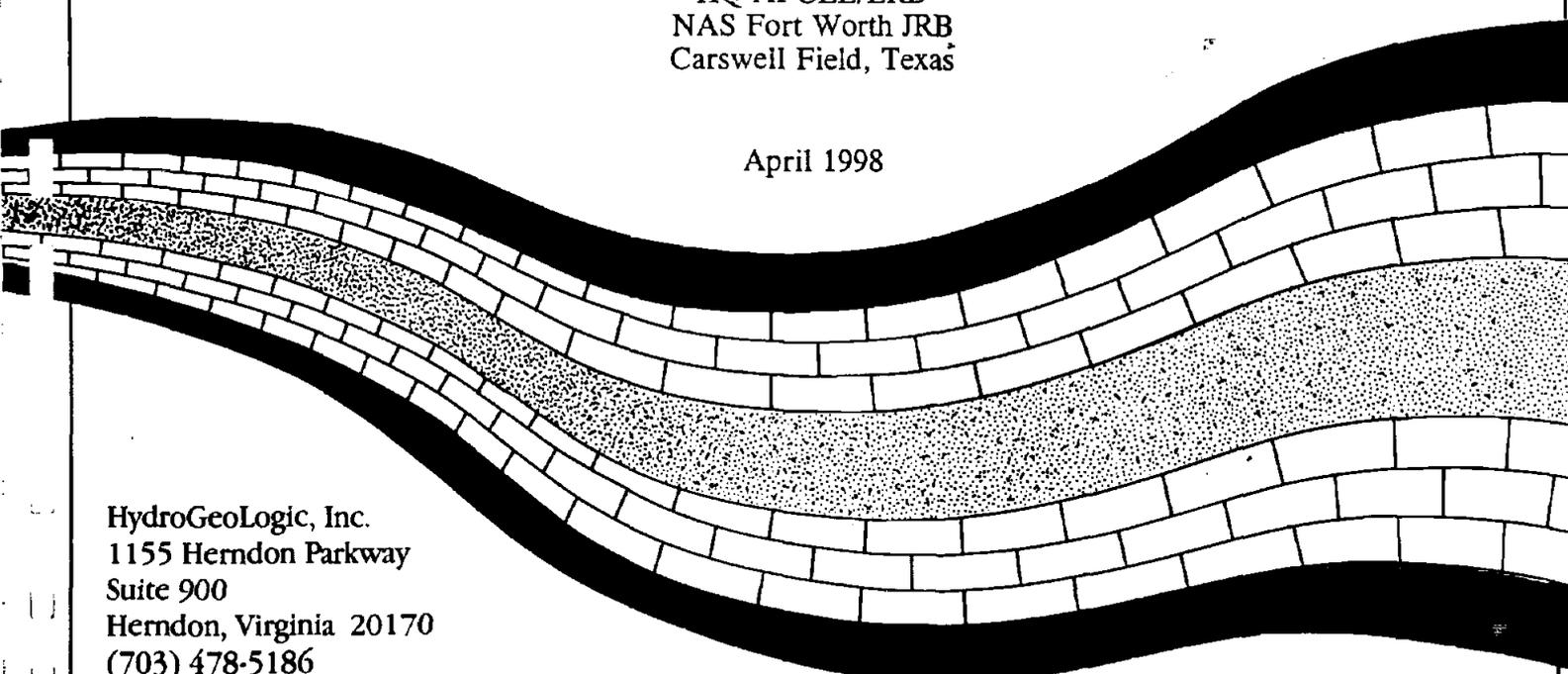
Final
Basewide Groundwater Sampling and Analysis Program
1997 Annual Report

Contract No.: F41624-95-D-8005-0007



Prepared for:
HQ AFCEE/ERD
NAS Fort Worth JRB
Carswell Field, Texas

April 1998

A decorative graphic at the bottom of the page consists of several wavy, horizontal bands. The top and bottom bands are solid black. The middle bands are filled with a stippled or brick-like pattern, creating a layered, geological appearance.

HydroGeoLogic, Inc.
1155 Herndon Parkway
Suite 900
Herndon, Virginia 20170
(703) 478-5186

HQ Air Force Center for Environmental Excellence

**Final
Basewide Groundwater Sampling and Analysis Program
1997 Annual Report**

Contract No.: F41624-95-D-8005-0007



Prepared for:
HQ AFCEE/ERD
NAS Fort Worth JRB
Carswell Field, Texas

Prepared by:
HydroGeoLogic, Inc.
1155 Herndon Parkway, Suite 900
Herndon, VA 20170

April 1998

TABLE OF CONTENTS

	Page
PREFACE	xi
1.0 INTRODUCTION	1-1
1.1 PURPOSE OF THE ANNUAL REPORT	1-1
1.2 GROUNDWATER MONITORING OBJECTIVES IN 1997	1-1
1.2.1 Assumptions	1-1
1.2.2 Short-Term Objective	1-2
1.2.3 Long-Term Objective	1-2
1.3 GROUNDWATER MONITORING ACTIVITIES CONDUCTED IN 1997	1-3
1.4 SOLID WASTE MANAGEMENT UNITS AND AREAS OF CONCERN	1-3
1.5 REPORT ORGANIZATION	1-11
2.0 SITE DESCRIPTION	2-1
2.1 PHYSIOGRAPHY	2-1
2.2 REGIONAL GEOLOGY	2-1
2.3 GROUNDWATER	2-1
2.3.1 Terrace Alluvium Deposits	2-8
2.3.2 Goodland/Walnut Aquitard	2-8
2.3.3 Paluxy Aquifer	2-11
2.3.4 Glen Rose Aquitard	2-11
2.3.5 Twin Mountains Aquifer	2-11
2.4 SURFACE WATER	2-11
2.5 CLIMATE	2-12
3.0 MONITORING ACTIVITIES	3-1
3.1 WELL INSPECTION AND WATER LEVEL MEASUREMENTS	3-1
3.2 SAMPLE WELL SELECTION	3-1
3.3 WELL PURGING AND ANALYTICAL SAMPLING	3-6
3.4 INVESTIGATION-DERIVED WASTE (IDW) MANAGEMENT	3-7
3.5 LABORATORY AND FIELD ANALYSIS	3-7
3.5.1 Laboratory Analysis	3-7
3.5.2 Field Analysis - Ferrous Iron	3-7
3.6 QUALITY ASSURANCE/QUALITY CONTROL PROGRAM	3-7
3.6.1 Ambient Blanks	3-8
3.6.2 Equipment Blanks	3-8
3.6.3 Trip Blanks	3-8
3.6.4 Field Duplicates	3-8
3.6.5 Laboratory Procedures	3-8
3.7 SAMPLE TRACKING PROTOCOL	3-9

TABLE OF CONTENTS

	Page
4.0	FIELD DATA RESULTS 4-1
4.1	WELL INSPECTIONS 4-1
4.2	GROUNDWATER LEVEL ELEVATIONS 4-1
4.3	FREE PRODUCT 4-9
5.0	ANALYTICAL RESULTS 5-1
5.1	CONTAMINANT EVALUATION 5-1
5.1.1	Background Concentrations 5-1
5.1.2	Practical Quantitation Limits (PQLs) 5-5
5.1.3	Risk Reduction Standard 2 (RRS 2) 5-5
5.2	QUALITY CONTROL ELEMENTS 5-5
5.2.1	Precision 5-5
5.2.2	Accuracy 5-8
5.2.3	Representativeness 5-8
5.2.4	Completeness 5-8
5.2.5	Comparability 5-9
5.3	ANALYTICAL DATA QUALITY EVALUATION 5-9
5.3.1	Flightline Area Groundwater 5-10
5.3.2	East Area Groundwater 5-12
5.3.3	Landfill Area Groundwater 5-14
5.4	ADDITIONAL DATA USED FOR EVALUATION 5-15
5.5	ANALYTICAL RESULTS FOR VOLATILE ORGANIC COMPOUNDS SAMPLING 5-15
5.5.1	Chlorinated Solvents 5-23
5.5.2	BTEX Compounds 5-39
5.5.3	Other Petroleum-Related Compounds 5-39
5.5.4	Other Solvents 5-39
5.6	NATURAL ATTENUATION OF BTEX COMPOUNDS 5-43
5.6.1	Changes in Contaminant Mass 5-43
5.6.2	Evidence of Intrinsic Bioremediation 5-45
5.6.2.1	BTEX Plume Associated With AOC1 5-45
5.6.2.2	BTEX Plumes Associated With SWMUs 64, 67, and 68 and AOC 7 (ST14/SD13 Area) 5-48
5.7	ANALYTICAL RESULTS FOR METALS SAMPLING 5-48
5.7.1	Comparison to Background and RRS 2 Values 5-57
5.7.2	Other Base Sampling Programs for Metals 5-57
5.7.3	Influence of Turbidity on Metals Concentrations 5-62
5.7.4	Influence of Metals on Natural Attenuation Parameters 5-62
6.0	CONCLUSIONS 6-1
6.1	SHORT-TERM OBJECTIVE 6-1

TABLE OF CONTENTS

	Page
6.2 LONG-TERM OBJECTIVES	6-1
7.0 REFERENCES	7-1

APPENDICES

Appendix A

- Appendix A-1. Field Notes
- Appendix A-2. Groundwater Field Data Sampling Sheets

Appendix B

- Appendix B-1. Water Level Measurements and Well Inspection Data
- Appendix B-2. Groundwater Ferrous Iron Concentrations

Appendix C

- Appendix C-1. Flightline Area Laboratory Results
- Appendix C-2. East Area Laboratory Results
- Appendix C-3. Landfill Area Laboratory Results

LIST OF TABLES

		<u>Page</u>
Table 1-1	Summary of Groundwater Monitoring Activities Since Publication of 1997 GSAP	1-4
Table 1-2	Solid Waste Management Units (SWMUs) at NAS Fort Worth JRB	1-7
Table 1-3	Areas of Concern (AOCs) at NAS Fort Worth JRB	1-9
Table 2-1	Stratigraphic Units at NAS Fort Worth JRB, Texas	2-9
Table 3-1	Monitoring Wells Selected for Analytical Sampling Program NAS Fort Worth JRB Basewide Groundwater Sampling 1997	3-4
Table 3-2	Field Quality Control Samples Collected for October 1997 Sampling Event	3-11
Table 4-1	Summary of Well Inspection Observations During 1997 Quarterly Sampling Events	4-2
Table 4-2	Water Table Elevations for January and July 1997	4-3
Table 5-1	Chemical Analysis Performed NAS Fort Worth JRB Basewide Groundwater Sampling 1997	5-2
Table 5-2	Background and Risk Reduction Standard 2 (RRS 2) Values for Inorganic Constituents	5-6
Table 5-3	Risk Reduction Standard 2 (RRS 2) Values for Volatile Organic Compounds (VOCs)	5-7
Table 5-4	Data Qualification Flags	5-11
Table 5-5	Volatile Organic Compounds (VOCs) Detected Above Practical Quantitation Limits (PQLs) NAS Fort Worth JRB Basewide Groundwater Sampling 1997	5-16
Table 5-6	Volatile Organic Compounds (VOCs) Detected Above Risk Reduction Standard 2 (RRS 2) NAS Fort Worth JRB Basewide Groundwater Sampling 1997	5-24
Table 5-7	Maximum Detected Concentrations for Selected Volatile Organic Compounds (VOCs) NAS Fort Worth JRB Basewide Sampling 1997	5-26
Table 5-8	Volatile Organic Compounds (VOCs) Detected Above Practical Quantitation Limits (PQLs) AFP 4 Basewide Groundwater Sampling 1997	5-27
Table 5-9	Volatile Organic Compounds (VOCs) Detected Above Risk Reduction Standard 2 (RRS 2) AFP 4 Basewide Groundwater Sampling 1997	5-29
Table 5-10	Volatile Organic Compounds (VOCs) Detected Above Practical Quantitation Limits (PQLs) and Risk Reduction Standard 2 (RRS 2) Sanitary Sewer System RFI April 1997	5-31
Table 5-11	Total and Average Total BTEX Concentrations NAS Fort Worth JRB Basewide Groundwater Sampling 1997	5-41

LIST OF TABLES

	Page
Table 5-12 Preferred Reactions by Energy Potential	5-46
Table 5-13 Indicators of Bioactivity	5-47
Table 5-14 Metals Detected Above Background Concentrations NAS Fort Worth JRB Basewide Groundwater Sampling 1997	5-51
Table 5-15 Metals Detected Above Risk Reduction Standard 2 (RRS 2) NAS Fort Worth JRB Basewide Groundwater Sampling 1997	5-55
Table 5-16 Metals Detected Above Background Concentrations AFP 4 Basewide Groundwater Sampling 1997	5-58
Table 5-17 Metals Detected Above Risk Reduction Standard 2 (RRS 2) AFP 4 Basewide Groundwater Sampling 1997	5-59
Table 5-18 Metals Detected Above Background Concentrations and Risk Reduction Standard 2 (RRS 2) Sanitary Sewer System RFI April 1997	5-60

LIST OF FIGURES

		Page
Figure 1-1	SWMU/AOC Location Map	1-10
Figure 2-1	Site Location Map	2-2
Figure 2-2	Base Boundaries	2-3
Figure 2-3	Lake Worth Topographic Map	2-4
Figure 2-4	Cross Section Location A-A'	2-5
Figure 2-5	Generalized Geologic Cross Section A-A'	2-6
Figure 2-6	Areal Distribution of Geologic Units	2-7
Figure 2-7	Stratigraphic Column Correlating Hydrogeologic Units and Geologic Units	2-10
Figure 3-1	Wells Selected for Inspection and Water Level Measurements (plate)	3-2
Figure 4-1	Groundwater Elevations January 1997	4-7
Figure 4-2	Groundwater Elevations July 1997	4-8
Figure 4-3	Change in Water Level From January to July 1997	4-10
Figure 5-1	Wells Sampled for Analytical Parameters (plate)	5-4
Figure 5-2	Distribution of TCE for October Sampling Event	5-35
Figure 5-3	Distribution of Cis-1,2-DCE for October Sampling Event	5-36
Figure 5-4	TCE and cis-1,2-DCE Concentrations Over 1997 for Selected Wells in the North Lobe in 1997	5-37
Figure 5-5	TCE and cis-1,2-DCE Concentrations Over 1997 for Selected Wells in the South Lobe in 1997	5-38
Figure 5-6	Total BTEX Concentrations October 1997	5-40
Figure 5-7	Total BTEX Concentrations Over 1997 for Selected Wells in the East Area	5-44
Figure 5-8	Maximum Metal Concentrations Detected Above RRS 2 in 1997 in the East Area	5-49
Figure 5-9	Maximum Metal Concentrations Detected Above RRS 2 in 1997 in the Flightline Area	5-50
Figure 6-1	TCE, cis-1,2-DCE, and Benzene Plumes for October 1997	6-2

LIST OF ACRONYMS AND ABBREVIATIONS

ACL	alternative concentration limits
AFB	Air Force Base
AFCEE	U.S. Air Force Center for Environmental Excellence
AFP 4	Air Force Plant 4
AOC	Area of Concern
BRAC	Base Realignment and Closure
BTEX	benzene, toluene, ethylbenzene, and xylenes
cm/sec	centimeters per second
COC	contaminants of concern
DCE	1,1-dichloroethene
DERA	Defense Environmental Restoration Account
DO	dissolved oxygen
DPDO	Defense Property Disposal Office
DQE	data quality evaluation
DQO	data quality objectives
EC	electrical conductance
Eh	oxidation-reduction potential
EPA	U.S. Environmental Protection Agency
F	data qualifier indicating analyte was detected at concentration less than PQL but greater than MDL. Value may not be accurate or precise (estimated)
°F	degrees Fahrenheit
Fe ²⁺	ferrous iron
Fe ³⁺	ferric iron
FSP	Field Sampling Plan
ft/d	feet per day
gpd/ft	gallons per day per foot
gpd/ft ²	gallons per day per square foot
GSAP	Groundwater Sampling and Analysis Plan
ICP	inductively coupled plasma
IDW	investigative-derived waste
ILS	Instrument Landing System
IRP	Installation Restoration Program
IRPIMS	Installation Restoration Program Information Management System
LCS	laboratory control sample
LNAPL	light non-aqueous phase liquid
LTM	Long-term monitoring
µg/L	micrograms per liter
mg/L	milligrams per liter
MDL	method detection limit
MSC	medium specific concentrations
NFA	no further action

LIST OF ACRONYMS AND ABBREVIATIONS (con't)

NGVD	National Geodetic Vertical Datum
NPDES	National Pollutant Discharge Elimination System
ORP	oxidation-reduction potential
OVM	organic vapor meter
%R	percent recovery
PCE	Tetrachloroethene
PD-680	Petroleum naphtha
PE	performance evaluation
PID	photoionization detector
POL	petroleum, oil, and lubricants
PQL	practical quantitation limit
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RPD	relative percent difference
RRS	Risk Reduction Rule Standards
RSD	relative standard deviation
SWMU	Solid Waste Management Unit
TAC	Texas Administrative Code
TCE	Trichloroethene
TI	Tolerance Interval
TNRCC	Texas Natural Resource Conservation Commission
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
U	data qualifier indicating analyte was not detected at the specified detection limit
UJ	data qualifier indicating analyte was not detected and the detection limit is estimated
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
UST	Underground Storage Tanks
UTL	Upper Tolerance Limit
VC	Vinyl Chloride
VOC	volatile organic compound
WSA	Weapons Storage Area

PREFACE

This Basewide Groundwater Sampling and Analysis Program Annual Report was prepared for the Air Force Center for Environmental Excellence (AFCEE) to describe the basewide quarterly groundwater monitoring events conducted at Naval Air Station Fort Worth Joint Reserve Base (NAS Fort Worth JRB), Carswell Field, Texas during 1997. The work has been conducted under Contract Number F41624-95-D-8005-0007, Delivery Order 07, issued to HydroGeoLogic, Inc. The AFCEE Contracting Officer's Representative (COR) is Joseph Dunkle. HydroGeoLogic's Program Manager is James Costello.

Activities described by the Annual Report were performed in accordance with CH2M Hill's draft Groundwater Sampling & Analysis Plan (CH2M Hill, 1996a), the draft Basewide Quality Assurance Project Plan (CH2M Hill, 1996b), and AFCEE-approved modifications.

REPORT DOCUMENTATION PAGE

Form Approved
QMB No. 0704-0188

Public reporting for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1024, Arlington, VA 22202-1302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE April 1998		3. REPORT TYPE AND DATES COVERED Final Basewide Groundwater Sampling and Analysis Program Quarterly Monitoring Report October 1997	
4. TITLE AND SUBTITLE Final Basewide Groundwater Sampling and Analysis Plan 1997 Annual Report NAS Fort Worth, Carswell Field, Texas				4. FUNDING NUMBERS C-F41624-95-D-8005-0007	
6. AUTHOR(S) HydroGeoLogic, Inc					
7. PERFORMANCE ORGANIZATION NAME(S) AND ADDRESS(S) HydroGeoLogic, Inc. 1155 Herndon Parkway, Suite 900 Herndon, VA 20170				8. PERFORMANCE ORGANIZATION REPORT NUMBER N/A	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(S) AFCEE/ERD 3207 North Road Brooks AFB, TX 78235-5328				10. SPONSORING/MONITORING AGENCY REPORT NUMBER CDRL No.: Project 72435	
11. SUPPLEMENTARY NOTES					
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for Public Release Distribution is Unlimited				12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) This document presents the Final Basewide Groundwater Sampling and Analysis Plan 1997 Annual Report for the quarterly monitoring events conducted at Naval Air Station Fort Worth JRB (NAS Fort Worth, JRB), Carswell Field, Texas. The objectives of the basewide quarterly monitoring program for 1997 were to 1) identify potential impacts to off-site receptors through perimeter monitoring, 2) delineate the contaminant source and the dissolved and non-aqueous phase plumes, and 3) establish a process for collecting data to support closure of solid waste management units (SWMUs) and areas of concern (AOCs) at the base. This report summarizes the results of field screening and analytical results of samples collected during the fourth quarter 1997 event and provides recommendations for the adjustments to the basewide program.					
14. SUBJECT TERMS				15. NUMBER OF PAGES	
				16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT		18. SECURITY CLASSIFICATION OF THIS PAGE.		19. SECURITY CLASSIFICATION OF ABSTRACT.	
				20. LIMITATION OF ABSTRACT	

TAB

7.0

1.0 INTRODUCTION

Groundwater monitoring at Naval Air Station Fort Worth Joint Reserve Base (NAS Fort Worth JRB), Texas has been performed to provide a basis for development and implementation of remedial actions under the Air Force Installation Restoration Program (IRP). This report summarizes the four scheduled quarterly sampling events for 1997, performed in accordance with the draft Groundwater Sampling and Analysis Plan (GSAP) (CH2M Hill, 1996a) and the draft Basewide Quality Assurance Project Plan (CH2M Hill, 1996b), to characterize the presence and extent of groundwater contamination and potential surface water contamination.

1.1 PURPOSE OF THE ANNUAL REPORT

The purpose of this annual report is to summarize and interpret the results of the 1997 quarterly groundwater sampling program at NAS Fort Worth JRB. The interpretation includes evaluating the collected data for any trends and determining whether or not the objectives of the 1997 groundwater sampling and analysis plan were met (CH2M Hill, 1996a). This annual report summarizes the data for all four quarters of groundwater sampling performed in 1997. In addition, the report provides a detailed description of the October 1997 sampling event in lieu of a quarterly monitoring report for this sampling event. The results of the January, April, and July sampling events were presented individually in the quarterly reports for each event published previously (CH2M Hill, 1997a, 1997b; HGL, 1997a).

1.2 GROUNDWATER MONITORING OBJECTIVES IN 1997

Objectives of the 1997 basewide quarterly monitoring program were (1) to identify potential impacts to off-site receptors through perimeter monitoring, (2) to delineate the potential contaminant sources and the dissolved and non-aqueous phase plumes, and (3) to establish a process for collecting data to support closure of Solid Waste Management Units (SWMUs) and areas of concern (AOCs) at the base. These objectives include both short- and long-term plans based on several assumptions described in the sections below.

1.2.1 Assumptions

The objectives of this quarterly monitoring program, as originally outlined in the draft GSAP (CH2M Hill, 1996a), were based on the following assumptions:

- There is a potential for impacts to off-site groundwater, which could potentially be used by off-site residents as a drinking water source, and which could migrate and discharge to surface water bodies (e.g., Farmers Branch Creek and the West Fork of the Trinity River).
- There is no current exposure to on-site groundwater (i.e., groundwater is not currently used for drinking water or irrigation), and future chronic exposure to on-site groundwater is unlikely, although exposure during future intrusive activities could occur.
- Natural attenuation of contaminants is likely occurring in soil and groundwater.

1.2.2 Short-Term Objective

The short-term objective for the 1997 groundwater sampling and analysis program was to identify potential impacts to off-site groundwater receptors. Perimeter wells selected for the program include wells located near the NAS Fort Worth JRB boundaries and/or immediately upgradient of surface water bodies where groundwater might discharge to the surface water (CH2M Hill, 1996a).

1.2.3 Long-Term Objective

The long-term objective for the 1997 groundwater sampling and analysis program was to establish a process for collecting data to support closure of SWMUs and AOCs and to identify and/or confirm potential impacts to off-site receptors (CH2M Hill, 1996a).

The 1997 groundwater sampling and analysis program was structured to provide information to support the following activities in light of the long-term objective:

- Long-term monitoring to collect data for regulatory compliance issues associated with closure of SWMUs/AOCs;
- Additional source and plume delineation to define horizontal or vertical migration of contamination associated with miscellaneous hot spots and potential source areas where data are not currently available;
- Non-aqueous phase liquid (NAPL) delineation to determine the presence and thickness of light non-aqueous phase liquids (LNAPL) and dense non-aqueous phase liquids (DNAPL);
- Off-site monitoring program to monitor off-base or potential off-base contamination (surface water and/or groundwater);
- Paluxy aquifer (i.e., municipal water supply aquifer) investigation to monitor/identify bedrock contamination potential and review boring logs to identify locations for additional bedrock wells;
- Modeling to demonstrate that natural attenuation of contaminants is occurring and to approximate the extent of attenuation expected at the perimeter of the facility, particularly in the East Area groundwater;
- Monitoring of contaminants of concern (COCs) for comparison to alternative concentration limits (ACLs) that could potentially be applied to on-base sites for closures; and
- Development of a process for identifying wells to be closed because they are no longer needed for source identification or long-term monitoring.

The components of the quarterly monitoring and analysis program that were designed to support the long-term objective were based on a review of existing data from previous investigations and

an understanding of the current remediation plans for SWMUs and AOCs. These objectives were developed specifically for the 1997 quarterly groundwater sampling program. A Groundwater Sampling and Analysis Plan for 1998 (GSAP) (HGL, 1997g) was recently drafted which alters some of these objectives, based on review of existing data, including that obtained from the 1997 quarterly sampling at NAS Fort Worth JRB.

1.3 GROUNDWATER MONITORING ACTIVITIES CONDUCTED IN 1997

Since the publication of the 1997 GSAP, a number of activities have taken place at NAS Fort Worth JRB related to groundwater monitoring; these activities are summarized in Table 1-1. The table also provides a brief description of the anticipated monitoring activities to be conducted in 1998 as part of the on-going and/or proposed remediation/assessment efforts.

During 1997, four rounds of quarterly groundwater sampling were performed by CH2M Hill and HydroGeoLogic, Inc. as part of the NAS Fort Worth JRB basewide groundwater sampling program. A total of 53 monitoring wells were scheduled for inclusion in each of these sampling events (in January, an additional four wells in the Paluxy aquifer were included), with analytes for individual wells chosen based on results from past sampling events and information about source contaminants (CH2M Hill, 1996a).

In a effort to monitor the contamination resulting from past activities at Neighboring Air Force Plant (AFP 4), Jacobs Engineering has been sampling wells on AFP 4 property, as well as several wells on western portion of NAS Fort Worth JRB property. Analytical results from Jacob's sampling at twenty monitoring wells on NAS Fort Worth JRB property in 1997 have been included in this report.

As part of a Resource Conservation and Recovery Act (RCRA) Facility Investigation for SWMU 66 (Sanitary Sewer System), IT Corporation installed and sampled 34 new monitoring wells and sampled six existing monitoring wells in April/May 1997 (IT Corporation, 1997c). SWMU 66 consists of a network of underground pipes which collect sanitary and industrial wastewater. The results of this sampling event have been included in this report.

1.4 SOLID WASTE MANAGEMENT UNITS AND AREAS OF CONCERN

Since 1942, most hazardous waste generated through operations and activities at the Base has been disposed of in landfills, reused on base, or processed through the Defense Property Disposal Office (DPDO) for off-base recycling or disposal. Since 1984, many of these sites (which include landfills, fire training areas, oil/water separators, and evidence of spills at waste accumulation areas) have been investigated. A total of 68 SWMUs were identified as part of a RCRA Facility Assessment (RFA) conducted for what was then Carswell Air Force Base (USEPA, 1989a). Additionally, 16 AOCs were identified in Permit HW50289 for Carswell Air Force Base issued by the Texas Natural Resources Conservation Commission (formerly Texas Water Commission) on February 13, 1991 (TNRCC, 1991). A number of the SWMUs and AOCs identified have been determined to require no further action (NFA) and are currently considered closed by TNRCC (TNRCC, 1995). All SWMUs and AOCs are listed on Table 1-2 and Table 1-3 and the locations of the active SWMUs and AOCs are shown on Figure 1-1.

Table 1-1. Summary of Groundwater Monitoring Activities Since Publication of 1997 GSAP

Documentation of Project/Activities	Description of Project/Activity	Contractor	post-1997 GSAP Activities	Anticipated Monitoring Activities
Final Remedial Action Plan for the Risk-Based Remediation of SWMUs 64, 67, and 68 and AOC 7 (POL Tank Farm) [Parsons, 1997]	In-situ bioventing of the BTEX contaminated soil at the petroleum, oil and lubricants (POL) tank farm	Parsons	N/A	Quarterly sampling of selected wells (22 total) for VOCs, and metals. Nine wells associated with SD-13 will be sampled for Appendix IX in the first quarter. Sampling will continue until concentrations of contaminants are at or below RRS 2 levels. Four of the 22 wells proposed for sampling will be installed in 1998.
Corrective Action Plan for Base Service Station [IT Corporation, 1997b]	Monitoring plans to support closure of Base Service Station	IT Corp	N/A	4 quarterly monitoring events for one year (MW-01, BSS-B, and MW-10) for BTEX (SW8020), MTBE, standard field parameters
Corrective Action Plan for Base Gas Station [IT Corporation, 1997a]	Monitoring plans to support closure of Base Gas Station	IT Corp	Installed seven new wells and sampled in August and November	4 quarterly sampling events for one year (BGSMW03, BGSMW05 and BGSMW06) for BTEX (SW8020), MTBE, standard field parameters
AOC-2 Workplan [CH2M Hill, 1997c]	Proposed plan to characterize the TCE Plume underlying Flightline Area	CH2M Hill	N/A	Installing approximately 16 new wells. Sampling is scheduled for December '97 - January '98
Pre-Draft RFI Report for Landfills 4, 5, and 8 and Waste Pile 7 (SWMU 22, 23, 24, and 25) [HGL, 1997h]	Complete RFI at Landfills/Waste Pile underlying Flightline Area	HGL	Installed and sampled three new wells in September 1997	Incorporate into Quarterly sampling events.

Table 1-1. Summary of Groundwater Monitoring Activities Since Publication of 1997 GSAP (continued)

Documentation of Project/Activities	Description of Project/Activity	Contractor	post-1997 GSAP Activities	Anticipated Monitoring Activities
Basewide Groundwater Sampling and Analysis of Quarterly Sampling [CH2M Hill, 1997a, 1997b; HGL, 1997a]	Sampling of monitoring wells basewide	CH2M / HGL	Four sampling events conducted in January, April, July, and October	As per 1998 GSAP.
Letter Report of LNAPL Removal [Dunkle, 1997]	Summary of six monthly free-product monitoring events	CH2M	Monthly monitoring of free-product from wells (i.e., 17M, SD13-07, SD13-04) during February - August. No significant accumulation (over 0.01 feet) occurred over a monthly period between May -August.	Incorporate these wells into the quarterly monitoring events.
AFP 4 Sampling	Continued monitoring of delineated plume(s) under AFP 4	Jacobs	Sampled thirteen wells on NAS Fort Worth. Wells sampled in January, April, July and October 1997.	Continue interim quarterly monitoring until remediation systems are activated. LTM proposal is currently in regulatory review (includes sampling of 7 wells on Base).
Final Work Plan/RFI of Landfills (SWMU 17, 27, 29, 30, 62) [HGL, 1997b]	Delineate contamination within and underlying 5 landfills	HGL	N/A	Installed approximately 20 new wells. Sample each initially for Appendix IX list. Two additional rounds will include a reduced list.
Final Work Plans for SWMU 26 and 28 [HGL, 1997e, 1997f]	Support closure of units.	HGL	N/A	Installing and sampling wells for Appendix IX constituents.

Table 1-1. Summary of Groundwater Monitoring Activities Since Publication of 1997 GSAP (continued)

Documentation of Project/Activities	Description of Project/Activity	Contractor	post-1997 GSAP Activities	Anticipated Monitoring Activities
Draft Work Plan for Site Investigation of AOC-4 [HGL, 1997d]	Delineate contamination associated with the abandoned fuel hydrant system located at the Navy Ramp and Alert Apron.	HGL	N/A	17 monitoring wells will be installed and sampled for VOCs and TPH. (Nine of these wells will be newly installed.)
Draft RFI for SWMU 66 (Sanitary Sewer System) [IT Corporation, 1997c]	Delineate contamination associated with the Base sanitary sewer system.	IT Corp	Installed 34 wells; sampled in April 1997.	Incorporate wells in quarterly sampling events if practical.
Background Study [Jacobs, 1997]	Established background concentrations for 24 inorganic constituents (i.e., metals)	Jacobs	Installed 4 new background wells and sampled 12 background wells in December 1996.	Incorporate several background wells into quarterly sampling events.
Characterization of Oil/Water Separators (OWSs)	Review of OWSs and propose remedial actions	Jacobs	N/A	Install 5 wells January '98 (locations have not been proposed) in vicinity of Bldg 1145.
Characterization of Underground Storage Tanks (USTs)	Review of USTs and propose remedial actions	TBD	N/A	Potential installation of wells
Characterization of Waste Accumulation Areas (WAAs)	Review of WAAs and propose remedial actions	TBD	N/A	Potential installation of wells

Table 1-2. Solid Waste Management Units (SWMUs) at NAS Fort Worth JRB

SWMU	Description	OPR ¹
1	Pathological Waste Incinerator (NFA)	BRAC
2	Pathological Waste Storage Shed (NFA)	BRAC
3	Metal Cans (NFA)	BRAC
4	Facility Dumpsters (NFA)	BRAC
5	Building 1626 Waste Accumulation Area	DERA
6	Building 1628 Wash Rack and Drain	DERA
7	Building 1628 Oil/Water Separator	DERA
8	Building 1628 Sludge Collection Tank	DERA
9	Building 1628 Work Station Waste Accumulation Area (NFA)	DERA
10	Building 1617 Work Station Waste Accumulation Area (NFA)	DERA
11	Building 1617 Waste Accumulation Area	DERA
12	Building 1619 Waste Accumulation Area	DERA
13	Building 1710 Visual Information Center Work Station Waste Accumulation Areas	DERA
14	Building 1060 Bead Blaster Collection Tray (NFA)	DERA
15	Building 1060 Paint Booth Vault (NFA)	DERA
16	Building 1060 Waste Accumulation Area	DERA
17	Landfill No.7	DERA
18	Fire Training Area No.1 (NFA)	BRAC
19	Fire Training Area No.2	BRAC/DERA
20	Waste Fuel Storage Tank	BRAC/DERA
21	Waste Oil Tank	BRAC/DERA
22	Landfill No.4	BRAC
23	Landfill No.5	BRAC
24	Waste Burial Area	BRAC
25	Landfill No.8	BRAC/DERA
26	Landfill No.3	DERA
27	Landfill No.10	DERA
28	Landfill No.1	DERA
29	Landfill No.2	DERA
30	Landfill No.9	DERA
31	Building 1050 Waste Accumulation Area	DERA
32	Building 1410 Waste Accumulation Area	DERA
33	Building 1420 Waste Accumulation Area	DERA
34	Building 1194 Waste Accumulation Area	DERA
35	Vehicle Refueling Shop (Building 1194) Oil/Water Separation System	DERA
36	Building 1191 Waste Accumulation Area	DERA
37	Vehicle Maintenance Shop (Building 1191) Oil/Water Separation System	DERA
38	Building 1269 PCB Transformers Building (NFA)	DERA
39	Building 1643 Waste Accumulation Area	DERA
40	Building 1643 Oil/Water Separation System	DERA
41	Building 1414 Oil/Water Separation System, Field Maintenance Squadron Aerospace Ground Equipment	DERA

**Table 1-2. Solid Waste Management Units (SWMUs) at NAS Fort Worth JRB
(continued)**

SWMU	Description	OPR¹
42	Building 1414 Waste Accumulation Area	DERA
43	Building 1414 NonDestructive Inspection (NDI) Waste Accumulation Point (NFA)	DERA
44	Building 1027 Oil/Water Separation System at the Aircraft Washing Hangar	DERA
45	Building 1027 Waste Oil Tank Vault at the Aircraft Washing Hangar	DERA
46	Building 1027 Waste Accumulation Area (NFA)	DERA
47	Building 1015 Jet Engine Test Cell Oil/Water Separator	DERA
48	Building 1048 Fuel Systems Shop Floor Drains (NFA)	DERA
49	Aircraft Washing Area No.1	DERA
50	Aircraft Washing Area No.2	DERA
51	Building 1190 Central Waste Holding Area	DERA
52	Building 1190 Oil/Water Separation System	DERA
53	Storm Water Drainage System	DERA
54	Storm Water Interceptors	DERA
55	East Gate Oil/Water Separator	DERA
56	Building 1405 Waste Accumulation Area (NFA)	DERA
57	Buildings 1432/1434 Waste Accumulation Area (NFA)	DERA
58	Pesticide Rinse Area	BRAC
59	Building 8503 Weapons Storage Area Waste Accumulation Area	BRAC
60	Building 8503 Radioactive Waste Burial Site	BRAC
61	Building 1320 Power Production Maintenance Facility Waste Accumulation Area	DERA
62	Landfill No.6	DERA
63	Entomology Dry Well (NFA)	DERA
64	French Underdrain System	BRAC/ DERA
65	Weapons Storage Area Disposal Site (NFA)	BRAC
66	Sanitary Sewer System	BRAC/DERA
67	Building 1340 Oil/Water Separator	BRAC/DERA
68	POL Tank Farm	BRAC/DERA

Notes:

¹OPR is Office of Primary Responsibility

Table 1-3. Areas of Concern (AOCs) at NAS Fort Worth JRB

AOC	Description	OPR¹
1	Former Base Service Station/ former Base Gas Station	BRAC/DERA
2	Airfield Groundwater	DERA
3	Waste Oil Dump (NFA)	DERA
4	Fuel Hydrant System	DERA
5	Grounds Maintenance Yard	BRAC
6	RV Storage Area	DERA
7	Former Base Refueling Area	DERA
8	Aerospace Museum	BRAC
9	Golf Course Maintenance Yard	BRAC
10	O/W Separator	DERA
11	O/W Separator	DERA
12	O/W Separator	DERA
13	O/W Separator	DERA
14	Unnamed Stream	BRAC
15	Storage Shed	DERA
16	Family Camp	BRAC

Notes:

¹OPR is Office of Primary Responsibility

This page was intentionally left blank.

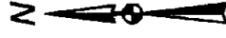
Figure 1-1

**SWMU/AOC LOCATION MAP
 NAS Fort Worth JRB**

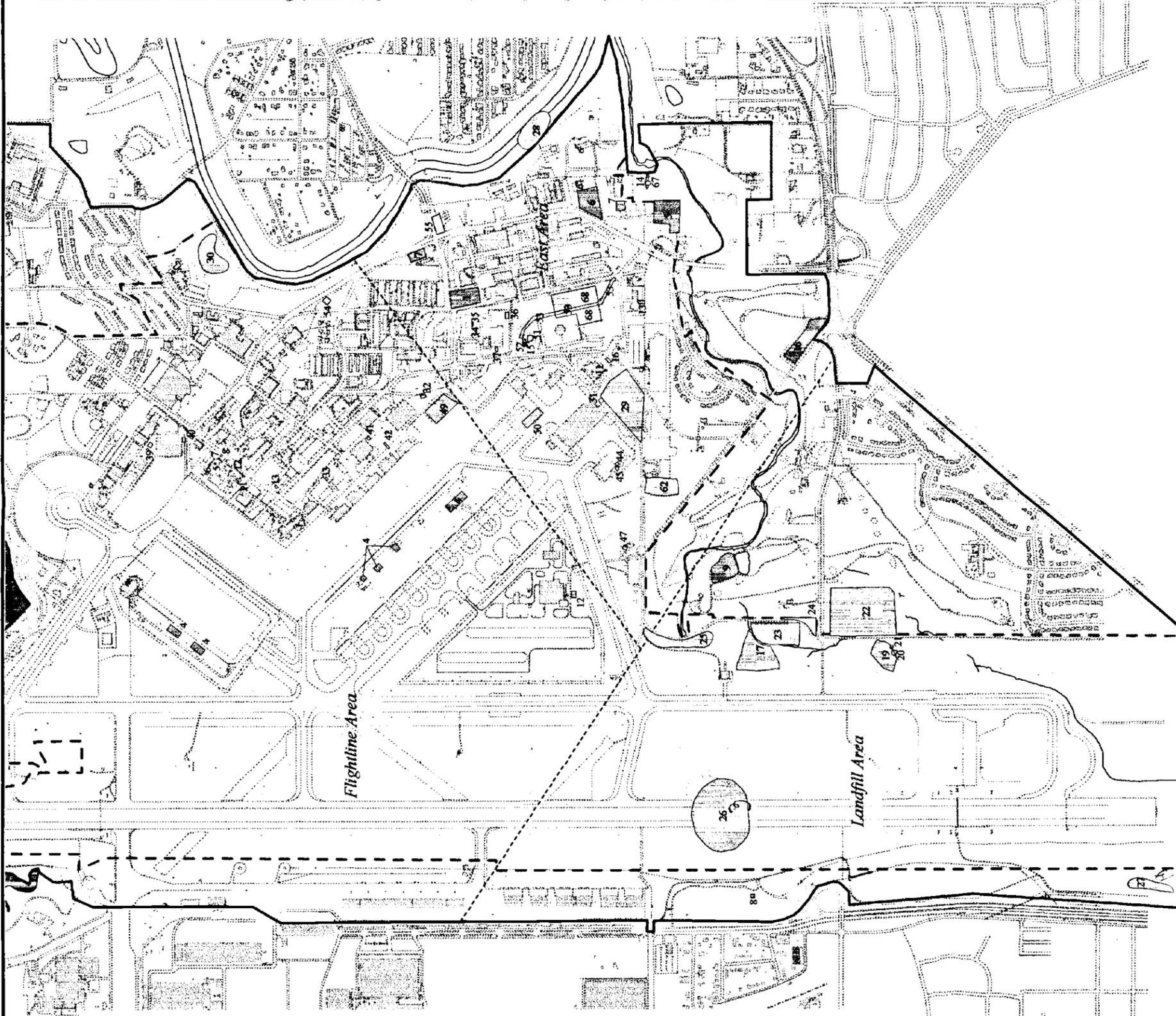
Air Force Center For
 Environmental Excellence
 Brooks AFB, Texas

Legend

- - - - - NAS Fort Worth JRB (Carswell Field)
- Former Carswell Air Force Base
- ▲ Area of Concern (AOC)
- ◻ 68 Solid Waste Management Unit (SWMU)
- Groundwater Management Areas



Filename: AFC001/07GBB/FIG1_1
 Revised: nzehms 04/08/98
 Project: AFC001-07GBB
 Map Source: Jacobs, 1996



Area of Concern (AOC)

- 1 Former Base Service Station/ Former Base Gas Station
- 2 Airfield Groundwater (Basewide Coverage)
- 3 Fuel Hydrant System
- 4 Grounds Maintenance Yard
- 5 RV Storage Area
- 6 Former Base Refueling Area
- 7 Aerospace Museum
- 8 Golf Course Maintenance Yard
- 9 O/W Separator
- 10 O/W Separator
- 11 O/W Separator
- 12 Unnamed Stream
- 13 Storage Shed
- 14 Family Camp
- 15
- 16

Solid Waste Management Unit (SWMU)

- 5 Building 1626 Waste Accumulation Area
- 6 Building 1628 Wash Rack and Drain
- 7 Building 1628 Oil/Water Separator
- 8 Building 1628 Shdige Collection Tank
- 11 Building 1617 Waste Accumulation Area
- 12 Building 1619 Waste Accumulation Area
- 13 Building 1710 Visual Information Center Work Station Waste Accumulation Areas
- 16 Building 1060 Waste Accumulation Area
- 17 Landfill No.7
- 19 Fire Training Area No.2
- 20 Waste Fuel Storage Tank
- 21 Waste Oil Tank
- 22 Landfill No.4
- 23 Landfill No.5
- 24 Waste Burial Area
- 25 Landfill No.8
- 26 Landfill No.3
- 27 Landfill No.10
- 28 Landfill No.1
- 29 Landfill No.2
- 30 Landfill No.9
- 31 Building 1050 Waste Accumulation Area
- 32 Building 1410 Waste Accumulation Area
- 33 Building 1420 Waste Accumulation Area
- 34 Building 1194 Waste Accumulation Area
- 35 Vehicle Refueling Shop (Building 1194) Oil/Water Separation System
- 36 Building 1191 Waste Accumulation Area
- 37 Vehicle Maintenance Shop (Building 1191) Oil/Water Separation System
- 39 Building 1643 Waste Accumulation Area
- 40 Building 1643 Oil/Water Separation System
- 41 Building 1414 Oil/Water Separation System, Field Maintenance Squadron Aerospace Ground Equipment
- 42 Building 1414 Waste Accumulation Area
- 44 Building 1027 Oil/Water Separation System at the Aircraft Washing Hangar
- 45 Building 1027 Waste Oil Tank Vault at the Aircraft Washing Hangar
- 47 Building 1015 Jet Engine Test Cell Oil/Water Separator
- 49 Aircraft Washing Area No.1
- 50 Aircraft Washing Area No.2
- 51 Building 1190 Central Waste Holding Area
- 52 Building 1190 Oil/Water Separation System
- 53 Storm Water Drainage System
- 54 Storm Water Interceptions
- 55 East Gate Oil/Water Separator
- 58 Peabody Rinse Area
- 59 Building 8503 Weapons Storage Area Waste Accumulation Area
- 60 Building 8503 Radioactive Waste Burial Site
- 61 Building 1320 Power Production Maintenance Facility Waste Accumulation Area
- 62 Landfill No.6
- 64 French Underdrain System
- 66 Sanitary Sewer System (Basewide Coverage)
- 67 Building 1340 Oil/Water Separator
- 68 POL Tank Farm

* Off-site Locations

Portions of the facility are subject to Air Force Base Realignment and Closure (BRAC) management, while other portions are managed by the Air Force Center for Environmental Excellence (AFCEE) under the Defense Environmental Restoration Account (DERA). These management responsibilities are included on Table 1-2 and Table 1-3. The reader should reference the Site Characterization Summary Informal Technical Information Report (CH2M Hill, 1996c) and the Compliance Plan Application (Waste Policy Institute, 1997) for more information on the description and status of individual SWMUs and AOCs.

1.5 REPORT ORGANIZATION

Section 2.0 of this report provides a description of the environmental setting, while Section 3.0 includes a description of the monitoring activities performed during 1997 as part of the basewide groundwater monitoring program. Section 4.0 of this report describes the results of the field analyses, including well inspections, water level measurements, and LNAPL surveys. Section 5.0 presents the analytical results. Section 6.0 provides a summary of the basewide groundwater sampling program for 1997, while Section 7.0 lists references. Appendix A presents field notes and field data sampling sheets for the October 1997 sampling event. Water level measurements and inspection sheets for October 1997, and ferrous iron concentrations in wells sampled in October 1997, are contained in Appendix B. Appendix C provides a summary of the analytical data for the October 1997 sampling event. Field and analytical data for the January, April, and July 1997 sampling events are presented in the appendices in the individual quarterly reports (CH2M Hill, 1997a, 1997b; HGL, 1997a).

This page was intentionally left blank.

TAB

2.0

2.0 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 (Figure 2-1). The facility consists of the main Base and two noncontiguous parcels, the Instrument Landing System (ILS) marker beacon and the Weapons Storage Area (WSA), both located west of the city of White Settlement. The main Base comprises 2,264 acres and is bordered by Lake Worth to the north, the West Fork of the Trinity River, River Oaks, and Westworth Village to the east, other urban areas of Fort Worth to the northeast and southeast, White Settlement to the west and southwest, and Air Force Plant 4 (AFP 4) to the west (Figure 2-2). The area surrounding NAS Fort Worth JRB is mostly suburban. Land use in the immediate vicinity of the Base is industrial, commercial, residential, and recreational (A.T. Kearney, 1989).

2.1 PHYSIOGRAPHY

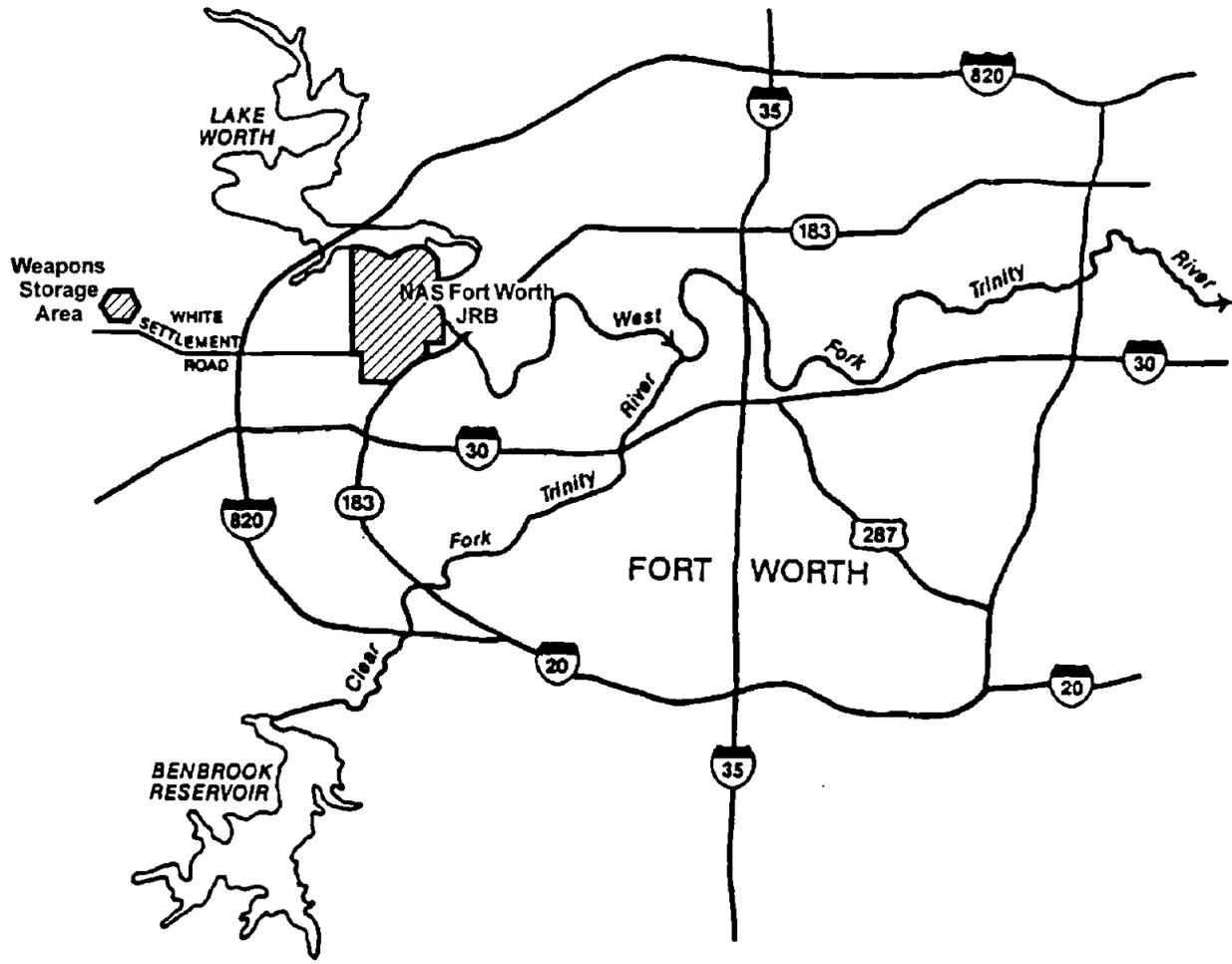
The NAS Fort Worth JRB area is located along the border zone between two physiographic provinces. The southeastern part of the Base is situated within the Grand Prairie section of the Central Lowlands Physiographic Province. Most of NAS Fort Worth JRB is located within this province. This region is characterized 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 2-3 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.

2.2 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 2-4 and Figure 2-5 (Radian, 1989). The areal limits of surface exposure of these units at NAS Fort Worth JRB are shown in Figure 2-6. 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.

2.3 GROUNDWATER

The water-bearing geologic formations located in the NAS Fort Worth JRB area are 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



Filename: AFCEE\NAS Ft Worth\Annual\SiteLctn.cdr



Legend



Site

SCALE IN MILES

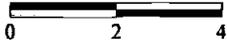


Figure 2-1
NAS Fort Worth JRB
SITE LOCATION MAP

[From Radian, 1989]

HydroGeologic, Inc. — Final 1997 Annual Report
NAS Fort Worth JRB, Texas

Figure 2-2

BASE BOUNDARIES NAS Fort Worth JRB

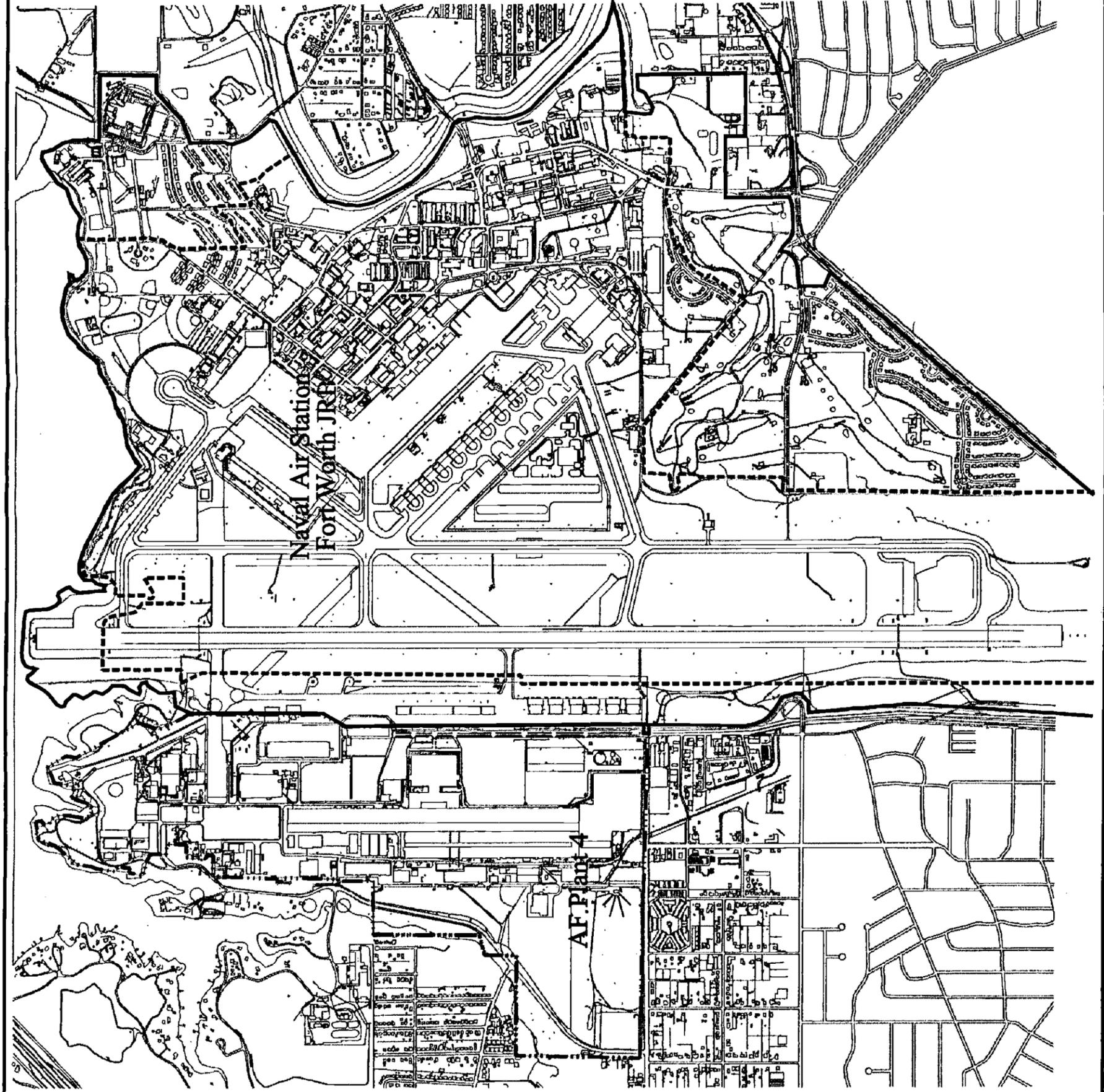
Air Force Center
For Environmental Excellence
Brooks AFB, Texas

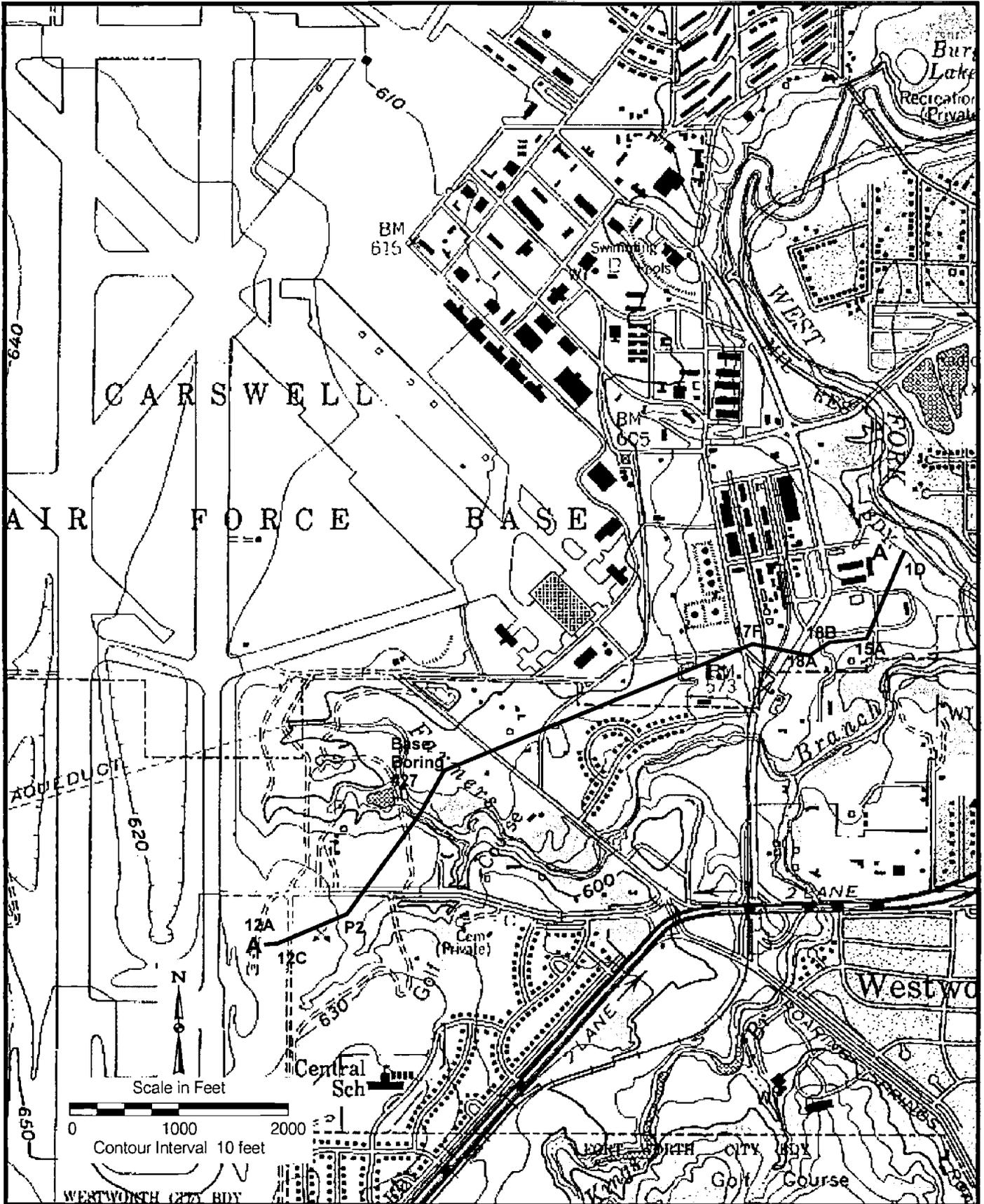
LEGEND

- NAS Ft. Worth JRB Site Boundary
- Former Carswell Air Force Base Property Boundary
- · - · - AFP4 Property Boundary



Filename: AFCEE\NAS Ft. Worth\Annual\BseBnd.dwg
Revised: 04/03/98 rze/mms
Project: AF001-07GBB
Map Source: Jacobs, 1996





Filename: AFCEE\NAS Ft Worth\Annual\X-sect.cdr
Project: AF001-079BB
Source: Radian, 1986

Figure 2-4
NAS Fort Worth JRB
CROSS SECTION LOCATION A - A'

Figure 2-5

NAS Fort Worth JRB GENERALIZED GEOLOGIC CROSS SECTION A - A'

Air Force Center
 For Environmental Excellence
 Brooks AFB, Texas

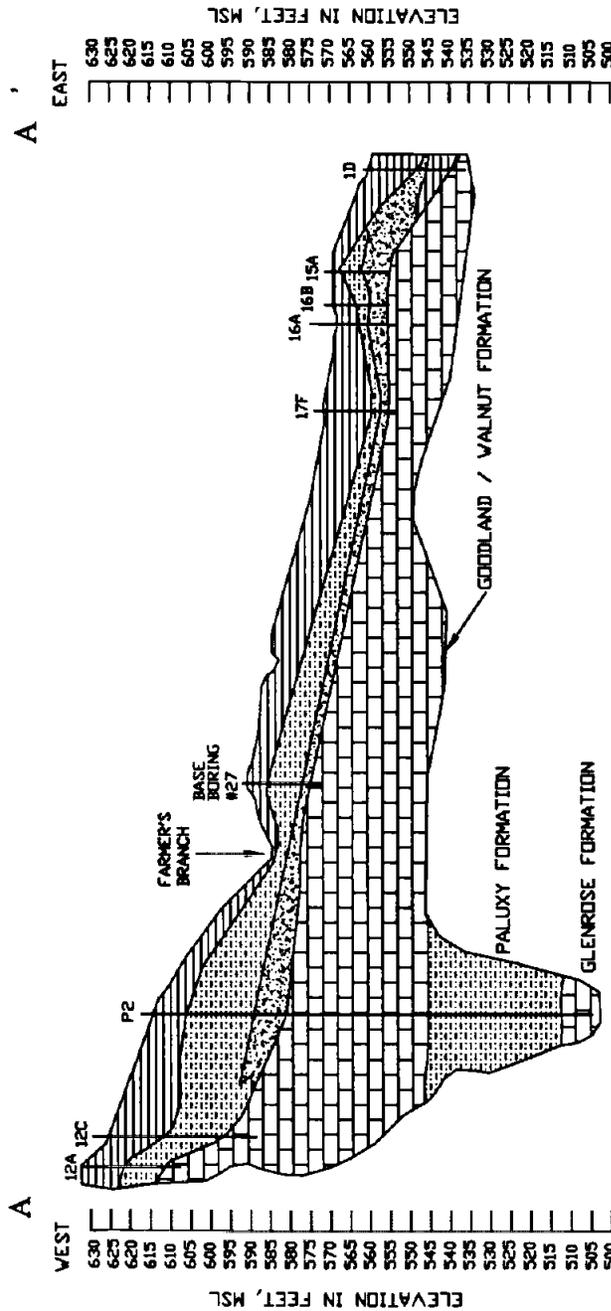
LEGEND

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

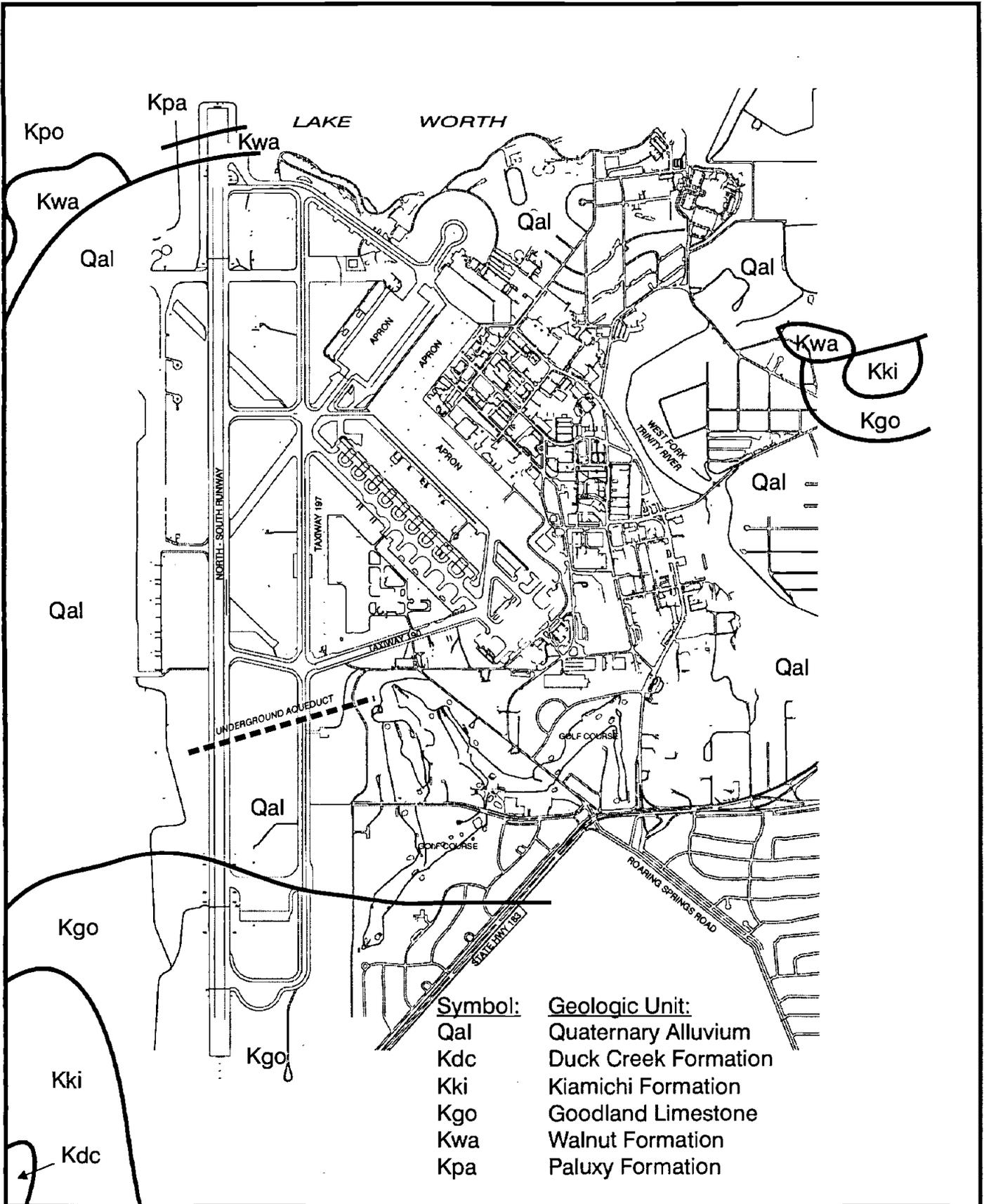


800 400 0 800
 HORIZONTAL SCALE IN FEET
 VERTICAL EXAGGERATION = 15X

Filename: AFCEEVNAS Ft Worth\ANNUAL\FIG2_5
 Revised: 12/1/97 rzh/mms
 Project: AF0001-GBB
 Map Source: Radtke, 1986



- 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.



Filename: AFCEENAS Ft Worth\Annual\geology.cdr
 Revised: 04/03/98
 Project: AFC001-079BB
 Map Source: Radian, 1989

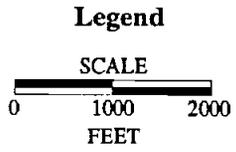


Figure 2-6
NAS Fort Worth JRB
AREAL DISTRIBUTION
OF GEOLOGIC UNITS

(Terrace Alluvium); (2) an aquitard of predominantly dry limestone of the Goodland and Walnut Formations; (3) an aquifer in the Paluxy Formation; (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. Table 2-1 presents additional information on the stratigraphic units found beneath NAS Fort Worth JRB. Each of these units is examined in more detail in the following paragraphs. This relationship is illustrated in Figure 2-7.

2.3.1 Terrace Alluvium Deposits

The uppermost groundwater in the area occurs within the pore space of the grains of silt, clay, 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, poor yield, and susceptibility to surface/stormwater pollution (USGS, 1996). No potable water supply wells are completed in the Terrace Alluvium within 0.5 miles of NAS Fort Worth JRB.

Recharge to the water-bearing deposits occurs through infiltration from precipitation (USGS, 1996). Extensive on-site pavement and construction restricts this recharge. Additional recharge, however, comes from leakage in water fuel feeder lines, sewer systems, storm drains, and cooling water systems. This inflow of water to the shallow aquifer locally affects groundwater flow patterns and contamination transport. The estimated hydraulic conductivity of the alluvial aquifer is 4.57 gallons per day per square foot (gpd/ft²) (Radian, 1989).

Flow between aquifers is restricted by the Goodland/Walnut Formations; therefore, the terrace alluvium groundwater has no significant hydraulic connection 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 Base. 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 on-site, specifically Farmers Branch Creek.

2.3.2 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 Formations. 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 1.2E-09 centimeters per second (cm/sec) to 7.3E-11 cm/sec for the NAS Fort Worth JRB and AFP 4 area. This corresponds to a vertical advective velocity rate that ranges between 1.16E-03 feet per day (ft/d) to 5.22E-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

Table 2-1. Stratigraphic Units at NAS Fort Worth JRB, Texas¹

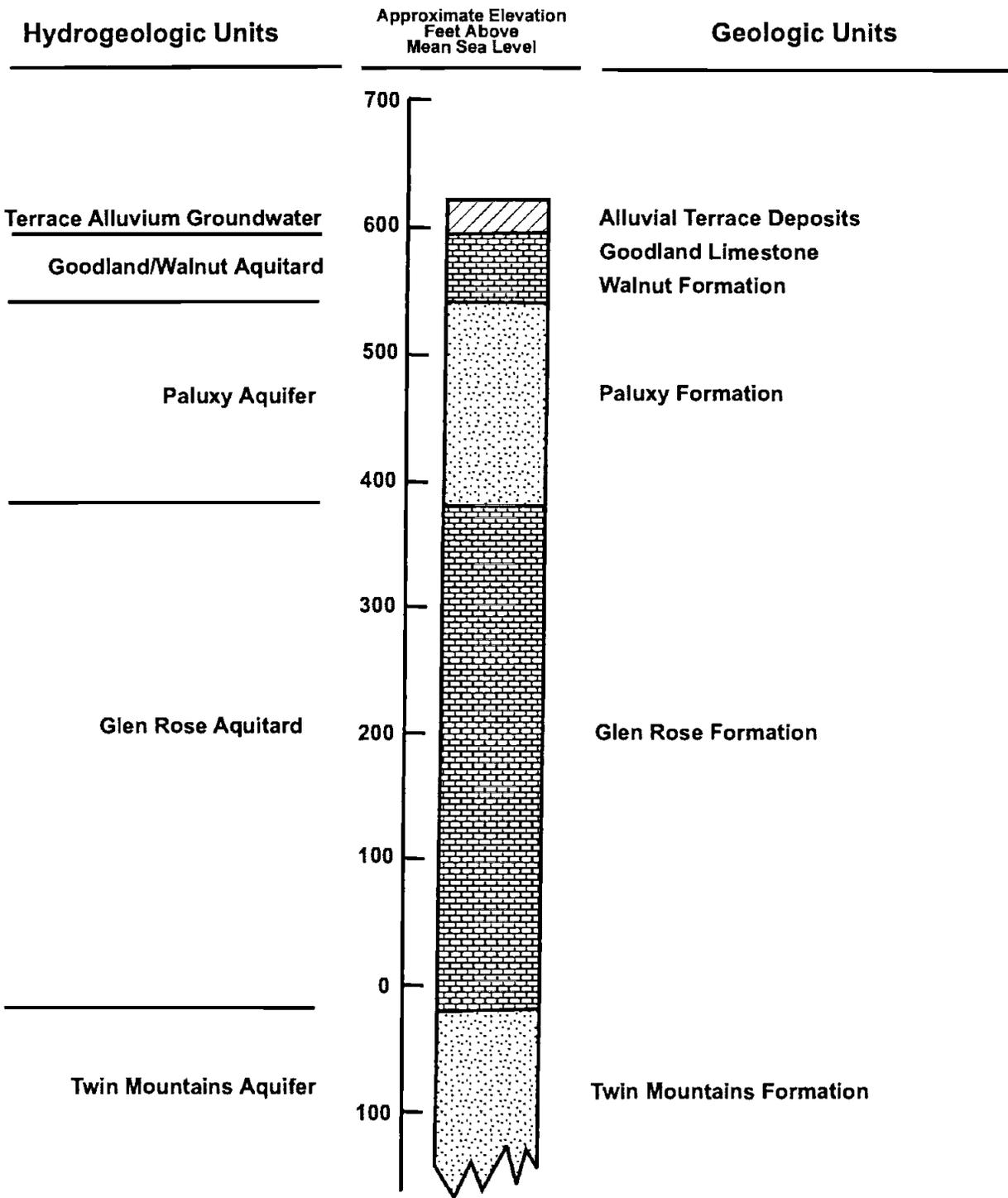
Era	System	Series/Group	Stratigraphic Unit	Thickness (feet) ²	Lithologic Characteristics ³	Water-Yielding Characteristics
Cenozoic	Quaternary (1.8 mya to present)	Holocene	Fill material	0	Construction debris	Permeability varies, gravels and sands permeable
			Recent alluvial deposits	0-50	Gravel, sand, silt, clay	
		Pleistocene	Terrace alluvial deposits	0-60	Gravel, sand, silt, clay	Permeability varies, gravels and sands permeable
	Tertiary (1.8 to 65 mya)	Eocene/Wilcox		-	-	-
		Paleocene/Midway		-	-	-
Mesozoic	Cretaceous (65 to 140 mya)	Gulfian		-	-	-
				-	-	-
		Comanchean/Washita		-	-	-
				-	-	-
		Comanchean/Fredericksburg	Goodland limestone	0-40	White fossiliferous limestone, coarsely nodular, resistant, and dense; contains some marl	Impermeable where not weathered; considered confining unit
			Walnut Formation	0.5-30	Medium to dark grey clay and limestone with shell conglomerates, fossiliferous, Gryphaea beds	Very low permeability; considered confining unit
		Comanchean/Trinity	Paluxy Formation	130-175	Light grey to greenish-grey sandstone and mudstone; fine-grained to coarse-grained sandstone	Considered aquifer, yields small to moderate quantities of water
			Glen Rose Formation	150, range unknown at AFP 4	Brownish-yellow and gray alternating limestone, marl, shale, and sand	Low permeability-considered confining unit in area of AFP 4
Twin Mountains Formation ⁴	200, range unknown at AFP 4		Fine- to coarse-grained sandstone shale and claystone, basal gravel conglomerate	Coarse sandstones and parts of formation considered aquifer, yields moderate to large quantities of water		

¹ Table adapted from USGS, 1996.

² Thickness determined from site logs, except for Glen Rose Limestone and Twin Mountains Formation (Baker et al., 1990, Figure 4 in USGS 1996).

³ Lithologic characteristics determined from field observations and from Winton and Adkins, 1919; University of Texas, Bureau of Economic Geology, 1972; U.S. Army Corps of Engineers, 1986; Baker et al., 1990; Environmental Science and Engineering, Inc., 1994, all in USGS 1996.

⁴ This stratigraphic name does not conform in the usage of the U.S. Geological Survey.



Filename:
AFCEENAS Ft Worth\Annual\strat.cdr
Revised: 04/03/98
Project: AFC001-079BB
Map Source: Radian, 1989

- Legend**
-  Alluvium
 -  Limestone
 -  Sandstone

Figure 2-7
NAS Fort Worth JRB
STRATIGRAPHIC COLUMN
CORRELATING HYDROGEOLOGIC
UNITS AND GEOLOGIC UNITS

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 beneath NAS Fort Worth JRB.

2.3.3 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 aquifer 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 1,263 to 13,808 gallons per day per foot (gpd/ft), respectively.

2.3.4 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.

2.3.5 Twin Mountains Aquifer

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 follows the regional eastward slope of the bedrock. 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 down dip. 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).

2.4 SURFACE WATER

NAS Fort Worth JRB is located within the Trinity River Basin adjacent to Lake Worth. The main surface water features of interest are Lake Worth, West Fork of the Trinity River, and Farmers

Branch Creek. Lake Worth, which was constructed in 1941 as a source of municipal water for the City of Fort Worth, borders the base to the north of AFP 4. The surface area of the lake is approximately 2,500 acres. The Paluxy aquifer discharges to Lake Worth near its western extent. However, at the middle of the lake near Bomber Road, the top of the Paluxy aquifer is recharged by Lake Worth. There does not appear to be a hydraulic connection between the Paluxy aquifer and the lake in the eastern portion where the Walnut Formation separates the Paluxy aquifer and Lake Worth. The elevation of the lake is fairly constant at approximately 594 feet above NGVD, the fixed elevation of the dam spillway (USGS, 1996).

The West Fork of the Trinity River, a major river in north central Texas, defines the eastern boundary of the Base. The Trinity River flows southeast towards the Gulf of Mexico. Because the river has been dammed, the 100- and 500-year flood plains downstream of the dam do not extend more than 400 feet from the center of the river or any of its tributaries.

Storm water runoff from NAS Fort Worth that is not routed to the Base or city sewer system is discharged into Lake Worth. The outfall is permitted under the National Pollution Discharge Elimination System (NPDES), and monitoring results document compliance with permit discharge limitations (IT Corporation, 1997b).

Surface drainage is mainly east towards the West Fork of the Trinity River. A portion of the base is 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. Most of the flow in the creek is due to surface runoff, with some groundwater recharge from the Terrace Alluvium aquifer. 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. 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.

2.5 CLIMATE

The climate in the Fort Worth area is classified as subhumid with long hot summers and short dry winters (USGS, 1996). 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 two to three days per year. The maximum precipitation recorded in a 24 hour period is 5.9 inches. On the average, measurable snowfall occurs two days per year.

This page was intentionally left blank.

TAB

3.0

3.0 MONITORING ACTIVITIES

This section describes the monitoring activities performed during the 1997 quarterly groundwater sampling events at NAS Fort Worth JRB. The work was performed in accordance with the draft GSAP (CH2M Hill, 1996a) and draft Basewide Quality Assurance Program Plan (QAPP) (CH2M Hill, 1996c). Where appropriate, October 1997 quarterly sampling procedures are described in detail in this section. Detailed descriptions of procedures followed for the previous quarterly sampling events in 1997 are provided in the individual quarterly reports (CH2M Hill, 1997a, 1997b; HGL, 1997a).

Monitoring activities included:

- Well inspection and water level measurements;
- Well purging and analytical sampling;
- Investigation-derived waste (IDW) management; and
- Laboratory and field analysis

3.1 WELL INSPECTION AND WATER LEVEL MEASUREMENTS

In order to evaluate existing groundwater flow patterns, 152 wells were selected for water level measurements during the January and July 1997 sampling events. The locations of these wells are provided in Figure 3-1. The wells were inspected, and water levels and total depths were measured. The water level measurements and total depths were taken several days prior to purging and sampling the wells in order to minimize water column disturbance.

A visual inspection of each monitoring well was conducted to determine the well's condition and integrity (e.g., pad condition, lock integrity, etc.). Following the visual inspection of each well, an organic vapor meter (OVM) was used to measure the levels of organic vapors in the background area, breathing zone, and at the top of each well casing immediately after the well cap had been removed. An electronic oil-water interface device was used to determine the presence and depth of NAPL, depth to water, and total well depth. All well inspection and measurement data were recorded in the field notes and on the groundwater field sampling data sheets (see Appendix A) and are summarized on Table B-1 in Appendix B.

3.2 SAMPLE WELL SELECTION

Of the 152 monitoring wells selected for water level measurements, 57 wells were selected for analytical sampling in the GSAP (CH2M Hill, 1996a). These wells met the following criteria, with several exceptions:

- The well was not located within 50 feet of another well constructed within the same geologic strata;
- The well was not recorded as being a dry well during construction or subsequent sampling or monitoring events;

This page was intentionally left blank.

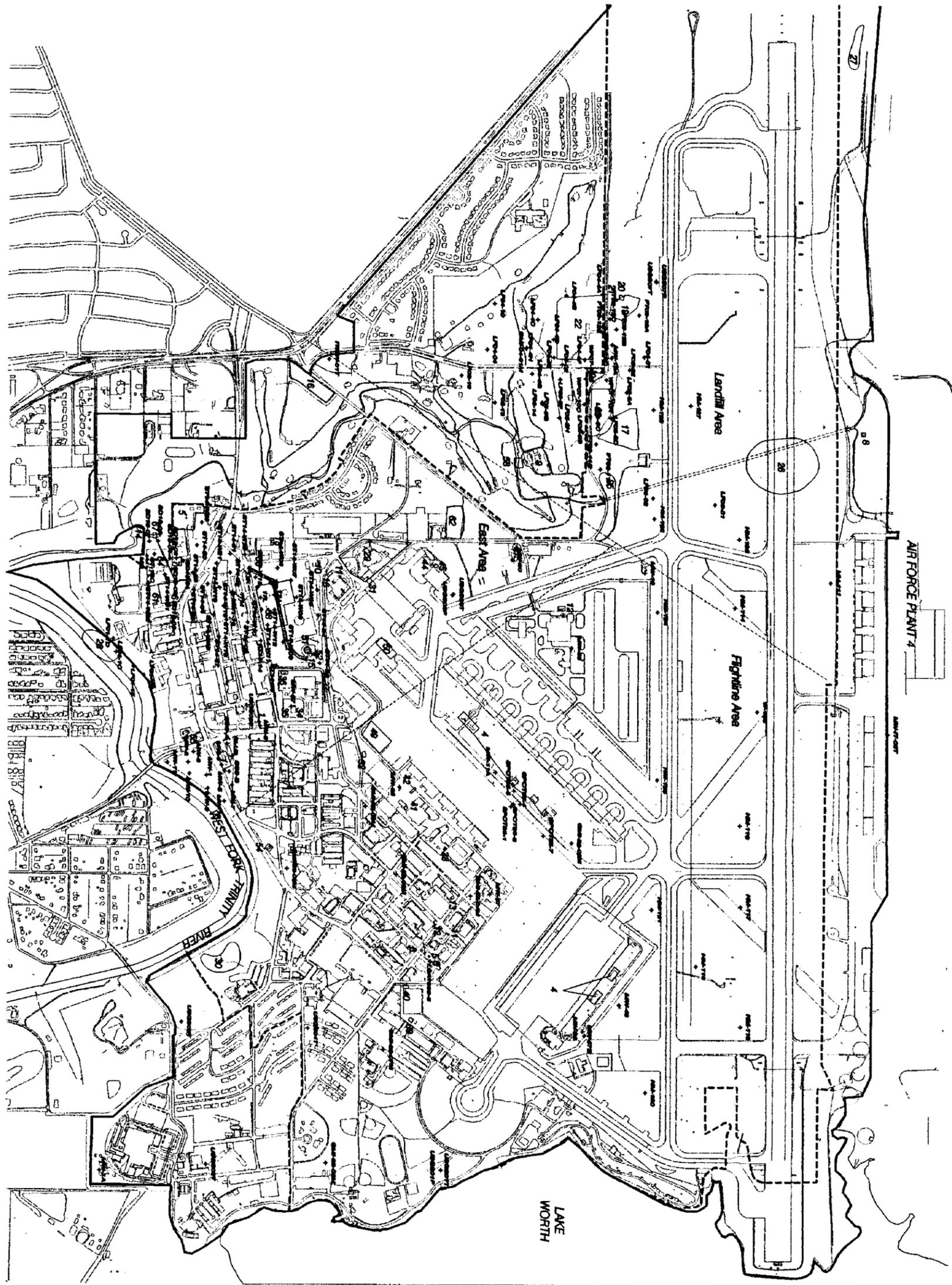


Figure 3-1
NAS Fort Worth JRB
WELLS SELECTED FOR INSPECTION
AND WATER LEVEL MEASUREMENTS

HydroGeologic, Inc. - Final 1997 Annual Report
 NAS Fort Worth JRB, Texas

Air Force Center
 For Environmental Excellence
 Brooks AFB, Texas

LEGEND

- NAS Fort Worth JRB (Current Plan)
- Former Command Air Force Base
- Building/Manufacturing Well Location
- △ Groundwater Management Areas

Active Areas of Concern (AOC)

- 1 Former Base Storage Building Former Base Gas Station
- 2 Former Base Storage Building Former Base Gas Station
- 3 Former Base Storage Building Former Base Gas Station
- 4 Former Base Storage Building Former Base Gas Station
- 5 Former Base Storage Building Former Base Gas Station
- 6 Former Base Storage Building Former Base Gas Station
- 7 Former Base Storage Building Former Base Gas Station
- 8 Former Base Storage Building Former Base Gas Station
- 9 Former Base Storage Building Former Base Gas Station
- 10 Former Base Storage Building Former Base Gas Station
- 11 Former Base Storage Building Former Base Gas Station
- 12 Former Base Storage Building Former Base Gas Station
- 13 Former Base Storage Building Former Base Gas Station
- 14 Former Base Storage Building Former Base Gas Station
- 15 Former Base Storage Building Former Base Gas Station
- 16 Former Base Storage Building Former Base Gas Station
- 17 Former Base Storage Building Former Base Gas Station
- 18 Former Base Storage Building Former Base Gas Station
- 19 Former Base Storage Building Former Base Gas Station
- 20 Former Base Storage Building Former Base Gas Station
- 21 Former Base Storage Building Former Base Gas Station
- 22 Former Base Storage Building Former Base Gas Station
- 23 Former Base Storage Building Former Base Gas Station
- 24 Former Base Storage Building Former Base Gas Station
- 25 Former Base Storage Building Former Base Gas Station
- 26 Former Base Storage Building Former Base Gas Station
- 27 Former Base Storage Building Former Base Gas Station
- 28 Former Base Storage Building Former Base Gas Station
- 29 Former Base Storage Building Former Base Gas Station
- 30 Former Base Storage Building Former Base Gas Station
- 31 Former Base Storage Building Former Base Gas Station
- 32 Former Base Storage Building Former Base Gas Station
- 33 Former Base Storage Building Former Base Gas Station
- 34 Former Base Storage Building Former Base Gas Station
- 35 Former Base Storage Building Former Base Gas Station
- 36 Former Base Storage Building Former Base Gas Station
- 37 Former Base Storage Building Former Base Gas Station
- 38 Former Base Storage Building Former Base Gas Station

Active Solid Waste Management Units (SWMU)

- 1 Building 1000 Waste Accumulation Area
- 2 Building 1000 Waste Accumulation Area
- 3 Building 1000 Waste Accumulation Area
- 4 Building 1000 Waste Accumulation Area
- 5 Building 1000 Waste Accumulation Area
- 6 Building 1000 Waste Accumulation Area
- 7 Building 1000 Waste Accumulation Area
- 8 Building 1000 Waste Accumulation Area
- 9 Building 1000 Waste Accumulation Area
- 10 Building 1000 Waste Accumulation Area
- 11 Building 1000 Waste Accumulation Area
- 12 Building 1000 Waste Accumulation Area
- 13 Building 1000 Waste Accumulation Area
- 14 Building 1000 Waste Accumulation Area
- 15 Building 1000 Waste Accumulation Area
- 16 Building 1000 Waste Accumulation Area
- 17 Building 1000 Waste Accumulation Area
- 18 Building 1000 Waste Accumulation Area
- 19 Building 1000 Waste Accumulation Area
- 20 Building 1000 Waste Accumulation Area
- 21 Building 1000 Waste Accumulation Area
- 22 Building 1000 Waste Accumulation Area
- 23 Building 1000 Waste Accumulation Area
- 24 Building 1000 Waste Accumulation Area
- 25 Building 1000 Waste Accumulation Area
- 26 Building 1000 Waste Accumulation Area
- 27 Building 1000 Waste Accumulation Area
- 28 Building 1000 Waste Accumulation Area
- 29 Building 1000 Waste Accumulation Area
- 30 Building 1000 Waste Accumulation Area
- 31 Building 1000 Waste Accumulation Area
- 32 Building 1000 Waste Accumulation Area
- 33 Building 1000 Waste Accumulation Area
- 34 Building 1000 Waste Accumulation Area
- 35 Building 1000 Waste Accumulation Area
- 36 Building 1000 Waste Accumulation Area
- 37 Building 1000 Waste Accumulation Area
- 38 Building 1000 Waste Accumulation Area



Reference: AFCEB/NAS Ft Worth/Annual Well Log
 Revised: 04/03/98
 Project: AFCEB/07-03B
 Map Source: Brooks, 1996

- The well did not have a screened interval greater than 20 feet, or was not screened within two or more separate geologic strata (exceptions include Paluxy wells); and
- The well did not contain free-product with a documented thickness greater than 0.01 feet (the thickness of the free-product, if encountered, was measured as described in Section 2.2.1 and in the draft GSAP [CH2M Hill, 1996a]).

Exceptions to these criteria were monitoring wells SD13-07, MW-1, MW-2, and GMI-04-01M. These wells were selected to provide additional horizontal flow data or critical chemical data near base boundaries. Well SD13-07 was selected even though LAW had detected free product in this well during their previous sampling round (LAW, 1996). A product recovery program implemented by LAW in January 1996 reduced product thickness in this well to 0.01 feet. Monitoring wells MW-1 and MW-2 have screened intervals greater than 20 feet; however, MW-1 was selected for its proximity to the documented contaminant plume, and MW-2 was selected due to its location near the base boundary. Well GMI-04-01M was also selected even though it was found to be dry during LAW's last sampling event (CH2M Hill, 1996a).

The wells selected for analytical sampling were further divided based on whether the wells were selected primarily to evaluate the potential for off-site migration or the extent of natural attenuation. The reason for selection of the well dictated the chemical parameters selected for analysis at each well. Table 3-1 includes a list of the wells selected for sampling, the rationale for their selection, and the chemical parameters analyzed at each well (CH2M Hill, 1996a).

Perimeter monitoring wells were selected from each groundwater management area in order to meet the short-term objective of identifying potential impacts to off-site groundwater receptors. Perimeter wells include wells screened in the alluvium and located near the NAS Fort Worth JRB boundaries and/or immediately upgradient of surface water bodies where groundwater may discharge to surface water bodies.

Natural attenuation wells were selected for evaluating and monitoring the extent of natural chemical attenuation that may be occurring in groundwater. The four well types are as follow:

- **Upgradient** - wells located upgradient of the impacted groundwater; results were used to evaluate background conditions.
- **Plume** - wells located within or at the lateral edges of the dissolved contaminant plume; results were used to evaluate the rate of contaminant removal by natural attenuation.
- **Sentry** - wells located at the edge or downgradient of the contaminant plume; results were used to verify that natural attenuation is reducing contaminant concentrations.
- **Perimeter** - wells located at the boundaries of NAS Fort Worth JRB and/or surface water boundaries where groundwater may discharge to surface water; results were used to monitor potential off-site migration.

Table 3-1. Monitoring Wells Selected for Analytical Sampling Program
NAS Fort Worth JRB Basewide Groundwater Sampling 1997

AREA	WELL	OBJECTIVE ²	RATIONALE	CHEMICAL PARAMETERS ¹ METHOD OF ANALYSIS ³										
				BTEX	VOCs	DO ⁴	COMMON ANIONS	Fe(II) ⁵	ALKALINITY	Eh ⁶	CH ₄	TOC	METALS	
Flightline	GMI-22-02M	2	Upgradient	SW78020A	SW8260A	X	X	X	SW9056	X	X	X	SW6010A/ SW7470	
	GMI-22-04M	2	Plume			X	X	X		X	X	X		
	GMI-22-05M	1,2	Perimeter			X								
	GMI-22-06M	2	Plume			X	X	X		X	X	X		
	GMI-22-07M	2	Sentry			X	X	X		X	X	X		
	LSA 1628-3	2	Plume			X	X	X		X	X	X		
	SPOT-35-2	2	Plume			X	X	X		X	X	X		
	SPOT-35-4	2	Plume			X	X	X		X	X	X		
	SPOT-35-5	2	Plume			X	X	X		X	X	X		
	USGS04T	1,2	Perimeter			X							X	
	17M	2	Plume			X	X	X		X	X	X		
	BSS-A	2	Upgradient			X	X	X		X	X	X		
	BSS-B	2	Plume			X	X	X		X	X	X		
	LF01-1B	1	Perimeter			X							X	
	LF01-1C	1	Perimeter			X							X	
LF01-1D	1	Perimeter			X							X		
LF01-1E	1	Perimeter			X							X		
MW-1	2	Sentry			X	X	X		X	X	X			
MW-10	1,2	Perimeter			X	X	X		X	X	X			
MW-11	1,2	Perimeter			X	X	X		X	X	X			
MW-12	1,2	Perimeter			X	X	X		X	X	X			
MW-3	2	Plume			X	X	X		X	X	X			
MW-5	2	Plume			X	X	X		X	X	X			
MW-8	2	Plume			X	X	X		X	X	X			
MW-9	1,2	Perimeter			X	X	X		X	X	X			
OT15C	1,2	Perimeter			X	X	X		X	X	X			
SD13-01	2	Sentry			X	X	X		X	X	X			
SD13-02	2	Sentry			X	X	X		X	X	X			
SD13-04	2	Sentry			X	X	X		X	X	X			
SD13-06	1,2	Perimeter			X	X	X		X	X	X			
SD13-07	1,2	Perimeter			X	X	X		X	X	X			
ST14-02	2	Plume			X	X	X		X	X	X			
ST14-03	2	Plume			X	X	X		X	X	X			
ST14-04	2	Plume			X	X	X		X	X	X			
ST14-14	2	Plume			X	X	X		X	X	X			
ST14-24	2	Plume			X	X	X		X	X	X			

**Table 3-1. Monitoring Wells Selected for Analytical Sampling Program
NAS Fort Worth JRB Basewide Groundwater Sampling 1997 (continued)**

AREA	WELL	OBJECTIVE ²	RATIONALE	CHEMICAL PARAMETERS ³ /METHOD OF ANALYSIS										
				BTEX	VOCs	DO ⁵	COMMON ANIONS	Fe(II) ⁵	ALKALINITY	Eh ⁵	CH ₄	TOC	METALS	
East	ST14-26	2	Upgradient	SW8020A	SW8260A		SW905G		E310.1		RSK475	SW9060	SW6010A/ SW7470A	
	ST14-28	2	Plume			X	X	X	X	X	X	X	X	
	ST14-29	2	Plume			X	X	X	X	X	X	X	X	
	ST14-W16	2	Plume			X	X	X	X	X	X	X	X	
	ST14-W18	2	Plume			X	X	X	X	X	X	X	X	
	ST14-W21	2	Plume			X	X	X	X	X	X	X	X	
	ST14-W31	2	Plume			X	X	X	X	X	X	X	X	
	FT09-12C	3	Plume			X	X	X	X	X	X	X	X	
Landfill	GM104-01M	3	Plume			X	X	X	X	X	X	X	X	
	LF04-10	3	Plume			X	X	X	X	X	X	X	X	
	LF04-4F	3	Plume			X	X	X	X	X	X	X	X	
	LF05-02	3	Plume			X	X	X	X	X	X	X	X	
	LF05-18	1	Perimeter			X	X	X	X	X	X	X	X	
	LF05-19	1	Perimeter			X	X	X	X	X	X	X	X	
	LF05-5G	3	Plume			X	X	X	X	X	X	X	X	
	WP07-10B	3	Plume			X	X	X	X	X	X	X	X	
	WP07-10C	3	Plume			X	X	X	X	X	X	X	X	

Notes:

- ¹The four wells screened in the Paluxy aquifer (USGS01P, USGS05P, USGS06P, and USGS07P) are not included in this table. They were sampled for VOCs in January only.
- ²Objectives are: (1) identify potential impacts to off-site groundwater receptors; (2) support closure of SWMUs/AOCs by modeling natural attenuation; and (3) support closure of SWMUs/AOCs by performing LTM for regulatory closure requirements.
- ³Chemical parameters include: benzene, toluene, ethylbenzene, and toluene (BTEX); volatile organic compounds (VOCs); dissolved oxygen (DO); common anions; ferrous iron Fe(II); alkalinity; oxidation-reduction potential (Eh); methane (CH₄); total organic carbon (TOC); and metals.
- ⁴CH2M Hill, 1996a; AFCEE, 1995
- ⁵Field Parameters

3.3 WELL PURGING AND ANALYTICAL SAMPLING

The procedures described below are specific to those used in the October 1997 sampling round. Similar procedures for well purging and analytical sampling for the other three sampling events can be found in the individual documents for those sampling rounds (CH2M Hill, 1997a, 1997b; HGL, 1997a).

Of the 57 wells selected for analytical sampling in the GSAP (CH2M Hill, 1996a), 52 wells were sampled during the October 1997 event. The four Paluxy monitoring wells (USGS01P, USGS05P, USGS06P, and USGS07P) and monitoring well SD13-07, which contained free product, were not sampled. Purging and sampling of the 52 selected wells for October sampling began on October 15, 1997, and was completed October 30, 1997. The wells were sampled using a low-flow purge technique (CH2M Hill, 1996b), the procedure recommended for AFCEE projects (AFCEE, 1996). The wells were purged with 2 inch stainless steel Grundfos Redi-Flo submersible pumps. Pumping rates were kept between 0.1 to 2.0 liter/minute to minimize turbidity, oxygenation, mixing of chemically distinct zones, and potential loss of volatile organic compounds (VOCs).

During purging, water quality stabilization criteria (pH, temperature, oxidation-reduction potential [Eh], turbidity, dissolved oxygen [DO], and electrical conductance [EC]) were continuously monitored and recorded on the well sampling field data sheets (Appendix A-2) using a flow-through cell. If the sampled well was not experiencing significant drawdown while purging (i.e., the water column did not drop more than 2 feet, or 10 percent of the screened interval length), the criteria for sample collection was the stabilization of water quality parameters as follows:

- Temperature +/-0.1°C
- pH +/-0.1 units
- EC +/-5% full scale range
- DO +/- 0.10 mg/L or 10% of value (whichever is greater)
- Eh +/-10%
- Turbidity +/-1% and less than 10 NTUs

A well was sampled when the water quality stabilization criteria were met, and the well did not experience a significant drawdown while purged (i.e., >2 ft or 10% of the screen length interval).

If these parameters did not stabilize, the sample was collected after three to five well volumes had been removed. If the sampled well was exhibiting excessive drawdown while being purged at the lowest possible flow rate for that well, the well was purged dry and the sample collected when a sufficient volume of water had accumulated in the well.

Samples for VOC analysis were collected first at each well. The remaining samples were collected based on the approximate order of susceptibility to artificial aeration (i.e., total metals, Total Organic Carbon (TOC), methane, ferrous iron, alkalinity, and anions). Required sample containers, preservation methods, volumes, and holding times are provided in Section 5 of the Basewide QAPP (CH2M Hill, 1996b) and on Table B-2 of the GSAP (CH2M Hill, 1996a).

3.4 INVESTIGATION-DERIVED WASTE (IDW) MANAGEMENT

IDW management procedures were followed as outlined in Section B.4.3 of the GSAP (CH2M Hill, 1996a). All drums are stored at SWMU 22. The purge water will be bulked, and samples will be collected and analyzed for the parameters necessary for profiling and disposal. The waste will be manifested using the Uniform Hazardous Waste Manifest to ensure a complete paper trail to document disposal, and transported to the disposal facility(s).

3.5 LABORATORY AND FIELD ANALYSIS

The methods selected for the chemical analyses for the October 1997 sampling event are summarized in the following paragraphs. They are also summarized on Table 2-2 and Table B-2 in the GSAP (CH2M Hill, 1996a). All samples, excluding those for ferrous iron analyses, were delivered by overnight courier to Quanterra Environmental Services in Tampa, Florida. Ferrous iron analyses were conducted on-site.

3.5.1 Laboratory Analysis

Fifty-two wells were sampled as part of the quarterly sampling program. Nineteen wells were analyzed for benzene, toluene, ethylene, and total xylenes (BTEX) using EPA Method SW8020, and 33 wells were sampled for VOCs, including BTEX, using EPA Method SW8260. Thirty wells were selected for natural attenuation monitoring and sampled for common anions using EPA Method SW9056, methane using EPA Method RSK-175, alkalinity using EPA Method E310.1, and TOC using EPA Method SW9060. Additionally, 14 samples collected from the perimeter wells, and six samples collected from the natural attenuation wells were analyzed for metals using EPA Method SW6010 (silver was analyzed using EPA Method SW7761, mercury was analyzed using EPA Method SW7470, and thallium was analyzed using EPA Method SW7841).

3.5.2 Field Analysis - Ferrous Iron

Samples collected from the 30 wells selected for natural attenuation monitoring (including the field quality control samples associated with these wells) were analyzed on-site for ferrous iron (Fe^{2+}), one of the parameters necessary to evaluate the potential presence of natural attenuation. A HACH Method 8146 spectrophotometer with a 1,10-phenanthroline reagent was used. This method is described in detail in the GSAP (CH2M Hill, 1996a). The reagent reacts with the Fe^{2+} in the sample to produce an orange color in proportion to the iron concentration. Ferric iron (Fe^{3+}) does not react in this test. All ferrous iron analyses were performed on the day of sample collection. All results of the on-site analyses were recorded in a field laboratory log book and are listed in Table B-2 in Appendix B.

3.6 QUALITY ASSURANCE/QUALITY CONTROL PROGRAM

The field quality control (QC) program for the collection of samples and the laboratory QC program for sample handling, laboratory control samples, and reporting are fully documented in the Basewide QAPP (CH2M Hill, 1996b). Field QC samples were collected to evaluate sampling technique and decontamination procedures. These samples included field duplicates, trip blanks,

and field equipment blanks. Documentation of the sampling was performed in the field to ensure that the sample collected, labeling, chain-of-custody and request for analysis were in agreement. Custody seals were placed on each cooler before shipment by common carrier.

3.6.1 Ambient Blanks

An ambient blank consists of ASTM Type II reagent grade water poured into VOC sample vials at a sampling site (in the vicinity of associated samples). The ambient blank is then handled like associated samples and transported to the laboratory for analysis. Ambient blanks are prepared only when VOC, BTEX, and/or methane samples are collected and are analyzed only for those 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.

3.6.2 Equipment Blanks

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

3.6.3 Trip Blanks

A trip blank consisted of a VOC sample vial filled in the laboratory with ASTM Type II reagent grade water, transported to the sampling site, handled as an environmental sample, and returned to the laboratory for analysis. Trip blanks were not opened in the field and were prepared only when VOC samples were collected for analysis. Trip blanks were used to assess the potential introduction of contaminants from sample containers, or during the transportation and storage procedures.

3.6.4 Field Duplicates

A field duplicate is a second sample collected in the same location as the original sample. Duplicate samples were collected simultaneously, or in immediate succession, using identical recovery techniques, and treated in an identical manner during transportation, storage, and analysis.

3.6.5 Laboratory Procedures

In the laboratory, sample handling included documentation of sample receipt, placement in storage, lab personnel use of the sample, and disposal. The laboratory control consisted of instrument calibration and maintenance, laboratory control samples, method blanks, and matrix spikes. Reporting of the laboratory control data was planned prior to the collection of the data,

allowing the laboratory to place the appropriate information into the data package so that the data quality evaluation (DQE) could be performed in a timely manner.

3.7 SAMPLE TRACKING PROTOCOL

Each sample was assigned a unique identification number that described where the sample was collected. The number consists of a maximum 12 digit alphanumeric code as follows:

xxxx-yyyzz-aa

where:

xxxx represents the site identification (e.g., LF04, LF06, LF07, LF09, LF10)

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

zz represents the medium (WG=water-ground, SO=soil, WS = water-surface, SD=sediment)

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

For example, the first groundwater sample collected from LF04 will be identified as "LF04-04FWG-01." The locations from which field duplicate samples were to be collected were determined prior to mobilization. Unique sample identification numbers, which do not associate the duplicate with its parent sample, were assigned to field duplicates. Documentation was maintained in the field sampling log book to track these field duplicate samples.

Field quality control samples, collected during the fourth quarterly groundwater sampling event, include blanks and duplicates and are summarized in Table 3-2.

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

xyyyyyyy

where:

xx represents medium (EB=equipment blank, TB=trip blank, AB=ambient blank)

yyyyyy represents date (month, day, year)

For example, an equipment blank obtained on September 22, 1997 would be identified as EB092297.

The Project Geologist/Field Coordinator maintained a list that described the connection between each QC sample and specific environmental samples. For instance, each trip blank was correlated

with a particular set of samples shipped to the laboratory, and each equipment blank was correlated to those samples collected using a particular set of sampling tools.

After the laboratory data were received and validated, the data were loaded into Installation Restoration Program Information management System (IRPIMS). An electronic deliverable report in the IRPIMS format will be provided.

**Table 3-2. Field Quality Control Samples
Collected for October 1997 Sampling Event**

Type of Sample	Frequency	Total Number	Time	Analysis
Ambient Blank ¹	1 ambient blank/ sampling event	1	During normal sample collection conditions	VOC, BTEX, and/or methane analyses consistent with sampling event
Equipment Blank ²	1 equipment blank/ day	8	Immediately after equipment had been decontaminated	All laboratory analyses consistent with daily sampling
Trip Blank ³	1 trip blank/ sample cooler	8	When VOC, BTEX, and/or methane samples were collected	VOC, BTEX, and/or methane analyses consistent with cooler contents
Field Duplicates (blind) ⁴	1 duplicate/10 environmental samples	5	Collected at the same time and location of original sample	Same as original sample

Notes:

¹Used to assess the impact of ambient conditions.

²Used to assess the effectiveness of equipment decontamination procedures.

³Used to assess the potential contaminants from sample containers or other foreign sources during the transportation and storage procedures.

⁴The duplicate sample is assigned a unique identification number in the field in order to trace the sample analyses to each duplicate.

This page was intentionally left blank.

TAB

4.0

4.0 FIELD DATA RESULTS

Well inspection observations for all quarters and groundwater elevation measurements for January and July sampling events are presented in the following section.

4.1 WELL INSPECTIONS

During all four quarterly sampling events, the integrity and condition of each monitoring well and the water level survey were noted in a field log book. A summary of the field inspection comments/observation for all of the quarterly sampling events are provided in Table 4-1. A copy of the field notes for the October 1997 sampling event is provided in Appendix A, along with copies of the groundwater field sampling data sheets. A summary of field observations for October 1997 is provided in Table B-1 of Appendix B. Field data for January, April, and July 1997 sampling can be found in the quarterly reports for these events (CH2M Hill, 1997a, 1997b; HGL, 1997a).

Out of the 53 wells proposed for sampling in the GSAP, 52 were sampled during the fourth quarter October 1997 event. The well that was not sampled, well SD13-07, was found to contain 0.24 feet of LNAPL, which exceeds the product thickness requirement for groundwater sampling specified in the GSAP (0.01 feet). This well has consistently contained free product of a thickness greater than 0.1 feet during all four quarters of sampling in 1997 and has not been sampled during any event.

4.2 GROUNDWATER LEVEL ELEVATIONS

Groundwater level elevations were measured in 152 wells in January and July in order to construct a potentiometric map for the uppermost aquifer (i.e., Terrace Alluvium). Of the 152 selected wells, seventeen wells did not have surveyed elevation points available, so the elevations could not be calculated. Four wells were eliminated because they were screened in the Paluxy Aquifer. During January 1997 water level measurements, monitoring well GMI-04-01M was dry. During July 1997 water level measurements, monitoring wells HM114 and HM126 were not located (due to high grass), and the elevation reading at monitoring well HM127 was eliminated because of an erroneous water-level measurement likely due to field measurement error.

Groundwater elevations from the remaining on-site wells screened in the Terrace Alluvium, provided in Table 4-2, were used to construct the potentiometric maps for January and July 1997, presented in Figure 4-1 and Figure 4-2. In general, the regional groundwater flow direction is from west to east. Groundwater elevation varied from 625 feet above national geodetic vertical datum (NGVD) along the western border to 535 feet NGVD in the eastern portion of the site. The head gradients toward the eastern end of the site are approximately double those on the western portion. The groundwater gradient ranges from approximately 0.05 ft/ft to 0.003 ft/ft.

Some local variations in groundwater direction are reflected on the potentiometric maps. The influence of the pump and treat system can be seen in the contours (i.e., contours curve towards the west) in the Landfill Area where flow is influenced by the drawdown from recovery wells. Monitoring well data on groundwater elevations in the central portion of Landfill Area indicate

**Table 4-1. Summary of Well Inspection Observations During
1997 Quarterly Sampling Events**

<p><u>Wells Omitting Petroleum Odor:</u> OT-15B, 17M, MW-1, MW-2, MW-38, MW-5, MW-6, OT-15C, SD13-01, SD13-03, SD13-04, SD13-06, SD13-07, SPOT35-1, SPOT35-2, ST14-02, ST14-29, ST14-W16, ST14-W19, BSS-B, 17L, ST14-W12, SPOT35-7, ST14-W15, SD13-05</p>
<p><u>Wells with Free Product:</u> 17M (Jan, Apr)¹, SD13-04 (Jan, Apr), SD13-07 (Jan, Apr, Jul, Oct), LF04-04 (Jul), SD13-05(Jul)</p>
<p><u>Wells Damaged to Some Degree:</u> MW-11, MW-12, MW-1A, MW-2, MW-7, SPOT35-5, USGS01T, SD13-05, ST14-W31, ST14-W22, LF01-1B, SPOT35-4, ST14-W20</p>
<p><u>Wells Destroyed or Abandoned:</u> PI-U9, USGS02T, MW-1A</p>
<p><u>Wells Not Located:</u> HM114 (Jul), HM126 (Jul)</p>
<p><u>Dry Wells:</u> GMI-04-01M (Jan, Apr), LF04-4H (Jan, Apr), LF05-14 (Jan, Apr), MW-12A (Jan, Apr)</p>

Notes:

¹ Well ID with Sampling Event in parentheses (i.e., Jan, Apr, Jul, Oct) are specific to that sampling event(s) only.

Table 4-2. Water Table Elevations for January and July 1997

Area	Location	Groundwater Elevation January 1997	Groundwater Elevation July 1997	Change in Elevation
Flightline	GMI-22-02M	608.79	610.12	1.33
	GMI-22-03M	587.29	587.83	0.54
	GMI-22-04M	590.66	591.61	0.95
	GMI-22-05M	572.56	575.08	2.52
	GMI-22-06M	588.32	589.06	0.74
	GMI-22-07M	589.69	591.48	1.79
	GMI-22-08M	590.58	592.18	1.60
	HM-116	610.48	612.95	2.47
	HM-117	611.04	613.27	2.23
	HM-118	610.24	612.48	2.24
	HM-119	611.02	613.28	2.26
	HM-120	611.65	614.02	2.37
	HM-121	609.16	610.54	1.38
	HM-124	607.87	611.40	3.53
	HM-125	610.34	613.19	2.85
	LSA1628-3	591.24	592.57	1.33
	MW-1A	-- ¹	-- ^{1,2}	--
	MW-11A	589.39	590.11	0.72
	MW-19	-- ¹	-- ¹	--
	MW-38	587.93	588.61	0.68
	MW-48	608.92	610.23	1.31
	MW-53	600.62	602.04	1.42
	MW-56	606.29	606.95	0.66
	MW-57	600.09	601.66	1.57
	MW-57B	606.09	606.76	0.67
	SPOT35-1	590.70	591.45	0.75
	SPOT35-2	591.88	592.68	0.80
	SPOT35-4	591.97	592.80	0.83
	SPOT35-5	591.88	592.74	0.86
	SPOT35-7	608.68	609.89	1.21
	USGS01P	-- ³	574.39 ³	--
	USGS01T	593.26	594.43	1.17
	USGS02T	585.91	-- ²	--
USGS03T	571.29	571.42	0.13	
USGS04T	586.78	588.06	1.28	
W-153	610.24	612.96	2.72	
East	15B	559.14	559.62	0.48
	17I	567.02	568.35	1.33
	17J	568.32	569.83	1.51
	17K	565.36	566.73	1.37
	17L	566.51	567.97	1.46
	17M	-- ¹	-- ¹	--
	BSS-A	561.43	561.88	0.45

Table 4-2. Water Table Elevations for January and July 1997 (continued)

Area	Location	Groundwater Elevation January 1997	Groundwater Elevation July 1997	Change in Elevation
East	BSS-B	559.65	560.20	0.55
	LF01-1B	546.59	550.44	3.85
	LF01-1C	544.79	548.74	3.95
	LF01-1D	545.36	549.73	4.37
	LF01-1E	545.15	548.95	3.80
	MW-1	548.73	553.37	4.64
	MW-2	546.26	549.63	3.37
	MW-3	564.88	566.23	1.35
	MW-5	560.45	560.63	0.18
	MW-6	560.55	560.82	0.27
	MW-7	558.90	559.87	0.97
	MW-8	549.59	552.76	3.17
	MW-9	549.56	553.93	4.37
	MW-10	545.15	549.25	4.10
	MW-11	531.99	536.04	4.05
	MW-12	550.42	554.65	4.23
	MW-20	591.93	591.95	0.02
	MW-37	581.58	581.93	0.35
	MW1-16	-- ¹	-- ¹	--
	PI-U9	-- ^{1,2}	-- ¹	--
	SD13-01	560.83	561.41	0.58
	SD13-02	560.12	560.65	0.53
	SD13-03	560.24	560.75	0.51
	SD13-04	559.42	559.98	0.56
	SD13-05	562.41	562.72	0.31
	SD13-06	547.47	547.77	0.30
	SD13-07	542.58	543.86	1.28
	ST14-01	562.06	562.83	0.77
	ST14-02	563.36	564.24	0.88
	ST14-03	566.90	568.70	1.80
	ST14-04	563.05	563.91	0.86
	ST14-14	-- ¹	-- ¹	--
	ST14-24	582.96	583.39	0.43
	ST14-25	-- ¹	-- ¹	--
	ST14-26	-- ¹	-- ¹	--
	ST14-27	-- ¹	-- ¹	--
	ST14-28	-- ¹	-- ¹	--
	ST14-29	561.85	562.57	0.72
	ST14-30	561.25	561.67	0.42
	ST14-W05	585.09	585.83	0.74
ST14-W06	571.76	573.13	1.37	
ST14-W07	568.11	569.76	1.65	
ST14-W08	569.70	571.30	1.60	

Table 4-2. Water Table Elevations for January and July 1997 (continued)

Area	Location	Groundwater Elevation January 1997	Groundwater Elevation July 1997	Change in Elevation
East	ST14-W09	567.07	568.65	1.58
	ST14-W10	567.51	568.93	1.42
	ST14-W11	569.02	570.46	1.44
	ST14-W12	569.78	571.19	1.41
	ST14-W13	566.18	567.54	1.36
	ST14-W15	562.98	563.63	0.65
	ST14-W16	565.21	566.55	1.34
	ST14-W18	564.60	565.71	1.11
	ST14-W19	563.66	564.53	0.87
	ST14-W20	564.31	565.13	0.82
	ST14-W21	562.61	563.33	0.72
	ST14-W22	561.31	561.74	0.43
	ST14-W23	559.55	560.21	0.66
	ST14-W31	560.70	561.22	0.52
	ST14-W32	-- ¹	-- ¹	--
	USGS05P	-- ³	538.99 ³	--
	USGS06P	-- ³	548.79 ³	--
USGS06T	588.31	589.46	1.15	
Landfill	FT08-11A	596.09	600.17	4.08
	FT08-11B	597.41	600.39	2.98
	FT09-12A	617.37	621.19	3.82
	FT09-12B	595.29	598.42	3.13
	FT09-12C	594.92	598.01	3.09
	FT09-12D	595.51	598.72	3.21
	FT09-12E	594.99	598.07	3.08
	GMI-04-01M	-- ⁴	595.22	--
	HM-111	610.20	614.07	3.87
	HM-114	-- ¹	-- ^{1,5}	--
	HM-122	599.99	602.37	2.38
	HM-123	597.39	601.12	3.73
	HM-126	607.75	-- ⁵	--
	HM-127	598.15	586.21	-- ⁶
	ITMW-01T	-- ¹	-- ¹	--
	LF04-01	596.66	600.17	3.51
	LF04-02	593.72	596.31	2.59
	LF04-04	592.41	592.57	0.16
	LF04-10	592.72	595.21	2.49
	LF04-4A	612.25	617.65	5.40
	LF04-4B	600.35	602.47	2.12
	LF04-4C	593.24	595.93	2.69
	LF04-4D	593.64	596.35	2.71
LF04-4E	593.62	596.20	2.58	

Table 4-2. Water Table Elevations for January and July 1997 (continued)

Area	Location	Groundwater Elevation January 1997	Groundwater Elevation July 1997	Change in Elevation
Landfill	LF04-4F	594.69	597.62	2.93
	LF04-4G	591.82	594.70	2.88
	LF04-4H	-- ^{1,4}	-- ¹	--
	LF05-01	601.90	604.55	2.65
	LF05-02	596.60	599.16	2.56
	LF05-14	-- ⁴	594.96	--
	LF05-18	592.02	593.56	1.54
	LF05-19	591.37	592.79	1.42
	LF05-5A	596.86	600.32	3.46
	LF05-5B	592.47	593.73	1.26
	LF05-5C	596.15	598.94	2.79
	LF05-5D	597.25	601.92	4.67
	LF05-5E	596.59	600.18	3.59
	LF05-5F	-- ¹	-- ¹	--
	LF05-5G	593.31	594.92	1.61
	LF05-5H	593.80	595.43	1.63
	MW-12A	-- ^{1,4}	-- ¹	--
	MW-IT-02T	-- ¹	-- ¹	--
	OT-15C	555.81	556.33	0.52
	USGS07P	-- ³	545.26 ³	--
USGS07T	620.65	624.24	3.59	
WP07-10A	596.22	599.79	3.57	
WP07-10B	594.68	597.12	2.44	
WP07-10C	595.85	597.98	2.13	

Notes:

¹Groundwater elevation could not be calculated due to missing survey data.²Well was found destroyed and abandoned.³Groundwater elevation data was not used in analyses since this well is in the Paluxy Aquifer.⁴Well was dry during monitoring event.⁵This well was not located during the monitoring event.⁶Groundwater elevation data was not used in analyses since this was considered an erroneous reading.

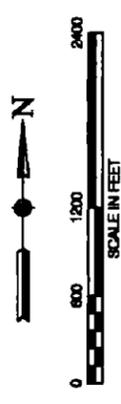
Figure 4-1

NAS Fort Worth JRB
GROUNDWATER ELEVATIONS
JANUARY 1997

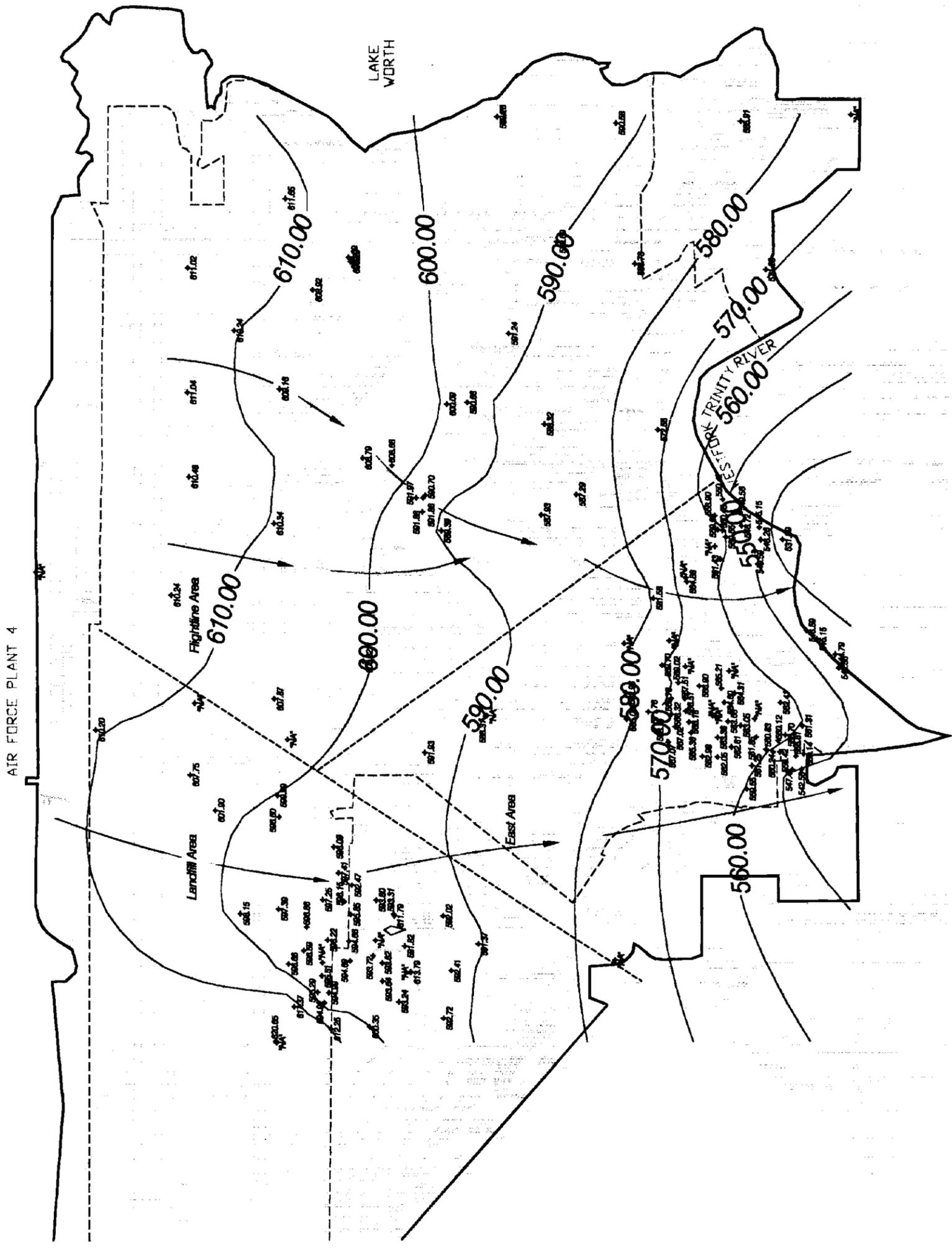
Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

-  Approximate Groundwater Management Areas
-  NAS Fort Worth JRB (Carswell Field)
-  Former Carswell Air Force Base
-  Monitoring Well Groundwater Elevation (ft NVGD)
-  Groundwater Contour Interval
-  Generalized Direction of Flow
-  Data Not Available



Filename: AFCEE\NAS Ft Worth\ANNUAL\GmdWfr.dwg
 Revised: 04/07/98 jb
 Project: AFC001-07GBB
 Map Source: Jacobs, 1996



AIR FORCE PLANT 4

Figure 4-2

NAS Fort Worth JRB GROUNDWATER ELEVATIONS JULY 1997

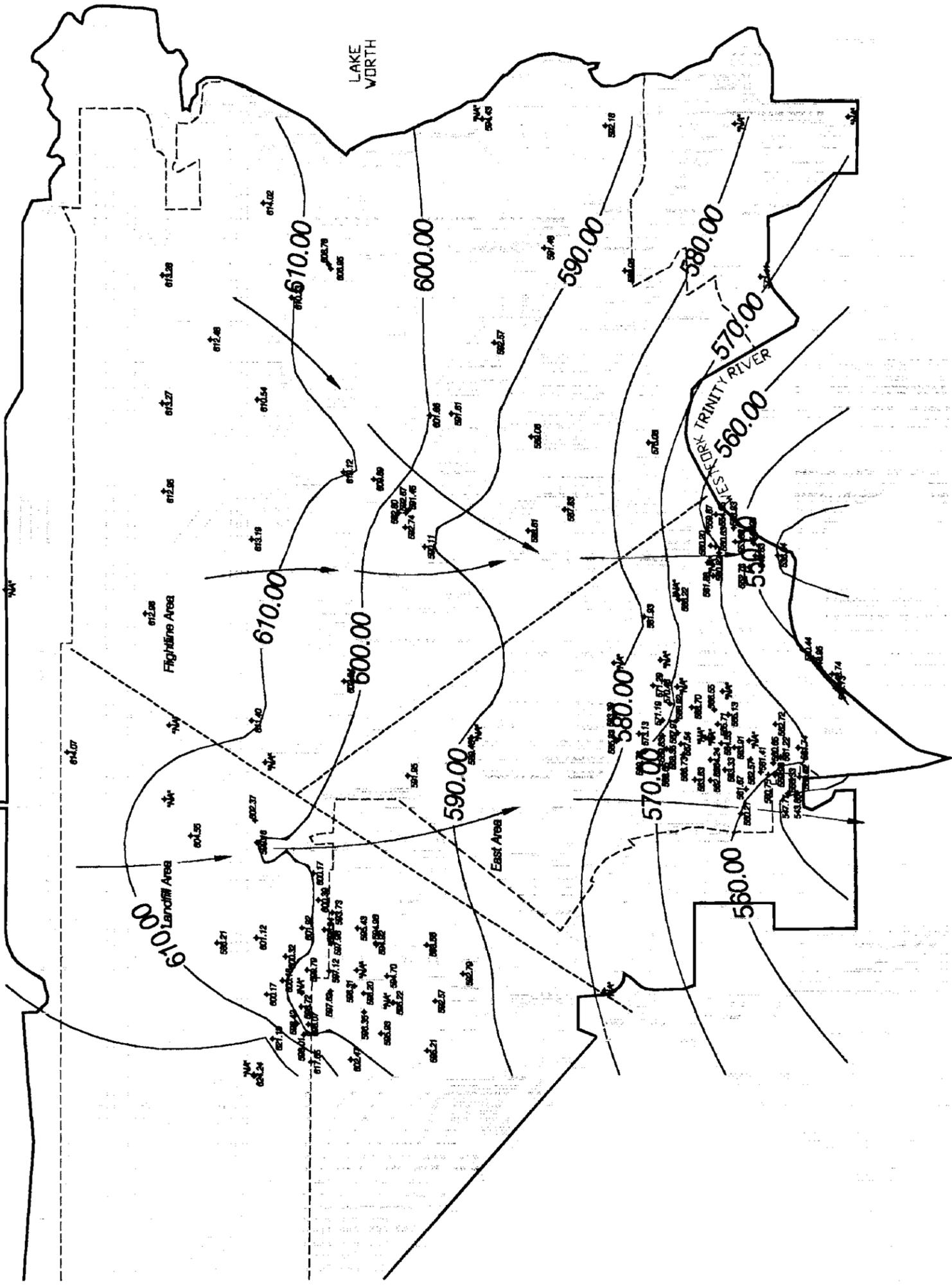
Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

-  Approximate Groundwater Management Areas
-  NAS Fort Worth JRB (Carswell Field)
-  Former Carswell Air Force Base
-  Monitoring Well Groundwater Elevation (ft NVGD)
-  Groundwater Contour Interval
-  Generalized Direction of Flow
-  Data Not Available



Filename: AFCEE\NAS Ft Worth\ANNUAL\GndWtr.dwg
 Revised: 04/07/98 jb
 Project: AFC001-07GBB
 Map Source: Jacobs, 1996



that the local groundwater flow is toward the north-eastern direction towards Farmers Branch Creek. Monitoring data from the East Area suggest that the local flow is from west to east. However, contours in the southern portion of East Area indicate possible flow bifurcation toward the downgradient which are likely due to the interaction with the West Fork of the Trinity River.

Groundwater elevations range from 610 feet NVDG to 590 feet NVDG along the northern border adjacent to Lake Worth. The terrace alluvial aquifer (0-60 feet thick) is discharged by evapotranspiration, and seepage to Lake Worth, Meandering Road Creek, and Farmers Branch (USGS, 1996). Based on groundwater contour maps generated by the USGS (1996) and for quarterly gauging, flow from the terrace alluvial aquifer (in the vicinity of the Base) also appears to be discharging to the West Fork of the Trinity River.

Groundwater elevations in a majority of the wells increased by 1 to 4 feet between the January and July sampling events. This is consistent with the seasonal trends of wet springs and dry winters. The July measurements were likely influenced by a precipitation event of 0.87 inches which occurred on July 7, 1997, one to two days before the July measurements were taken (www.ncdc.noaa.gov). A comparison between groundwater elevations contours of January 1997 (Figure 4-1) and July 1997 (Figure 4-2) indicates no significant change in elevations except for a few areas. These areas are depicted in Figure 4-3 by the contours of the difference between the January and July water level measurements. The differential between the two water level elevations is greatest along the western bank of the West Fork Trinity River and the southwest corner of the Base in the vicinity of the pump and treat system. Both of these areas are likely influenced by hydrologic controls such as bank storage and potential variations in pumping scenarios related to the pump and treat system.

4.3 FREE PRODUCT

During well inspection in January 1997, free product was found in three wells: 17M (0.04 feet); SD13-04 (0.17 feet); and SD13-07 (0.16 feet). As a result, these wells were not sampled during the January event. In addition, the water in well SD13-06 (located between SD13-04 and SD13-07) exhibited a visible sheen and strong odor, and therefore, was not sampled.

A 6-month free product measurement and removal program was initiated in February 1997 for those wells found to contain free product during the January 1997 sampling event (17M, SD13-04, and SD13-07). After two removal events were completed (on February 27, 1997 and March 31, 1997), wells 17M and SD13-04 were observed to have less than 0.01 feet of free product. During the April 1997 basewide sampling event, monitoring wells 17M and SD13-04 were also found to contain no free product and were sampled; monitoring well SD13-07 contained 0.02 feet of product, and again, was not sampled.

During the July 1997 sampling event, two monitoring wells, LF04-04 and SD13-05, had measurable free product, but at thicknesses of less than 0.01 feet; these two wells were sampled. SD13-07 had measured free product thickness of 0.015 feet, and therefore, was not sampled.

During October 1997, only monitoring well SD13-07 contained measurable free product and was not sampled.

This page was intentionally left blank.

Figure 4-3
CHANGE IN WATER LEVEL
FROM JANUARY TO JULY 1997
NAS Fort Worth JRB

Air Force Center For
Environmental Excellence
Brooks AFB, Texas

LEGEND

- - - - - NAS Fort Worth JRB (Carswell Field)
- Former Carswell Air Force Base
- +2— Groundwater Elevation Change Contour (feet)
- ▲ Approximate Groundwater Management Areas



Filename: AFCEE00\07GRR\FIG4_3.apr
Revised: 04/05/98 rnz/lms
Project: AFC001-07GRR
Map Source: Jacobs, 1996



TAB

5.0

5.0 ANALYTICAL RESULTS

As described in the 1997 GSAP (CH2M Hill, 1996a), well locations and chemical parameters were the primary factors considered for well selection in basewide quarterly sampling program. Table 5-1 presents the chemical parameters monitored at each well sampled throughout the year. In some cases, wells originally selected for sampling in the GSAP were not sampled due to the presence of free product or insufficient flow. Figure 5-1 shows the location of the wells selected for the quarterly sampling events conducted in 1997. The criteria for well and chemical parameter selection are described in detail in the 1997 GSAP and are summarized as follows:

- Perimeter Wells - sampled for VOCs and metals
- Bedrock Wells - sampled for VOCs
- Natural Attenuation Wells - sampled for natural attenuation parameters and BTEX compounds
- Long-Term Monitoring (LTM) Wells - sampled for VOCs to address long-term compliance issues related to SWMUs/AOCs located in the Landfill Area

5.1 CONTAMINANT EVALUATION

To facilitate discussion of contamination at NAS Fort Worth JRB, levels of contamination determined from analytical sampling were compared to several threshold values. The results of metals analyses were compared to established background concentrations (Jacobs, 1997), and the results of the VOCs analyses were compared to practical quantitation limits (PQLs). These comparisons identified locations where contamination is likely, and monitoring should be continued to provide further characterization. In addition, both metals and VOCs were compared to the TNRCC Risk Reduction Standard 2 (RRS 2) values. Comparison of contaminant concentrations to their respective RRS 2 value provides a basis for risk assessment. Concentrations that exceed their RRS 2 values indicate areas where continued monitoring and remedial action is necessary.

5.1.1 Background Concentrations

Background concentrations were determined for 24 inorganic constituents at NAS Fort Worth JRB (Jacobs, 1997). A single groundwater sample was taken from each of twelve background wells in December 1996 using a low-stress technique to approximate filtered samples. The groundwater monitoring wells sampled, both newly installed and existing, were located up- and cross-gradient from wells that were known to contain volatile and semivolatile compounds.

The Tolerance Interval (TI) method suggested by EPA (1989b, 1992) was used to estimate background concentrations for the 24 inorganic constituents for comparison to compliance wells. Tolerance intervals are useful for groundwater data analysis because it is important to ensure that, at most, a small fraction of the compliance wells sampled exceed a specific concentration level (EPA, 1992). Two coefficients are associated with any tolerance interval; one is the proportion

Table 5-1. Chemical Analyses Performed
NAS Fort Worth JRB Basewide Groundwater Sampling 1997

Area	Location	January 1997				April 1997				July 1997				October 1997				
		VOCs	BTEX	Metals	NAPL													
Fightline	GMI-22-02M	X			X	X			X	X			X	X			X	
	GMI-22-04M	X			X	X			X	X			X	X			X	
	GMI-22-05M	X		X	X	X		X	X			X	X			X	X	
	GMI-22-06M	X			X	X			X	X			X	X			X	
	GMI-22-07M	X			X	X			X	X			X	X			X	
	LSA1628-3	X			X	X			X	X			X	X			X	
	SPOT35-2	X			X	X			X	X			X	X			X	
	SPOT35-4	X			X	X			X	X			X	X			X	
	SPOT35-5	X			X	X			X	X			X	X			X	
	USGS04T	X		X	X	X		X	X			X	X	X			X	
	17M	not sampled - LNAPL found				X	X			X	X			X	X			X
	BSS-A	X			X	X			X	X			X	X			X	
	BSS-B	X			X	X			X	X			X	X			X	
	LF01-1B	X		X	X	X			X	X			X	X			X	
	LF01-1C	X		X	X	X			X	X			X	X			X	
	LF01-1D	X		X	X	X			X	X			X	X			X	
LF01-1E	X		X	X	X			X	X			X	X			X		
MW-1	X			X	X			X	X			X	X			X		
MW-10	X		X	X	X			X	X			X	X			X		
MW-11	X		X	X	X			X	X			X	X			X		
MW-12	X		X	X	X			X	X			X	X			X		
MW-3	X			X	X			X	X			X	X			X		
MW-5	X			X	X			X	X			X	X			X		
MW-8	X			X	X			X	X			X	X			X		
MW-9	X		X	X	X			X	X			X	X			X		
OT-15C	X		X	X	X			X	X			X	X			X		
SD13-01	X		X	X	X			X	X			X	X			X		
SD 13-02	X		X	X	X			X	X			X	X			X		
SD13-04	not sampled - LNAPL found				X	X			X	X			X	X			X	
SD13-06	not sampled - odor and sheen				X	X			X	X			X	X			X	
SD13-07	not sampled - LNAPL found				X	X			X	X			X	X			X	
ST14-02	X		X	X	X			X	X			X	X			X		
					not sampled - LNAPL found	not sampled - LNAPL found			not sampled - LNAPL found	not sampled - LNAPL found			not sampled - LNAPL found	not sampled - LNAPL found			not sampled - LNAPL found	

Table 5-1. Chemical Analyses Performed
NAS Fort Worth JRB Basewide Groundwater Sampling 1997 (continued)

Area	Location	January 1997				April 1997				July 1997				October 1997			
		VOCs	BTEX	Metals	NAPs ¹	VOCs	BTEX	Metals	NAPs ¹	VOCs	BTEX	Metals	NAPs ¹	VOCs	BTEX	Metals	NAPs ¹
East	ST14-03	X			X	X			X	X			X	X			X
	ST14-04		X		X				X	X					X		X
	ST14-14	X		X	X	X			X				X		X		X
	ST14-24	X		X	X	X			X				X		X		X
	ST14-26	X		X	X	X			X				X		X		X
	ST14-28		X		X	X			X				X		X		X
	ST14-29		X		X	X			X				X		X		X
	ST14-W16		X		X	X			X				X		X		X
	ST14-W18		X		X	X			X				X		X		X
	ST14-W21		X		X	X			X				X		X		X
	ST14-W31		X		X	X			X				X		X		X
Landfill	FT09-12C	X				X											X
	GMI-04-01M																X
	LF04-10	X															X
	LF04-4F	X															X
	LF05-02	X															X
	LF05-18	X		X		X										X	X
	LF05-19	X		X		X										X	X
	LF05-5G	X				X											X
	WP07-10B	X				X											X
	WP07-10C	X				X											X

Notes:
¹Natural Attenuation Parameters

This page was intentionally left blank.

of the population that the interval is supposed to contain, called the coverage; the second is the degree of confidence with which the interval reaches the specified coverage, known as the tolerance coefficient. The $UTL_{95,95}$ is the upper tolerance limit (UTL) of a TI with a coverage of 95 percent and a tolerance coefficient of 95 percent. The $UTL_{95,95}$ was determined by Jacobs (1997) as the background concentration for comparison to contaminant concentrations. These values are provided in Table 5-2.

5.1.2 Practical Quantitation Limits (PQLs)

The PQL is the lowest level that can reasonably be achieved within specified limits of precision and accuracy during routine laboratory conditions. The PQL value is higher than the method detection limit (MDL), which is the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. Sample concentrations falling in between the MDL and PQL are assigned an "F" flag indicating the variability of the result (CH2M Hill, 1996b). Since a background concentration for organic compounds is not appropriate, the PQL is used as a comparison to determine those compounds which can be detected within established limits of precision and accuracy.

5.1.3 Risk Reduction Standard 2 (RRS 2)

RRS 2 values are the chemical-specific, clean-up levels for remediation of groundwater that has been contaminated by a release(s) from a SWMU/AOC. These values are established from health-based standards and criteria (Texas and/or Federal) pursuant to the TNRC Regulations, 30 Texas Administrative Code (TAC) 335.551-335.569. If the PQL and/or background concentration for a given chemical is greater than the RRS 2 level, the greater of the PQL, or background, is to be used for determining compliance with requirements of the groundwater remediation. If RRS 2 values are not available, or do not provide appropriate protection for human health or the environment, cleanup levels based on other numeric criteria, referred to as Medium Specific Concentrations (MSCs) must be established. Formulas to develop MSCs, based on exposure factors and pathways and chemical-specific toxicity, are provided in 30 TAC 335.558 (i.e., Medium Specific Concentrations for Risk Reduction Standard Number 2). RRS 2 values for metals and VOCs are provided in Table 5-2 and Table 5-3, respectively.

5.2 QUALITY CONTROL ELEMENTS

The basis for assessing each element of data quality (precision, accuracy, representativeness, completeness and comparability) is discussed in the following subsections.

5.2.1 Precision

Precision measures the reproducibility of measurements. It is strictly defined as the degree of mutual agreement among independent measurements as the result of repeated application of the same process under similar conditions. Analytical precision is the measurement of the variability associated with duplicate (two) or replicate (more than two) analyses. AFCEE uses the laboratory control sample (LCS) to determine the precision of the analytical method. If the recoveries of

Table 5-2. Background and Risk Reduction Standard 2 (RRS2) Values for Inorganic Constituents

Metal	Background Value (ug/L)	RRS2 Value (ug/L)	RRS2 Value Source ¹
Aluminum	1,332	200	Derived
Antimony	2	6	TNRCC
Arsenic	4.9	50	TNRCC
Barium	587	2,000	TNRCC
Beryllium	0.3	4	TNRCC
Cadmium	0.5	5	TNRCC
Calcium	266,300	--	Essential Nutrient ²
Chromium	6	100	TNRCC
Cobalt	8.9	6,100	Derived
Copper	2.8	1,300	Derived
Iron	223.9	300	Derived
Lead	1.6	15	TNRCC
Magnesium	37,800	--	Essential Nutrient ²
Manganese	175	2,400	Derived
Mercury	0.1	2	TNRCC
Molybdenum	14.4	510	Derived
Nickel	20.4	100	TNRCC
Potassium	15,030	--	Essential Nutrient ²
Selenium	7.7	50	TNRCC
Silver	0.2	183	TNRCC
Sodium	167,200	--	Essential Nutrient ²
Thallium	63.2	8.2	Derived
Vanadium	12.3	710	Derived
Zinc	118	5,000	Derived

Notes:

¹Source of all values was Texas Natural Resource Conservation Commission (TNRCC) Risk Reduction Standards 2 (30 TAC 335). Those noted as "Derived" were derived based on procedures presented in the regulations.

²Essential Nutrient - no risk values available.

**Table 5-3. Risk Reduction Standard 2 (RRS 2)
Values for Volatile Organic Compounds (VOCs)**

VOC	RRS2 Value (ug/L)	RRS2 Value Source ¹
1,1,1,2-Tetrachloroethane	32.8	TNRCC
1,1,1-Trichloroethane	200	TNRCC
1,1,2,2-Tetrachloroethane	4.26	TNRCC
1,1,2-Trichloroethane	5	TNRCC
1,1-Dichloroethane	3,650	TNRCC
1,1-Dichloroethene	7	TNRCC
1,2,3-Trichloropropane	219	TNRCC
1,2,4-Trichlorobenzene	70	TNRCC
1,2,4-Trimethylbenzene	5,100	Derived
1,2-Dichlorobenzene	600	TNRCC
1,2-Dichloroethane	5	TNRCC
1,2-Dichloropropane	5	TNRCC
1,3,5-Trimethylbenzene	5,100	Derived
1,3-Dichlorobenzene	600	TNRCC
1,4-Dichlorobenzene	75	TNRCC
2-Methylnaphthalene	4,100	Derived
Benzene	5	TNRCC
Bromodichloromethane	100	TNRCC
Bromoform	100	TNRCC
Bromomethane	51.1	TNRCC
Carbon tetrachloride	5	TNRCC
Chlorobenzene	100	TNRCC
Chloroethane	730	TNRCC
Chloroform	100	TNRCC
Chloromethane	5	TNRCC
cis-1,2-Dichloroethene	70	TNRCC
Dibromochloromethane	100	TNRCC
Dichlorodifluoromethane	7,300	TNRCC
Ethylbenzene	700	TNRCC
Hexachlorobutadiene	10.9	TNRCC
Isopropylbenzene	10,000	TNRCC
m-Xylene & p-Xylene	10,000	Derived
Methylene chloride	5	TNRCC
n-Butylbenzene	1,000	Derived
n-Propylbenzene	10,000	Derived
Naphthalene	1,460	TNRCC
o-Xylene	10,000	TNRCC
p-Isopropyltoluene	1,000	Derived
sec-Butylbenzene	1,020	Derived
tert-Butylbenzene	1,020	Derived
Tetrachloroethene	5	TNRCC
Toluene	1,000	TNRCC
trans-1,2-Dichloroethene	100	TNRCC
Trichloroethene	5	TNRCC
Trichlorofluoromethane	11,000	TNRCC
Vinyl chloride	2	TNRCC

Notes:

¹Source of all values was Texas Natural Resource Conservation Commission (TNRCC) Risk Reduction Standards 2 (30 TAC 335). Those noted as "Derived" were derived based on procedures presented in the regulations.

analytes in the LCS are within established control limits, then precision is within limits. In this case, the comparison is not between a sample and a duplicate sample analyzed in the same batch; rather, the comparison is between the sample and samples analyzed in previous batches. Total precision is the measurement of the variability associated with the entire sampling and analysis process. It is determined by analysis of duplicate or replicate field samples and measures variability introduced by both the laboratory and field operations. Field duplicate samples and matrix duplicate spiked samples shall be analyzed to assess field and analytical precision, and the precision measurement is determined using the relative percent difference (RPD) between the duplicate sample results. For replicate analyses, the relative standard deviation (RSD) is determined. Acceptable values for precision for each analyte are listed by analysis method in the Basewide QAPP (CH2M Hill, 1996b).

5.2.2 Accuracy

Accuracy is a statistical measurement of correctness and includes components of random error (variability due to imprecision) and system error. It, therefore, reflects the total error associated with a measurement. A measurement is accurate when the value reported does not differ from the true value or known concentration of the spike or standard. Analytical accuracy is measured by comparing the percent recovery of analytes spiked into an LCS to a control limit. For volatile and semivolatile organic compounds, surrogate compound recoveries are also used to assess accuracy and method performance for each sample analyzed. Analysis of performance evaluation (PE) samples shall also be used to provide additional information for assessing the accuracy of the analytical data being produced.

Both accuracy and precision are calculated for each AFCEE analytical batch, and the associated sample results are interpreted by considering these specific measurements. The formula for calculation of accuracy is percent recovery (%R) from pure and sample matrices. Acceptable values for percent recovery for each analyte are listed by analysis method in the Basewide QAPP (CH2M Hill, 1996b).

5.2.3 Representativeness

Objectives for representativeness are defined for each sampling and analysis task and are a function of the investigative objectives. Representativeness shall be achieved through use of the standard field, sampling, and analytical procedures. Representativeness is also determined by appropriate program design with consideration of elements such as proper well locations, drilling and installation procedures, and sampling locations. Decisions regarding sample/well/ boring locations and numbers and the statistical sampling design are documented in the Field Sampling Plan (FSP).

5.2.4 Completeness

Completeness is calculated for the aggregation of data for each analyte measured for any particular sampling event or other defined set of samples. Completeness is calculated and reported for each method, matrix and analyte combination. The number of valid results divided by the number of possible individual analyte results, expressed as a percentage, determines the completeness of the

data set. For completeness requirements, valid results are all results not qualified with an "R" flag (see Section 8 for an explanation of flagging criteria). The requirement for completeness is 95 percent for aqueous samples and 90 percent for soil samples. For any instances of samples that could not be analyzed for any reason (holding time violations in which resampling and analysis were not possible, samples spilled or broken, etc.), the numerator of this calculation becomes the number of valid results minus the number of possible results not reported.

The formula for calculation of completeness is presented below:

$$\% \text{ completeness} = \frac{\text{number of valid (i.e., non-R-qualified) results}}{\text{number of possible results}}$$

5.2.5 Comparability

Comparability is the confidence with which one data set can be compared to another data set. The objective for this QA/QC program is to produce data with the greatest possible degree of comparability. The number of matrices that are sampled and the range of field conditions encountered are considered in determining comparability. Comparability is achieved by using standard methods for sampling and analysis, reporting data in standard units, normalizing results to standard conditions and using standard and comprehensive reporting formats. Complete field documentation using standardized data collection forms shall support the assessment of comparability. Analysis of PE samples and reports from audits shall also be used to provide additional information for assessing the comparability of analytical data produced among subcontracting laboratories. Historical comparability shall be achieved through consistent use of methods and documentation procedures throughout the project.

5.3 ANALYTICAL DATA QUALITY EVALUATION

The objective of the data quality evaluation (DQE) was to provide a professional review of the chemical data packages submitted by the laboratory and to qualify that data relative to the data quality objectives (DQOs) stated in the GSAP (CH2M Hill, 1996a). The DQE consisted of review of laboratory quality control data, field quality control parameters and flagging of the data as usable, usable with qualification, or unusable.

The data quality relative to laboratory analyses was evaluated using criteria stated in the Sampling and Analysis Plan (CH2M Hill, 1996a) for each analytical method performed. The following information was reviewed:

- Sample Integrity;
- Sample Completeness;
- Sample Holding Times;
- Laboratory Methods for Extraction and Analysis;
- Method Accuracy and Precision (Matrix Spike/Matrix Spike Duplicate);
- Laboratory Performance Criteria (Blanks, LCS Recoveries); and
- Instrument Calibrations

Field quality control parameters were evaluated through field duplicates, field blanks, field documentation and shipping criteria.

The DQE was summarized by use of flags which indicate to the user that the datum being considered has been qualified using the established criteria. The specific reason for the qualification is documented on the evaluation forms maintained in the project file. A brief explanation of the data qualification flags is provided in Table 5-4.

5.3.1 Flightline Area Groundwater

Ten groundwater samples and one field duplicate were collected from the Flightline Area and analyzed for one or more of the following parameters: alkalinity, dissolved gases (methane, ethane and ethene), metals by ICP and ICP/MS, mercury, VOCs, inorganic anions and total organic carbon (TOC). The analytical results for lead are rejected (R) in samples GMI-22-05MWG02 and DUP02-WG02. The remaining Flightline Area groundwater data are usable with qualification as described below.

Alkalinity - The alkalinity data are usable without qualification.

Methane, Ethane and Ethene - A MS/MSD was performed on sample GMI-22-02MWG02. Methane, ethane and ethene exhibited low percent recoveries. Methane and ethane are detected below the PQL and remain qualified with "F" flags; ethene is qualified as estimated and flagged "UJ" in sample GMI-22-02MWG02. The analytical results for methane, ethane and ethene are qualified "J" or "UJ" for samples collected within the Flightline Area (GMI-22-04MWG02, GMI-22-06MWG02, LSA1628-3WG02, SPOT35-2WG02, SPOT35-4WG02 and SPOT35-5WG02). Methane, ethane and ethene are reported below the PQL in sample GMI-22-07MWG02; hence, these results remain qualified with "F" flags.

Methane was present in the laboratory method blank, field equipment blank, and trip blank. Samples GMI-22-02MWG02 and GMI-22-07MWG02 are affected by the methane contamination; however, the results are reported below the PQL and remain qualified with "F" flags.

ICP Metals - The metals analyzed by ICP Atomic Emission Spectrometry are usable without qualification.

ICP/MS Metals - The analytical results for lead are rejected (R) in samples GMI-22-05MWG02 and DUP02-WG02 due to a low recovery in the LCS. One or more of the following analytes (aluminum, chromium, silver and zinc) were detected in the field equipment blank; however, the associated results in samples GMI-22-05MWG02, DUP02-WG02 and USGS04TWG02 are reported below the PQL and remain qualified with "F" flags.

Mercury - The mercury data are usable without qualification.

VOCs - Sample USGA04TWG02 received a "UJ" qualifier for hexachlorobutadiene due to a high recovery in the LCS.

Table 5-4. Data Qualification Flags

Flag ¹	Positive Results	Negative Results
Flags for Data Within Acceptance Limits (Usable as Reported)		
(no flag)	(Use datum without qualification)	(Not applicable)
U	(Not applicable)	The analyte was analyzed for, but not detected. The associated numerical value is at or below the MDL. (Use datum without qualification.)
Flags for Data Within Action Limits (Usable with Qualification)		
F	The analyte was positively identified, but the associated numerical value is below the PQL.	(Not applicable)
J	The analyte was positively identified, the quantitation is an estimation.	(Not applicable)
B ²	The analyte was found in an associated blank, as well as in the sample.	(Not applicable)
UJ	(Not applicable)	The analyte was not detected, the quantitation is an estimation.
Flags for Data Outside of Action Limits (Unusable)		
R	The data were unusable due to deficiencies in the ability to analyze the sample and meet QC criteria.	The data were unusable due to deficiencies in the ability to analyze the sample and meet QC criteria.

Notes:

¹If the results suggest contradictory flags, the following hierarchy should be used to select the appropriate flag to assign:

R > F > J > B > U

UJ = J

²The "B" flag is no longer a valid flag for use in this sampling program, as of publication of the latest Basewide QAPP (HGL, 1998).

Sample USGA04TWG02 is affected by toluene contamination in the field equipment blank; however, toluene is reported below the PQL and retains its "F" flag.

Inorganic Anions - The analytical result for sulfate in sample SPOT35-2WG02 is affected by the blank contamination; however, the result is reported below the PQL and remains qualified with an "F" flag.

TOC - Samples GMI-22-02MWG02, GMI-22-04MWG02, GMI-22-07MWG02 and LSA1628-3WG02 received "U" qualifiers for TOC due to contamination in the field equipment blank. The TOC result in sample GMI-22-06MWG02 is affected by the blank contamination; however, TOC is reported below the PQL and retains its "F" flag.

5.3.2 East Area Groundwater

Thirty-two groundwater samples and three field duplicates were collected from the East Area and analyzed for one or more of the following parameters: alkalinity, dissolved gases (methane, ethane and ethene), metals by ICP and ICP/MS, mercury, BTEX, VOCs, inorganic anions and TOC. The analytical results for 1,2,4-trichlorobenzene, hexachlorobutadiene, 1,2,3-trichlorobenzene and naphthalene are rejected (R) in samples LF01-1BWG02, LF01-1CWG02 and DUP04-WG02. Lead is rejected (R) in samples ST14-24WG02, ST14-26WG02 and DUP05-WG02. The remaining East Area groundwater data are usable with qualification as described below.

Alkalinity - The alkalinity data are usable without required qualification.

Methane, Ethane and Ethene - Methane is qualified "J", and ethane and ethene are qualified "UJ" in the following samples due to holding time exceedances of either one or two days: ST14-02WG02, ST14-W16WG02, 17MWG02, BSS-AWG02 and BSS-BWG02. Sample ST14-W18WG02 received a "J" qualifier for methane and a "UJ" qualifier for ethene; however, ethane was reported below the PQL and remains qualified with an "F" flag.

Sample MW-3WG02 received a "U" qualifier for methane due to contamination in the laboratory method blank and trip blank. Sample ST14-W31WG02 received a "U" qualifier for methane due to contamination in the trip blank. Samples ST14-26WG02 and DUP05-WG02 are affected by methane contamination in either the laboratory method blank, field equipment blank or trip blank.; however, these results are reported below the PQL and remain qualified with "F" flags.

ICP Metals - The metals analyzed by ICP Atomic Emission Spectrometry are usable without qualification.

ICP/MS Metals - Lead is rejected (R) in samples ST14-24WG02, ST14-26WG02 and DUP05-WG02 due to a low recovery in the LC.

The following qualifiers are due to possible inadequate decontamination of field sampling equipment. Samples LF01-1CWG02 and DUP04-WG02 received "U" qualifiers for zinc. The aluminum, chromium, copper and lead results are affected by the blank contamination; however,

results reported below the PQL remain qualified with "F" flags. Samples LF01-1EWG02, MW-9WG02, OT15C-WG02 and SD13-06WG02 received "U" qualifiers for zinc; however, their aluminum, copper and lead results were detected below the PQL and retain their "F" flags. The analytical results for aluminum, copper, lead and zinc in samples LF01-1DWG02, MW-12WG02 and ST14-14WG02 are affected by field equipment blank contamination; however, these results were detected below the PQL and remain qualified with "F" flags. One or more of the following analytes (aluminum, chromium, copper, lead, silver, vanadium and zinc) were detected in the field equipment blank associated with samples MW-10WG02, MW-11WG02, ST14-02WG02, ST14-24WG02, DUP05-WG02, ST14-26WG02 and ST14-W18WG02; however, these analytes were reported below the PQL and remain qualified with "F" flags.

Sample ST14-26WG02 and its field duplicate DUP05-WG02 received "J" qualifiers for iron due to poor precision between the two analytical results. Sample LF01-1CWG02 and its field duplicate DUP04-WG02 received "J" qualifiers for iron and manganese due to poor precision between analytical results. Zinc also exhibited poor precision; however, this analyte remains qualified due to blank contamination as described above.

Mercury - The mercury data are usable without qualification.

BTEX - The non-detect results for benzene, ethylbenzene and xylene are rejected (R) in sample MW-3WG02 due to poor surrogate recovery. Toluene is detected below the PQL and remains qualified with an "F" flag (positive results are not rejected).

Sample MW-10WG02 received "J" qualifiers for benzene and methyl tert-butyl ether due to percent difference exceedances between the primary and confirmation column results. Sample MW-5WG02 received a "J" qualifier for ethylbenzene due to a high percent difference between primary and confirmation column results.

A MS/MSD was performed on sample MW-3WG02. Xylene exhibited low percent recoveries but remains rejected due to surrogate failure as stated above. The analytical results for xylene are qualified "J" or "UJ" for samples collected within the east area (17MWG02, BSS-AWG02, BSS-BWG02, MW-1WG02, MW-8WG02, MW-10WG02, SD13-02WG02, ST14-02WG02, ST14-03WG02, DUP03-WG02, ST14-04WG02, ST14-W16WG02, ST14-W18WG02, ST14-W21WG02 and ST14-W31WG02). Xylene is reported below the PQL in samples MW-5WG02, SD13-01WG02, SD13-04WG02, ST14-28WG02 and ST14-29WG02; hence, these results remain qualified with "F" flags.

Benzene, toluene and xylene were present in either the laboratory method blank, field equipment blank or trip blank. The benzene result in sample ST14-W21WG02 and the toluene and xylene results in sample MW-5WG02 are affected by the blank contamination; however, these compounds are reported below the PQL and remain qualified with "F" flags. Sample ST14-29WG02 received a "U" qualifier for toluene due to contamination in the associated field equipment blank. Samples 17MWG02, BSS-AWG02, MW-5WG02, SD13-01WG02, SD13-02WG02, ST14-02WG02, ST14-04WG02, ST14-28WG02 and ST14-W16WG02 are affected by toluene contamination in either the laboratory method blank, field equipment blank or trip blank; however, their results are reported below the PQL and they retain their "F" flags.

Toluene exhibited poor precision between field duplicate samples ST14-04WG02 and DUP03-WG02. Toluene is qualified "UJ" in sample DUP03-WG02. Toluene is reported below the PQL in sample ST14-04WG02; therefore, it retains its "F" flag.

VOCs - The analytical results for 1,2,4-trichlorobenzene, hexachlorobutadiene, 1,2,3-trichlorobenzene and naphthalene are rejected (R) in samples LF01-1BWG02, LF01-1CWG02 and DUP04-WG02 due to percent relative standard deviation exceedances in the initial calibration or percent difference exceedances in the continuing calibration.

Inorganic Anions - Sample MW-1WG02 received a "U" qualifier for nitrate due to contamination in the field equipment blank.

Samples 17MWG02, ST14-02WG02, ST14-W18WG02, SD13-01WG02, SD13-02WG02, SD13-04WG02 and ST14-W21WG02 received "U" qualifiers for sulfate due to contamination in either the laboratory method blank or field equipment blank.

Sample ST14-14WG02 is affected by the sulfate contamination in the field equipment blank; however, sulfate is detected below the PQL and remains qualified with an "F" flag.

TOC - Samples MW-3WG02, MW-8WG02, ST14-04WG02, DUP03-WG02, ST14-14WG02, ST14-24WG02, ST14-26WG02, DUP05-WG02 and ST14-W31WG02 received "U" qualifiers for TOC due to contamination in the field equipment blank.

5.3.3 Landfill Area Groundwater

Ten groundwater samples and one field duplicate were collected from the Landfill Area and analyzed for one or more of the following parameters: metals by Inductively Coupled Plasma (ICP) Atomic Emission Spectrometry and Mass Spectrometry (ICP/MS), mercury and volatile organic compounds (VOCs). No data were rejected. The Landfill Area groundwater data are usable with qualification as described below.

ICP Metals - The metals analyzed by ICP Atomic Emission Spectrometry are usable without qualification.

ICP/MS Metals - The following qualifiers are due to possible inadequate decontamination of field sampling equipment. Samples LF05-18WG02 and LF05-19WG02 received "U" qualifiers for barium and iron. The aluminum, arsenic, cobalt, copper, lead, manganese, molybdenum, nickel, selenium, vanadium and zinc results in both samples were affected by blank contamination; however, these analytes are reported below the PQL and remain qualified with "F" flags. In addition, silver is affected by the blank contamination in sample LF05-19WG02; however, silver is reported below the PQL and remains qualified with an "F" flag. The aluminum, manganese, nickel and selenium results in sample DUP01-WG02 are affected by contamination in the field equipment blank; however, these analytes are detected below the PQL and retain their "F" flags.

Mercury - The mercury data are usable without qualification.

VOCs - Sample FT09-12CWG02 received "U" qualifiers for 1,2-dichlorobenzene and 1,4-dichlorobenzene due to contamination in the field equipment blank and ambient condition blank.

A MS/MSD was performed on sample LF05-02WG02. Naphthalene and 1,2-dibromo-3-chloropropane exhibited high relative percent differences (RPD). The naphthalene and 1,2-dibromo-3-chloropropane results for samples located within the landfill area (FT09-12CWG02, GMI-04-01MWG02, LF04-4FWG02, LF04-10WG02, LF05-02WG02, LF05-5GWG02, LF05-18WG02, LF05-19WG02, DUP01-WG02, WP07-10BWG02 and WP07-10CWG02) are qualified as estimated and flagged "UJ".

The field duplicate samples LF05-19WG02 and DUP01-WG02 exhibited poor precision for toluene, m&p-xylene and o-xylene. Sample LF05-19WG02 received "J" qualifiers for m&p-xylene, a "UJ" qualifier for o-xylene; however, toluene was reported below the practical quantitation limit (PQL) and retains its "F" flag. Sample DUP01-WG02 received "J" qualifiers for m&p-xylene, a "J" qualifier for toluene; o-xylene was reported below the PQL and remains qualified with an "F" flag.

5.4 ADDITIONAL DATA USED FOR EVALUATION

The available analytical data collected during studies conducted in 1997 at NAS Fort Worth JRB and AFP 4 were reviewed to evaluate the nature and extent of groundwater contamination. These data came from the following studies:

- NAS Fort Worth JRB Basewide Sampling;
- AFP 4 Basewide Sampling; and
- Sanitary Sewer RFI (SWMU 66)

The locations of wells sampled in each of these programs are provided on Figure 5-1. In several cases, wells were sampled by more than one program.

5.5 ANALYTICAL RESULTS FOR VOLATILE ORGANIC COMPOUNDS SAMPLING

The VOCs, detected above their PQL, during 1997 basewide quarterly sampling at NAS Fort Worth JRB, are presented in Table 5-5. These detected VOCs can be divided into four categories:

- Chlorinated solvents and their daughter products;
- Benzene, Toluene, Ethylbenzene, and Xylenes (BTEX compounds) associated with gasoline fuels and industrial solvents;
- Other petroleum-related compounds that originate from fuel oils such as Naphthalene, Butylbenzene, and Isopropyltoluene; and

**Table 5-5. Volatile Organic Compounds (VOCs) Detected Above Practical Quantitation Limits (PQLs)
NAS Fort Worth JRB Basewide Groundwater Sampling 1997**

Area	Location	January 1997	April 1997	July 1997	October 1997
Flightline	GMI-22-02M	(none)	(none)	(none)	
	GMI-22-04M*	Chloroform (0.52 ug/L) cis-1,2-Dichloroethene (61 ug/L) trans-1,2-Dichloroethene (8.23 ug/L) Trichloroethene (388 ug/L)	1,1-Dichloroethene (1.4 ug/L) cis-1,2-Dichloroethene (182 ug/L) trans-1,2-Dichloroethene (15.5 ug/L) Trichloroethene (9.56 ug/L)	Trichloroethene (440 ug/L)	cis-1,2-Dichloroethene (68 ug/L) Trichloroethene (480 ug/L)
	GMI-22-05M	(none)	(none)	Ethylbenzene (0.7 ug/L) m-Xylene & p-Xylene (3 ug/L) o-Xylene (1.3 ug/L) Toluene (1.9 ug/L)	(none)
	GMI-22-06M*	cis-1,2-Dichloroethene (44.6 ug/L) trans-1,2-Dichloroethene (48.1 ug/L) Trichloroethene (298 ug/L) Vinyl chloride (4.23 ug/L)	1,1-Dichloroethene (1.9 ug/L) Benzene (0.71 ug/L) cis-1,2-Dichloroethene (239 ug/L) trans-1,2-Dichloroethene (98 ug/L) Trichloroethene (533 ug/L) Vinyl Chloride (11.4 ug/L)	cis-1,2-Dichloroethene (99 ug/L) trans-1,2-Dichloroethene (67 ug/L) Trichloroethene (220 ug/L)	cis-1,2-Dichloroethene (35 ug/L) trans-1,2-Dichloroethene (29 ug/L) Trichloroethene (120 ug/L)
	GMI-22-07M	(none)	(none)	(none)	(none)
	LSA1628-3*	Chloroform (0.33 ug/L) cis-1,2-Dichloroethene (57 ug/L) Tetrachloroethene (1.04 ug/L) trans-1,2-Dichloroethene (30.2 ug/L) Trichloroethene (329 ug/L) Vinyl chloride (1.09 ug/L)	cis-1,2-Dichloroethene (150 ug/L) trans-1,2-Dichloroethene (64 ug/L) Trichloroethene (790 ug/L) Vinyl Chloride (2.2 ug/L)	Trichloroethene (400 ug/L)	cis-1,2-Dichloroethene (32 ug/L) trans-1,2-Dichloroethene (17 ug/L) Trichloroethene (320 ug/L)
	SPOT35-2	Benzene (1.12 ug/L) Ethylbenzene (0.62 ug/L) n-Propylbenzene (21.9 ug/L) Naphthalene (20 ug/L) p-Isopropyltoluene (3.16 ug/L) sec-Butylbenzene (6.83 ug/L) tert-Butylbenzene (1.44 ug/L) Trichloroethene (1.02 ug/L)	Benzene (1.1 ug/L) Isopropylbenzene (0.69 ug/L) n-Butylbenzene (1.8 ug/L) n-Propylbenzene (8.4 ug/L) Naphthalene (58.6 ug/L) p-Isopropyltoluene (1.2 ug/L) sec-Butylbenzene (2.4 ug/L)	Isopropylbenzene (24 ug/L) n-Propylbenzene (24 ug/L) Naphthalene (140 ug/L)	Isopropylbenzene (46 ug/L) m-Xylene & p-Xylene (2.7 ug/L) n-Propylbenzene (46 ug/L) Naphthalene (73 ug/L) sec-Butylbenzene (25 ug/L)
	SPOT35-4	n-Butylbenzene (4.48 ug/L) n-Propylbenzene (64.3 ug/L) Naphthalene (25.6 ug/L) sec-Butylbenzene (19.1 ug/L) tert-Butylbenzene (4.61 ug/L)	Naphthalene (38.4 ug/L) tert-Butylbenzene (3.3 ug/L)	Isopropylbenzene (38 ug/L) n-Propylbenzene (38 ug/L) Naphthalene (72 ug/L) sec-Butylbenzene (13 ug/L)	Isopropylbenzene (49 ug/L) n-Propylbenzene (51 ug/L) Naphthalene (100 ug/L) sec-Butylbenzene (22 ug/L)

**Table 5-5. Volatile Organic Compounds (VOCs) Detected Above Practical Quantitation Limits (PQLs)
NAS Fort Worth JRB Basewide Groundwater Sampling 1997 (continued)**

Area	Location	January 1997	April 1997	July 1997	October 1997	
Flightline East	SPOT35-5	Benzene (1.28 ug/L)	Ethylbenzene (0.87 ug/L)	Isopropylbenzene (29 ug/L)	Isopropylbenzene (48 ug/L)	
		m,p-Xylene (0.86 ug/L)	Isopropylbenzene (1.1 ug/L)	n-Propylbenzene (31 ug/L)	n-Propylbenzene (52 ug/L)	
		n-Propylbenzene (35.7 ug/L)	m,p-Xylene (2.5 ug/L)	Naphthalene (76 ug/L)	Naphthalene (110 ug/L)	
		Naphthalene (63.8 ug/L)	n-Butylbenzene (1.1 ug/L)		sec-Butylbenzene (16 ug/L)	
		sec-Butylbenzene (8.84 ug/L)	n-Propylbenzene (7.4 ug/L)			
		tert-Butylbenzene (2.28 ug/L)	Naphthalene (35.2 ug/L)			
			o-Xylene (1.3 ug/L)			
			sec-Butylbenzene (3.9 ug/L)			
			tert-Butylbenzene (1.6 ug/L)			
			Toluene (1.2 ug/L)			
		USGS04T	(none)	(none)	(none)	(none)
		17M	(not sampled)	1,2-Dichlorobenzene (7.21 ug/L)	(none)	(none)
		BSS-A	(none)	Ethyl benzene (0.771 ug/L)	(none)	(none)
		BSS-B	(not sampled)	Xylenes (2.651 ug/L)	(none)	(none)
LF01-1B	(none)	(none)	Ethylbenzene (1830 ug/L)	Ethylbenzene (1800 ug/L)		
LF01-1C	sec-Butylbenzene (2.97 ug/L) tert-Butylbenzene (1.4 ug/L)	Toluene (11900 ug/L) Xylenes (12400 ug/L)	(none)	Toluene (9100 ug/L)		
LF01-1D	(none)	(none)	m-Xylene & p-Xylene (2.1 ug/L) Toluene (1.8 ug/L)	(none)		
LF01-1E	(none)	(none)	Isopropylbenzene (2 ug/L) sec-Butylbenzene (5.7 ug/L)	Isopropylbenzene (1.6 ug/L) p-Isopropyltoluene (6.3 ug/L) sec-Butylbenzene (2.5 ug/L) tert-Butylbenzene (1.5 ug/L)		
MW-1	Benzene (1750 ug/L) Ethyl benzene (5030 ug/L) m,p-Xylene (7130 ug/L) o-xylene (887 ug/L) Toluene (336 ug/L)	n-Butylbenzene (1.6 ug/L) n-Propylbenzene (0.92 ug/L) sec-Butylbenzene (3.7 ug/L) Chlorobenzene (2.1 ug/L)	m-Xylene & p-Xylene (0.94 ug/L) Chlorobenzene (2 ug/L)	Chlorobenzene (0.7 ug/L) Benzene (0.44 ug/L) Chlorobenzene (0.65 ug/L)		
		1,2-Dichlorobenzene (994 ug/L) Benzene (678 ug/L) Ethyl benzene (2470 ug/L) Toluene (174 ug/L) Xylenes (3240 ug/L)	Benzene (3200 ug/L) Ethylbenzene (1700 ug/L) Toluene (240 ug/L)	Benzene (3000 ug/L) Ethylbenzene (1700 ug/L) Toluene (160 ug/L)		

**Table 5-5. Volatile Organic Compounds (VOCs) Detected Above Practical Quantitation Limits (PQLs)
NAS Fort Worth JRB Basewide Groundwater Sampling 1997 (continued)**

Area	Location	January 1997	April 1997	July 1997	October 1997
East	MW-10	1,2,3-Trichloropropane (5.44 ug/L)	1,3,5-Trimethylbenzene (727 ug/L)	1,2,4-Trimethylbenzene (2600 ug/L)	1,2,4-Trimethylbenzene (3000 ug/L)
		1,2,4-Trimethylbenzene (666 ug/L)	Benzene (4540 ug/L)	1,3,5-Trimethylbenzene (650 ug/L)	1,3,5-Trimethylbenzene (780 ug/L)
		1,3,5-Trimethylbenzene (879 ug/L)	Ethyl benzene (4920 ug/L)	Benzene (4200 ug/L)	Benzene (5500 ug/L)
		Benzene (6250 ug/L)	Isopropylbenzene (3430 ug/L)	Ethylbenzene (4800 ug/L)	Ethylbenzene (6000 ug/L)
		Ethylbenzene (5110 ug/L)	m,p-Xylene (9630 ug/L)	m-Xylene & p-Xylene (9400 ug/L)	Isopropylbenzene (300 ug/L)
		m,p-Xylene (9630 ug/L)	n-Propylbenzene (384 ug/L)	n-Propylbenzene (400 ug/L)	m-Xylene & p-Xylene (11000 ug/L)
		n-Propylbenzene (342 ug/L)	Naphthalene (1010 ug/L)	Naphthalene (770 ug/L)	Naphthalene (950 ug/L)
		Naphthalene (172 ug/L)	o-Xylene (3320 ug/L)	o-Xylene (3700 ug/L)	o-Xylene (4300 ug/L)
		o-Xylene (3680 ug/L)	Toluene (10600 ug/L)	Toluene (9000 ug/L)	Toluene (8700 ug/L)
		p-Isopropyltoluene (17.4 ug/L)			
	sec-Butylbenzene (19.3 ug/L)				
	Toluene (10300 ug/L)				
	MW-11	(none)	(none)	Ethylbenzene (1.7 ug/L) m-Xylene & p-Xylene (3.3 ug/L) Naphthalene (0.49 ug/L) Toluene (1.5 ug/L)	(none)
MW-12	(none)	(none)	m-Xylene & p-Xylene (0.56 ug/L)	(none)	
MW-3	(none)	(none)	(none)	(none)	
MW-5	Benzene (29.7 ug/L)	Benzene (2.06 ug/L)	Benzene (65 ug/L)	Benzene (4 ug/L)	
	Ethyl benzene (68.9 ug/L) m,p-Xylene (22.9 ug/L) o-xylene (3.32 ug/L) Toluene (8.24 ug/L)		Ethylbenzene (360 ug/L) Toluene (18 ug/L)	Ethylbenzene (15 ug/L)	
MW-8	(none)	Toluene (5.25 ug/L)	(none)	(none)	
MW-9	Methylene chloride (0.81 ug/L)	(none)	(none)	(none)	
OT-15C	(none)	Tetrachloroethene (4.1 ug/L)	Chloroform (0.36 ug/L) m-Xylene & p-Xylene (0.79 ug/L)	(none)	
		(none)	(none)	(none)	
SD13-01	Ethyl benzene (4.88 ug/L)	(none)	(none)	(none)	
	m,p-Xylene (10.7 ug/L)	Toluene (2.02 ug/L)	(none)	(none)	
	o-xylene (7.75 ug/L)	Xylenes (5.99 ug/L)	(none)	(none)	
SD 13-02	(none)	1,2-Dichlorobenzene (24.8 ug/L)	(none)	(none)	
SD13-04	(not sampled)				

**Table 5-5. Volatile Organic Compounds (VOCs) Detected Above Practical Quantitation Limits (PQLs)
NAS Fort Worth JRB Basewide Groundwater Sampling 1997 (continued)**

Area	Location	January 1997	April 1997	July 1997	October 1997
East	SD13-06	(not sampled)	(none)	Ethylbenzene (0.6 ug/L) m-Xylene & p-Xylene (0.94 ug/L)	Isopropylbenzene (2.1 ug/L) n-Propylbenzene (0.77 ug/L)
	ST14-02	(none)	(none)	Benzene (6.1 ug/L)	(none)
	ST14-03	(none)	(none)	(none)	(none)
	ST14-04	Ethyl benzene (6.25 ug/L) m,p-Xylene (12.1 ug/L) o-xylene (9.78 ug/L)	1,2-Dichlorobenzene (3.61 ug/L) Chlorobenzene (1.29J ug/L) Ethyl benzene (0.65J ug/L) Toluene (0.28J ug/L) Xylenes (1.08J ug/L)	(none)	(none)
	ST14-14	(none)	(none)	(none)	(none)
	ST14-24	(none)	(none)	Vinyl chloride (1.4 ug/L)	Vinyl chloride (3.4 ug/L)
	ST14-26	(none)	(none)	(none)	(none)
	ST14-28	Ethyl benzene (7.16 ug/L) m,p-Xylene (11.8 ug/L)	1,2-Dichlorobenzene (33.1J ug/L) 1,3-Dichlorobenzene (9.28J ug/L) Toluene (4.76J ug/L)	(none)	(none)
	ST14-29	Ethyl benzene (7.39 ug/L) m,p-Xylene (10.9 ug/L) o-xylene (9.79 ug/L)	1,2-Dichlorobenzene (23.8J ug/L) Chlorobenzene (1.65J ug/L) Ethyl benzene (1.5J ug/L)	(none)	Toluene (2.5 ug/L)
	ST14-W16	Benzene (59.9 ug/L) m,p-Xylene (2.07 ug/L) o-xylene (2.29 ug/L)	Benzene (5.96J ug/L)	Benzene (6.6 ug/L)	Benzene (6 ug/L)
	ST14-W18	Ethyl benzene (5.28 ug/L) m,p-Xylene (8.93 ug/L)	1,2-Dichlorobenzene (22.4J ug/L) 1,3-Dichlorobenzene (25.3J ug/L) Ethyl benzene (2.66J ug/L) Xylenes (5.37J ug/L)	Benzene (2.7 ug/L)	Ethylbenzene (9 ug/L) Toluene (41 ug/L)
	ST14-W21	Benzene (20.4 ug/L)	Ethyl benzene (1J ug/L) Toluene (0.25J ug/L) Xylenes (1.28J ug/L)	Benzene (9.3 ug/L)	(none)
	ST14-W31	m,p-Xylene (3.31 ug/L) Toluene (2.22 ug/L)	(none)	(none)	(none)

**Table 5-5. Volatile Organic Compounds (VOCs) Detected Above Practical Quantitation Limits (PQLs)
NAS Fort Worth JRB Basewide Groundwater Sampling 1997 (continued)**

Area	Location	January 1997	April 1997	July 1997	October 1997
Landfill	FT09-12C*	1,2-Dichlorobenzene (3.45 ug/L) 1,4-Dichlorobenzene (1.99 ug/L) cis-1,2-Dichloroethene (22.7 ug/L) tert-Butylbenzene (1.07 ug/L) Vinyl chloride (7.35 ug/L)	1,2-Dichlorobenzene (2.3 ug/L) 1,4-Dichlorobenzene (1.7 ug/L) Benzene (0.81 ug/L) cis-1,2-Dichloroethene (93.2 ug/L) trans-1,2-Dichloroethene (1 ug/L) Trichloroethene (2.2 ug/L) Vinyl Chloride (9 ug/L) (not sampled)	1,2-Dichlorobenzene (2.6 ug/L) 1,4-Dichlorobenzene (1.4 ug/L) Benzene (3 ug/L) cis-1,2-Dichloroethene (43 ug/L) Trichloroethene (3.3 ug/L) Vinyl chloride (6.6 ug/L)	1,2-Dichlorobenzene (3.7 ug/L) 1,4-Dichlorobenzene (2 ug/L) Benzene (5 ug/L) cis-1,2-Dichloroethene (60 ug/L) Trichloroethene (5.9 ug/L) Vinyl chloride (11 ug/L)
	GMI-04-01M*	(not sampled)	(not sampled)	cis-1,2-Dichloroethene (280 ug/L) Trichloroethene (1400 ug/L)	cis-1,2-Dichloroethene (240 ug/L) trans-1,2-Dichloroethene (41 ug/L) Trichloroethene (880 ug/L) (none)
	LF04-10*	cis-1,2-Dichloroethene (1.39 ug/L) Trichloroethene (1.94 ug/L)	1,2-Dichlorobenzene (1.9 ug/L) 1,3-Dichlorobenzene (0.25 ug/L) 1,4-Dichlorobenzene (1.4 ug/L) Benzene (0.69 ug/L) Chlorobenzene (0.23 ug/L) cis-1,2-Dichloroethene (85.2 ug/L) Tetrachloroethene (0.73 ug/L) trans-1,2-Dichloroethene (0.94 ug/L) Trichloroethene (2.2 ug/L) Vinyl Chloride (7.9 ug/L)	(none)	(none)
	LF04-4F*	1,1-Dichloroethene (1.66 ug/L) 1,2,4-Trimethylbenzene (7.61 ug/L) 1,3,5-Trimethylbenzene (9.42 ug/L) Benzene (1.84 ug/L) Chloroform (0.69 ug/L) cis-1,2-Dichloroethene (370 ug/L) Ethylbenzene (7.54 ug/L) Isopropylbenzene (10.6 ug/L) m,p-Xylene (16.6 ug/L) n-Propylbenzene (3.94 ug/L) Naphthalene (161 ug/L) o-Xylene (4.94 ug/L) Toluene (5.12 ug/L) trans-1,2-Dichloroethene (30.6 ug/L) Trichloroethene (2970 ug/L) Vinyl chloride (12.9 ug/L)	1,1-Dichloroethene (2.5 ug/L) cis-1,2-Dichloroethene (1190 ug/L) Trichloroethene (4340 ug/L) Vinyl Chloride (12.2 ug/L)	cis-1,2-Dichloroethene (390 ug/L) Trichloroethene (2300 ug/L)	cis-1,2-Dichloroethene (600 ug/L) Trichloroethene (2700 ug/L)

**Table 5-5. Volatile Organic Compounds (VOCs) Detected Above Practical Quantitation Limits (PQLs)
NAS Fort Worth JRB Basewide Groundwater Sampling 1997 (continued)**

Area	Location	January 1997	April 1997	July 1997	October 1997
Landfill	LF05-02*	cis-1,2-Dichloroethene (199 ug/L) trans-1,2-Dichloroethene (22 ug/L) Trichloroethene (11.5 ug/L) Vinyl chloride (10.5 ug/L)	cis-1,2-Dichloroethene (218 ug/L) trans-1,2-Dichloroethene (10.1 ug/L) Trichloroethene (61.6 ug/L) Vinyl Chloride (7 ug/L)	cis-1,2-Dichloroethene (370 ug/L) trans-1,2-Dichloroethene (35 ug/L) Trichloroethene (130 ug/L)	cis-1,2-Dichloroethene (650 ug/L) trans-1,2-Dichloroethene (46 ug/L) Trichloroethene (210 ug/L)
	LF05-18*	1,1-Dichloroethene (42.21 ug/L) Chlorobenzene (0.66 ug/L) cis-1,2-Dichloroethene (293 ug/L) Trichloroethene (970 ug/L) Vinyl chloride (10.3 ug/L)	1,1-Dichloroethane (1.4 ug/L) 1,1-Dichloroethene (3.6 ug/L) 1,4-Dichlorobenzene (0.55 ug/L) Benzene (0.44 ug/L) Chlorobenzene (0.7 ug/L) cis-1,2-Dichloroethene (364 ug/L) Trichloroethene (1150 ug/L) Vinyl Chloride (13.3 ug/L)	cis-1,2-Dichloroethene (200 ug/L) Trichloroethene (660 ug/L)	cis-1,2-Dichloroethene (310 ug/L) trans-1,2-Dichloroethene (41 ug/L) Trichloroethene (860 ug/L)
	LF05-19*	Chloroform (0.55 ug/L) cis-1,2-Dichloroethene (293 ug/L) trans-1,2-Dichloroethene (15.2 ug/L) Trichloroethene (998 ug/L)	1,1,1-Trichloroethane (0.391 ug/L) 1,1-Dichloroethene (1.61 ug/L) 1,2-Dichloroethane (0.361 ug/L) Chlorobenzene (0.21 ug/L) cis-1,2-Dichloroethene (8221 ug/L) trans-1,2-Dichloroethene (12.91 ug/L) Trichloroethene (17101 ug/L)	cis-1,2-Dichloroethene (85 ug/L) Trichloroethene (310 ug/L)	cis-1,2-Dichloroethene (22 ug/L) m-Xylene & p-Xylene (4.9 ug/L) Toluene (6.2 ug/L) Trichloroethene (68 ug/L)
	LF05-5G*	1,1-Dichloroethene (2.46 ug/L) 1,3,5-Trimethylbenzene (1.14 ug/L) 1,4-Dichlorobenzene (0.97 ug/L) Benzene (34.2 ug/L) Chloroform (0.73 ug/L) cis-1,2-Dichloroethene (219 ug/L) Ethyl benzene (2020 ug/L) Isopropylbenzene (3.27 ug/L) m,p-Xylene (7760 ug/L) n-Propylbenzene (0.54 ug/L) Naphthalene (25.4 ug/L) o-xylene (3300 ug/L) Toluene (13500 ug/L) trans-1,2-Dichloroethene (13.9 ug/L) Trichloroethene (595 ug/L) Vinyl chloride (10.9 ug/L)	1,1-Dichloroethene (2.8 ug/L) 1,2-Dichlorobenzene (0.31 ug/L) cis-1,2-Dichloroethene (488 ug/L) trans-1,2-Dichloroethene (12.1 ug/L) Trichloroethene (1240 ug/L) Vinyl Chloride (2.6 ug/L)	cis-1,2-Dichloroethene (140 ug/L) Trichloroethene (420 ug/L)	cis-1,2-Dichloroethene (220 ug/L) Trichloroethene (590 ug/L)

**Table 5-5. Volatile Organic Compounds (VOCs) Detected Above Practical Quantitation Limits (PQLs)
NAS Fort Worth JRB Basewide Groundwater Sampling 1997 (continued)**

Area	Location	January 1997	April 1997	July 1997	October 1997
Landfill	WP07-10B*	1,1-Dichloroethene (1.89 ug/L) 1,4-Dichlorobenzene (1 ug/L) Chloroform (0.94 ug/L) cis-1,2-Dichloroethene (267 ug/L) Tetrachloroethene (14.4 ug/L) trans-1,2-Dichloroethene (32.5 ug/L) Trichloroethene (3010J ug/L) Vinyl chloride (211 ug/L)	1,1-Dichloroethene (7.4 ug/L) 1,4-Dichlorobenzene (0.49 ug/L) cis-1,2-Dichloroethene (404 ug/L) Ethyl benzene (0.81 ug/L) Isopropylbenzene (1.2 ug/L) m,p-Xylene (3.2 ug/L) o-Xylene (1.6 ug/L) Tetrachloroethene (5 ug/L) Toluene (1.1 ug/L) trans-1,2-Dichloroethene (123J ug/L) Trichloroethene (3060 ug/L) Vinyl Chloride (84.2 ug/L)	cis-1,2-Dichloroethene (320 ug/L) trans-1,2-Dichloroethene (42F ug/L) Trichloroethene (2800 ug/L)	cis-1,2-Dichloroethene (450 ug/L) Trichloroethene (2500 ug/L)
	WP07-10C*	1,1-Dichloroethene (5.26 ug/L) 1,4-Dichlorobenzene (4.14 ug/L) Benzene (0.76 ug/L) Chlorobenzene (0.78 ug/L) Chloroform (0.37 ug/L) cis-1,2-Dichloroethene (167 ug/L) m,p-Xylene (0.61 ug/L) trans-1,2-Dichloroethene (16.7 ug/L) Trichloroethene (733 ug/L) Vinyl chloride (21.9 ug/L)	1,1-Dichloroethene (11.6 ug/L) 1,4-Dichlorobenzene (7.1 ug/L) Benzene (0.88 ug/L) Chlorobenzene (0.98 ug/L) Trichloroethene (816 ug/L) Vinyl Chloride (53.6 ug/L)	cis-1,2-Dichloroethene (230 ug/L) Trichloroethene (1400 ug/L)	cis-1,2-Dichloroethene (220 ug/L) Trichloroethene (990 ug/L)

Notes:

*All wells sampled are included in this table, although in some cases no contaminants above PQL were found. An asterisk next to the well name indicates the well is within the AOC 2 trichloroethene (TCE) plume.

- Other solvents such as Chloroform, and 1,2-Dichlorobenzene that are related to extractants, industrial solvents, and/or chemical intermediates. Although, some of the compounds are chlorinated solvents, they are discussed here due to their limited frequency of detection.

Table 5-6 provides a list of the VOCs detected at concentrations that exceeded their respective RRS 2 value for each quarterly sampling event. Table 5-7 provides a list of VOCs detected above RRS 2 values and the range of concentrations above PQL detected during the year.

5.5.1 Chlorinated Solvents

The chlorinated solvents most commonly found at NAS Fort Worth JRB are tetrachloroethene (PCE) and trichloroethene (TCE) and their daughter products, including cis-1,2-dichloroethene (cis-1,2-DCE), trans-1,2-dichloroethene (trans-1,2-DCE), 1,1-dichloroethene (1,1-DCE), and vinyl chloride (VC). Two likely sources of these contaminants include neighboring AFP 4 and SWMU 24 (Waste Pile 7), centrally located in the Landfill Area. At AFP 4, past spills of TCE have been reported in the Chemical Process Facility (Building 181). It is believed that the TCE has been migrating down a paleochannel towards NAS Fort Worth JRB to the site boundary. From this point, the plume has been spreading into both the Flightline and Landfill Areas along another paleochannel on NAS Fort Worth JRB property. It is also thought that a secondary source of TCE may exist at SWMU 24 in an area where 34 drums were removed in January 1991. Inspection of the drums revealed that 25 were empty. The remaining drums contained approximately 300 gallons of liquid, which tested positively for TCE, PCE, and total petroleum hydrocarbons (TPH). SWMU 24 is located in the Landfill Area in the heart of the plume believed to originate from AFP 4. The locations of the two plumes make it difficult to determine whether contamination originated at SWMU 24 is contributing.

Chlorinated solvents and their daughter products detected above PQLs during 1997 NAS Fort Worth JRB basewide sampling include PCE, TCE, cis-1,2-dichloroethene (cis-1,2-DCE), trans-1,2-dichloroethene (trans-1,2-DCE), 1,1-dichloroethene (1,1-DCE), and VC. During the natural biodegradation process, sequential dechlorination from PCE to TCE to DCE to VC occurs, with dechlorination of PCE to TCE occurring relatively quickly. The occurrence of TCE and its daughter products confirms that the process of biodegradation is at work. All three isomers of DCE can theoretically be produced; however, cis-1,2-DCE is the more common intermediate compared to trans-1,2-DCE and 1,1-DCE.

Data from AFP 4 basewide quarterly sampling in 1997 (Table 5-8 and Table 5-9) and from the RFI for SWMU 66 (Sanitary Sewer System) in April 1997 (Table 5-10) provide additional characterization of the north and south lobe of the TCE plume.

PCE was detected during 1997 in only two wells, OT-15C and WP07-10B. However, the sample collected from well WP07-10B in January 1997 (14.4 $\mu\text{g/L}$) was the only PCE sample which exceeded the RRS 2 value of 5 micrograms per liter ($\mu\text{g/L}$). WP07-10B is located in the Landfill Area and is associated with SWMU 24. As shown in Table 5-6, TCE and its degradation products (cis-1,2-DCE, trans-1,2- DCE, 1,1-DCE, and VC) have all been detected above the RRS 2 in numerous samples throughout the year.

**Table 5-6. Volatile Organic Compounds (VOCs) Detected Above Risk Reduction Standard 2 (RRS 2)
NAS Fort Worth JRB Basewide Groundwater Sampling 1997**

Area	Location	January 1997	April 1997	July 1997	October 1997	
Flightline	GMI-22-04M*	Trichloroethene (388 ug/L)	cis-1,2-Dichloroethene (182 ug/L) Trichloroethene (956 ug/L)	Trichloroethene (440 ug/L)	Trichloroethene (480 ug/L)	
	GMI-22-06M*	Trichloroethene (298 ug/L) Vinyl chloride (4.23 ug/L)	cis-1,2-Dichloroethene (239 ug/L) Trichloroethene (533 ug/L) Vinyl Chloride (11.4 ug/L)	cis-1,2-Dichloroethene (99 ug/L) Trichloroethene (220 ug/L)	Trichloroethene (120 ug/L)	
	LSA1628-3*	Trichloroethene (329 ug/L)	cis-1,2-Dichloroethene (150 ug/L) Trichloroethene (790 ug/L) Vinyl Chloride (2.2 ug/L)	Trichloroethene (400 ug/L)	Trichloroethene (320 ug/L)	
	East	BSS-B	(not sampled)	Ethyl benzene (1830 ug/L) Toluene (11900 ug/L) Xylenes (12400 ug/L)	Benzene (21U ug/L) Ethyl benzene (1600J ug/L) Toluene (9100 ug/L)	Ethylbenzene (1800 ug/L) Toluene (9100 ug/L)
		MW-1	Benzene (1750 ug/L) Ethyl benzene (5030 ug/L)	1,2-Dichlorobenzene (994 ug/L) Benzene (678 ug/L) Ethyl benzene (2470 ug/L)	Benzene (3200J ug/L) Ethyl benzene (1700 ug/L)	Benzene (3000 ug/L) Ethylbenzene (1700 ug/L)
		MW-10	Benzene (6250 ug/L) Ethylbenzene (5110 ug/L) Toluene (10300 ug/L)	Benzene (4540 ug/L) Ethyl benzene (4920 ug/L) Toluene (10600 ug/L)	Benzene (4200 ug/L) Ethyl benzene (4800 ug/L) Toluene (9000 ug/L) Xylene (13100 ug/L)	Benzene (5500 ug/L) Ethylbenzene (6000 ug/L) m-Xylene & p-Xylene (11000 ug/L) Toluene (8700 ug/L)
	Landfill	MW-5	Benzene (29.7 ug/L)	(none)	Benzene (65J ug/L)	(none)
		ST14-02	(none)	(none)	Benzene (6.1 ug/L)	(none)
		ST14-24	(none)	(none)	(none)	Vinyl chloride (3.4 ug/L)
		ST14-W16	Benzene (59.9 ug/L)	Benzene (5.96J ug/L)	Benzene (6.6J ug/L)	Benzene (6 ug/L)
ST14-W21		Benzene (20.4 ug/L)	(none)	Benzene (9.3J ug/L)	(none)	
FT09-12C*	Vinyl chloride (7.35 ug/L)	cis-1,2-Dichloroethene (93.2 ug/L) Vinyl Chloride (9 ug/L)	Vinyl chloride (6.6 ug/L)	Trichloroethene (5.9 ug/L) Vinyl chloride (11 ug/L)		
GMI-04-01M*	(not sampled)	(not sampled)	Trichloroethene (1400 ug/L) cis-1,2-Dichloroethene (280 ug/L)	cis-1,2-Dichloroethene (240 ug/L) Trichloroethene (880 ug/L)		
LF04-10*	(none)	cis-1,2-Dichloroethene (85.2 ug/L) Vinyl Chloride (7.9 ug/L)	(none)	(none)		
LF04-4F*	cis-1,2-Dichloroethene (370 ug/L) Trichloroethene (2970 ug/L) Vinyl chloride (12.9 ug/L)	cis-1,2-Dichloroethene (1190 ug/L) Trichloroethene (4340 ug/L) Vinyl Chloride (12.2 ug/L)	Trichloroethene (2300 ug/L) cis-1,2-Dichloroethene (390 ug/L)	cis-1,2-Dichloroethene (600 ug/L) Trichloroethene (2700 ug/L)		
LF05-02*	cis-1,2-Dichloroethene (199 ug/L) Trichloroethene (115 ug/L) Vinyl chloride (10.5 ug/L)	cis-1,2-Dichloroethene (218 ug/L) Trichloroethene (61.6 ug/L) Vinyl Chloride (7 ug/L)	Trichloroethene (130 ug/L) cis-1,2-Dichloroethene (370 ug/L)	cis-1,2-Dichloroethene (650 ug/L) Trichloroethene (210 ug/L)		

**Table 5-6. Volatile Organic Compounds (VOCs) Detected Above Risk Reduction Standard 2 (RRS 2)
NAS Fort Worth JRB Basewide Groundwater Sampling 1997 (continued)**

Area	Location	January 1997	April 1997	July 1997	October 1997
Landfill	LF05-18*	1,1-Dichloroethene (42.21 ug/L) cis-1,2-Dichloroethene (293 ug/L) Trichloroethene (970 ug/L) Vinyl chloride (10.3 ug/L)	cis-1,2-Dichloroethene (364 ug/L) Trichloroethene (1150 ug/L) Vinyl Chloride (13.3 ug/L)	Trichloroethene (660 ug/L) cis-1,2-Dichloroethene (200 ug/L)	cis-1,2-Dichloroethene (310 ug/L) Trichloroethene (860 ug/L)
	LF05-19*	cis-1,2-Dichloroethene (293 ug/L) Trichloroethene (998 ug/L)	cis-1,2-Dichloroethene (8221 ug/L) Trichloroethene (17101 ug/L)	Trichloroethene (3101 ug/L) cis-1,2-Dichloroethene (85 ug/L)	Trichloroethene (68 ug/L)
	LF05-5G*	Benzene (34.2 ug/L) cis-1,2-Dichloroethene (219 ug/L) Ethyl benzene (2020 ug/L) Toluene (13500 ug/L) Trichloroethene (595 ug/L) Vinyl chloride (10.9 ug/L)	cis-1,2-Dichloroethene (488 ug/L) Trichloroethene (1240 ug/L) Vinyl Chloride (2.6 ug/L)	Trichloroethene (420 ug/L) cis-1,2-Dichloroethene (140 ug/L)	cis-1,2-Dichloroethene (220 ug/L) Trichloroethene (590 ug/L)
	WP07-10B*	cis-1,2-Dichloroethene (267 ug/L) Tetrachloroethene (14.4 ug/L) Trichloroethene (3010J ug/L) Vinyl chloride (21J ug/L)	1,1-Dichloroethene (7.4 ug/L) cis-1,2-Dichloroethene (404 ug/L) trans-1,2-Dichloroethene (123J ug/L) Trichloroethene (3060 ug/L) Vinyl Chloride (84.2 ug/L)	Trichloroethene (2800 ug/L) cis-1,2-Dichloroethene (320 ug/L)	cis-1,2-Dichloroethene (450 ug/L) Trichloroethene (2500 ug/L)
	WP07-10C*	cis-1,2-Dichloroethene (167 ug/L) Trichloroethene (733 ug/L) Vinyl chloride (21.9 ug/L)	1,1-Dichloroethene (11.6 ug/L) Trichloroethene (816 ug/L) Vinyl Chloride (53.6 ug/L)	Trichloroethene (1400 ug/L) cis-1,2-Dichloroethene (230 ug/L)	cis-1,2-Dichloroethene (220 ug/L) Trichloroethene (990 ug/L)

Notes:

*Only wells with at least one contaminant above RRS 2 are included in this table. See Table 3-4 for all wells sampled. An asterisk next to the well name indicates the well is within the AOC 2 trichloroethene (TCE) plume.

**Table 5-7. Maximum Detected Concentrations
for Selected Volatile Organic Compounds (VOCs)
NAS Fort Worth JRB Basewide Sampling 1997**

VOC Category	VOC ¹	Maximum Detected Concentrations (ug/L)
Highly Chlorinated Solvents	Tetrachloroethene (PCE)	14.4
	Trichloroethene (TCE)	4,340
	cis-1,2-Dichloroethene (cis-1,2-DCE)	1,190
	trans-1,2-Dichloroethene (cis-1,2-DCE)	123J
	1,1-Dichloroethene (1,1-DCE)	42.4
	Vinyl Chloride (VC)	82.2
BTEX Compounds ²	Benzene	6,250
	Toluene	13,500
	Ethyl benzene	6,000
	m-Xylene and p-Xylene	11,000
	o-Xylene	4,300
	Total Xylenes	12,400
Other Petroleum-Related Compounds	none	N/A
Other Solvents	1,2-Dichloroethene	994

Notes:

¹This table contains only VOCs with at least one detection above RRS 2 during 1997 quarterly sampling at NAS Fort Worth JRB.

²In some cases, total xylene results were obtained; in others, separate results were available for o-xylene and for m- and p-xylenes.

Table 5-8. Volatile Organic Compounds (VOCs) Detected Above Practical Quantitation Limits (PQLs) AFP4 Basewide Groundwater Sampling 1997

Area	Location	January 1997	April 1997	July 1997	October 1997
Flightline	HM-119	Tetrachloroethene (2.49 ug/L) Trichloroethene (31.9 ug/L)	(not sampled)	Trichloroethene (4.3 ug/L)	(not sampled)
	HM-120	(none)	(not sampled)	(none)	(not sampled)
	HM-125	cis-1,2-Dichloroethene (9.14 ug/L) Trichloroethene (70.3 ug/L)	(not sampled)	cis-1,2-Dichloroethene (6.6 ug/L) Trichloroethene (61 ug/L)	(not sampled)
	HM-96	cis-1,2-Dichloroethene (2.07 ug/L) Trichloroethene (25.8 ug/L)	(not sampled)	cis-1,2-Dichloroethene (27 ug/L) Trichloroethene (160 ug/L)	(not sampled)
	HM-98	(none)	(not sampled)	(none)	(not sampled)
	MW-IT-02T	cis-1,2-Dichloroethene (847 ug/L) Trichloroethene (4150 ug/L)	cis-1,2-Dichloroethene (440 ug/L) Methylene chloride (270 ug/L) Trichloroethene (2200 ug/L)	cis-1,2-Dichloroethene (340 ug/L) Methylene chloride (51 ug/L) Trichloroethene (1800 ug/L)	cis-1,2-Dichloroethene (590 ug/L) Methylene chloride (170B ug/L) Trichloroethene (2300 ug/L)
	HM-110	cis-1,2-Dichloroethene (110 ug/L) Trichloroethene (1020 ug/L)	(not sampled)	Trichloroethene (73 ug/L)	(not sampled)
	HM-111	(not sampled)	cis-1,2-Dichloroethene (43 ug/L) Methylene chloride (18 ug/L) Trichloroethene (200 ug/L)	(not sampled)	Chloromethane (10 ug/L) cis-1,2-Dichloroethene (30 ug/L) Trichloroethene (130 ug/L)
	HM-112	(not sampled)	cis-1,2-Dichloroethene (270 ug/L) Trichloroethene (9900 ug/L)	(not sampled)	cis-1,2-Dichloroethene (250J ug/L) Methylene chloride (670B ug/L) Trichloroethene (9400 ug/L)
	HM-113	Chloroethane (70.9 ug/L) cis-1,2-Dichloroethene (186 ug/L) trans-1,2-Dichloroethene (33.8 ug/L) Trichloroethene (1480 ug/L) Vinyl chloride (115 ug/L)	(not sampled)	cis-1,2-Dichloroethene (38 ug/L) trans-1,2-Dichloroethene (15 ug/L) Trichloroethene (440 ug/L) Vinyl chloride (11 ug/L)	(not sampled)
	HM-114	cis-1,2-Dichloroethene (83.9 ug/L) Trichloroethene (610 ug/L)	(not sampled)	cis-1,2-Dichloroethene (160 ug/L) Trichloroethene (1000 ug/L)	(not sampled)
	HM-123	cis-1,2-Dichloroethene (548 ug/L) Trichloroethene (4310 ug/L)	(not sampled)	cis-1,2-Dichloroethene (470 ug/L) Methylene chloride (51 ug/L) Trichloroethene (2500 ug/L)	(not sampled)
	HM-127	(none)	(not sampled)	(none)	(not sampled)
LF04-02	cis-1,2-Dichloroethene (294 ug/L) Trichloroethene (2680 ug/L)	cis-1,2-Dichloroethene (630 ug/L) Methylene chloride (260 ug/L) Trichloroethene (7200 ug/L)	cis-1,2-Dichloroethene (310 ug/L) Methylene chloride (56 ug/L) Trichloroethene (2200 ug/L)	cis-1,2-Dichloroethene (380 ug/L) Methylene chloride (62J ug/L) Trichloroethene (2800 ug/L)	

Table 5-8. Volatile Organic Compounds (VOCs) Detected Above Practical Quantitation Limits (PQLs) AFP4 Basewide Groundwater Sampling 1997 (continued)

Area	Location	January 1997	April 1997	July 1997	October 1997
Landfill	LF04-10	Trichloroethene (2.46 ug/L)	Methylene chloride (2.9 ug/L) Trichloroethene (5.6 ug/L)	(not sampled)	Methylene chloride (9.3B ug/L)
	LF04-4C	cis-1,2-Dichloroethene (5.12 ug/L) Trichloroethene (7.26 ug/L)	Methylene chloride (2.5 ug/L) Trichloroethene (7.1 ug/L)	(none)	Chlorobenzene (2.61 ug/L) cis-1,2-Dichloroethene (2.51 ug/L) Trichloroethene (6.7 ug/L) Vinyl chloride (3.1J ug/L)
	LF04-4G	(not sampled)	cis-1,2-Dichloroethene (420 ug/L) Methylene chloride (290 ug/L) Trichloroethene (3800 ug/L)	cis-1,2-Dichloroethene (130 ug/L) Methylene chloride (25 ug/L) Trichloroethene (1100 ug/L)	cis-1,2-Dichloroethene (320 ug/L) Methylene chloride (180B ug/L) Trichloroethene (3000 ug/L)
	LF05-19	cis-1,2-Dichloroethene (354 ug/L) Trichloroethene (1560 ug/L)	cis-1,2-Dichloroethene (290 ug/L) Methylene chloride (150 ug/L) Trichloroethene (920 ug/L)	cis-1,2-Dichloroethene (63 ug/L) Methylene chloride (4.2 ug/L) Trichloroethene (230 ug/L)	(not sampled)
	LF05-5A	cis-1,2-Dichloroethene (521 ug/L) trans-1,2-Dichloroethene (19.6 ug/L) Trichloroethene (2850 ug/L)	cis-1,2-Dichloroethene (150 ug/L) Methylene chloride (100 ug/L) Trichloroethene (900 ug/L)	cis-1,2-Dichloroethene (46 ug/L) Methylene chloride (4 ug/L) Trichloroethene (340 ug/L)	cis-1,2-Dichloroethene (20 ug/L) Methylene chloride (9.6B ug/L) Trichloroethene (140 ug/L)
	MW-IT-01T	cis-1,2-Dichloroethene (30.2 ug/L) Trichloroethene (68.1 ug/L)	cis-1,2-Dichloroethene (27 ug/L) Methylene chloride (3.4 ug/L) Trichloroethene (50 ug/L)	cis-1,2-Dichloroethene (20 ug/L) trans-1,2-Dichloroethene (2.9 ug/L) Trichloroethene (51 ug/L)	cis-1,2-Dichloroethene (37 ug/L) Methylene chloride (9.5B ug/L) trans-1,2-Dichloroethene (5.8 ug/L) Trichloroethene (83 ug/L)

Notes:
 1 All wells sampled by AFP4 on NAS Fort Worth JRB property are included in this table, although in some cases no contaminants above PQL were found.

Table 5-9. Volatile Organic Compounds (VOCs) Detected Above Risk Reduction Standards (RRS 2) AFP4 Basewide Groundwater Sampling 1997

Area	Location	January 1997	April 1997	July 1997	October 1997	
Flightline	HM-119	Trichloroethene (31.9 ug/L)	(not sampled)	(none)	(not sampled)	
	HM-120	(none)	(not sampled)	(none)	(not sampled)	
	HM-125	Trichloroethene (70.3 ug/L)	(not sampled)	Trichloroethene (61 ug/L)	(not sampled)	
	HM-96	Trichloroethene (25.8 ug/L)	(not sampled)	Trichloroethene (160 ug/L)	(not sampled)	
	HM-98	(none)	(not sampled)	(none)	(not sampled)	
	MW-IT-02T		cis-1,2-Dichloroethene (847 ug/L)	cis-1,2-Dichloroethene (440 ug/L)	cis-1,2-Dichloroethene (340 ug/L)	cis-1,2-Dichloroethene (590 ug/L)
			Trichloroethene (4150 ug/L)	Methylene chloride (270 ug/L)	Methylene chloride (51 ug/L)	Methylene chloride (170B ug/L)
				Trichloroethene (2200 ug/L)	Trichloroethene (1800 ug/L)	Trichloroethene (2300 ug/L)
				(not sampled)	Trichloroethene (73 ug/L)	(not sampled)
	Landfill	HM-110	cis-1,2-Dichloroethene (110 ug/L)	(not sampled)		
		Trichloroethene (1020 ug/L)				
HM-111		(not sampled)	Methylene chloride (18 ug/L)	(not sampled)	Chloromethane (10 ug/L)	
			Trichloroethene (200 ug/L)		Trichloroethene (130 ug/L)	
HM-112		(not sampled)	cis-1,2-Dichloroethene (270 ug/L)	(not sampled)	cis-1,2-Dichloroethene (250J ug/L)	
			Trichloroethene (9900 ug/L)		Methylene chloride (670B ug/L)	
					Trichloroethene (9400 ug/L)	
HM-113		cis-1,2-Dichloroethene (186 ug/L)	(not sampled)	Trichloroethene (440 ug/L)	(not sampled)	
		Trichloroethene (1480 ug/L)		Vinyl chloride (11 ug/L)		
		Vinyl chloride (115 ug/L)				
HM-114		cis-1,2-Dichloroethene (83.9 ug/L)	(not sampled)	cis-1,2-Dichloroethene (160 ug/L)	(not sampled)	
		Trichloroethene (610 ug/L)		Trichloroethene (1000 ug/L)		
HM-123		cis-1,2-Dichloroethene (548 ug/L)	(not sampled)	cis-1,2-Dichloroethene (470 ug/L)	(not sampled)	
		Trichloroethene (4310 ug/L)		Methylene chloride (51 ug/L)		
HM-127		(none)	(not sampled)	Trichloroethene (2,500 ug/L)	(not sampled)	
				(none)	(not sampled)	
LF04-02		cis-1,2-Dichloroethene (294 ug/L)	cis-1,2-Dichloroethene (630 ug/L)	cis-1,2-Dichloroethene (310 ug/L)	cis-1,2-Dichloroethene (380 ug/L)	
		Trichloroethene (2680 ug/L)	Methylene chloride (260 ug/L)	Methylene chloride (56 ug/L)	Methylene chloride (62J ug/L)	
LF04-10		(none)	Trichloroethene (7200 ug/L)	Trichloroethene (2200 ug/L)	Trichloroethene (2800 ug/L)	
			Trichloroethene (5.6 ug/L)	(not sampled)	Methylene chloride (9.3B ug/L)	
LF04-4C	Trichloroethene (7.26 ug/L)	Trichloroethene (7.1 ug/L)	(none)	(none)	Trichloroethene (6.7 ug/L)	
					Vinyl chloride (3.1J ug/L)	

Table 5-9. Volatile Organic Compounds (VOCs) Detected Above Risk Reduction Standards (RRS 2) AFP4 Basewide Groundwater Sampling 1997 (continued)

Area	Location	January 1997	April 1997	July 1997	October 1997
Landfill	LF04-4G	(not sampled)	cis-1,2-Dichloroethene (420 ug/L) Methylene chloride (290 ug/L) Trichloroethene (3800 ug/L)	cis-1,2-Dichloroethene (130 ug/L) Methylene chloride (25 ug/L) Trichloroethene (1100 ug/L)	cis-1,2-Dichloroethene (320 ug/L) Methylene chloride (180B ug/L) Trichloroethene (3000 ug/L)
	LF05-19	cis-1,2-Dichloroethene (354 ug/L) Trichloroethene (1560 ug/L)	cis-1,2-Dichloroethene (290 ug/L) Methylene chloride (150 ug/L) Trichloroethene (920 ug/L)	Trichloroethene (230 ug/L)	(not sampled)
	LF05-5A	cis-1,2-Dichloroethene (521 ug/L) Trichloroethene (2850 ug/L)	cis-1,2-Dichloroethene (150 ug/L) Methylene chloride (100 ug/L) Trichloroethene (900 ug/L)	Trichloroethene (340 ug/L)	Methylene chloride (9.6B ug/L) Trichloroethene (140 ug/L)
	MW-IT-01T	Trichloroethene (68.1 ug/L)	Trichloroethene (50 ug/L)	Trichloroethene (51 ug/L)	Methylene chloride (9.5B ug/L) Trichloroethene (83 ug/L)

Table 5-10. Volatile Organic Compounds (VOCs) Detected Above Practical Quantitation Limits (PQLs) and Risk Reduction Standard 2 (RRS 2) Sanitary Sewer System RFI April 1997

Area	Location	Detections Above PQL	Detections Above RRS2
Flightline	GMI-22-05M	Methylene chloride (0.4 ug/L) Trichloroethene (0.51 ug/L)	(none)
	LSA1628-3	cis-1,2-Dichloroethene (74 ug/L) Methylene chloride (110 ug/L) Trichloroethene (410 ug/L)	cis-1,2-Dichloroethene (74 ug/L) Methylene chloride (110 ug/L) Trichloroethene (410 ug/L)
	WITCTA001	Bromodichloromethane (1 ug/L) Chloroform (1.7 ug/L) Methylene chloride (0.68 ug/L)	(none)
	WITCTA002	Chloroform (0.51 ug/L) Diethyl phthalate (2.6 ug/L) Methylene chloride (0.25 ug/L)	(none)
	WITCTA003	Methylene chloride (0.59 ug/L) Trichloroethene (0.33 ug/L)	(none)
	WITCTA004	cis-1,2-Dichloroethene (1.4 ug/L) Methylene chloride (0.56 ug/L) Trichloroethene (4.6 ug/L)	(none)
	WITCTA005	cis-1,2-Dichloroethene (97 ug/L) Methylene chloride (8.8 ug/L) Trichloroethene (310 ug/L)	cis-1,2-Dichloroethene (97 ug/L) Methylene chloride (8.8 ug/L) Trichloroethene (310 ug/L)
	WITCTA006	cis-1,2-Dichloroethene (110 ug/L) Methylene chloride (3.2 ug/L) Trichloroethene (25 ug/L)	cis-1,2-Dichloroethene (110 ug/L) Trichloroethene (25 ug/L)
	WITCTA007	cis-1,2-Dichloroethene (57 ug/L) Methylene chloride (1.1 ug/L) trans-1,2-Dichloroethene (0.46 ug/L) Trichloroethene (54 ug/L)	Trichloroethene (54 ug/L)
	WITCTA008	Chloroform (12J ug/L) cis-1,2-Dichloroethene (24 ug/L) Methylene chloride (20 ug/L) Trichloroethene (620 ug/L)	Methylene chloride (20 ug/L) Trichloroethene (620 ug/L)
	WITCTA009	cis-1,2-Dichloroethene (33J ug/L) Methylene chloride (39 ug/L) Trichloroethene (650 ug/L)	Methylene chloride (39 ug/L) Trichloroethene (650 ug/L)
	WITCTA010	cis-1,2-Dichloroethene (1.8 ug/L) Methylene chloride (0.44 ug/L)	(none)
	WITCTA011	Chloroform (15J ug/L) cis-1,2-Dichloroethene (58J ug/L) Trichloroethene (550 ug/L)	Trichloroethene (550 ug/L)
	WITCTA012	cis-1,2-Dichloroethene (94 ug/L) Methylene chloride (1.8 ug/L) Trichloroethene (6.8 ug/L)	cis-1,2-Dichloroethene (94 ug/L) Trichloroethene (6.8 ug/L)
WITCTA013	cis-1,2-Dichloroethene (50 ug/L) Methylene chloride (17 ug/L) Trichloroethene (330 ug/L)	Methylene chloride (17 ug/L) Trichloroethene (330 ug/L)	
WITCTA014	cis-1,2-Dichloroethene (15 ug/L) Methylene chloride (1.7 ug/L) Trichloroethene (92 ug/L)	Trichloroethene (92 ug/L)	

Table 5-10. Volatile Organic Compounds (VOCs) Detected Above Practical Quantitation Limits (PQLs) and Risk Reduction Standard 2 (RRS 2) Sanitary Sewer System RFI April 1997 (continued)

Area	Location	Detections Above PQL	Detections Above RRS2
Flightline	WITCTA015	Chloroform (4.8 ug/L) cis-1,2-Dichloroethene (240 ug/L) Methylene chloride (7.4 ug/L) Tetrachloroethene (11 ug/L)	cis-1,2-Dichloroethene (240 ug/L) Methylene chloride (7.4 ug/L) Tetrachloroethene (11 ug/L)
	WITCTA016	cis-1,2-Dichloroethene (72 ug/L) Methylene chloride (1.7 ug/L) Trichloroethene (29 ug/L)	cis-1,2-Dichloroethene (72 ug/L) Trichloroethene (29 ug/L)
	WITCTA017	Chloroform (0.25 ug/L) cis-1,2-Dichloroethene (0.22 ug/L) Methylene chloride (0.85 ug/L) Trichloroethene (0.76 ug/L)	(none)
	WITCTA020	Methylene chloride (0.58 ug/L) Trichloroethene (7.8 ug/L)	Trichloroethene (7.8 ug/L)
	WITCTA024	1,2,4-Trimethylbenzene (64 ug/L) 1,3,5-Trimethylbenzene (3.5 ug/L) Isopropylbenzene (1.3 ug/L) Methylene chloride (3.3 ug/L) n-Propylbenzene (3.7 ug/L) Naphthalene (4.1 ug/L) p-Isopropyltoluene (3.4 ug/L) sec-Butylbenzene (3.1 ug/L) tert-Butylbenzene (2.4 ug/L)	(none)
	WITCTA025	cis-1,2-Dichloroethene (71 ug/L) Methylene chloride (4.9 ug/L) Tetrachloroethene (14 ug/L)	cis-1,2-Dichloroethene (71 ug/L) Tetrachloroethene (14 ug/L)
East	BGSMW01	Methylene chloride (1.9 ug/L)	(none)
	ST14MW24	Methylene chloride (1.8 ug/L) trans-1,2-Dichloroethene (0.45 ug/L)	(none)
	ST14MW27	Methylene chloride (1.3 ug/L) tert-Butylbenzene (9.6 ug/L)	(none)
	ST14-W05	Methylene chloride (1.7 ug/L)	(none)
	WITCTA019	cis-1,2-Dichloroethene (1.5 ug/L) Methylene chloride (0.5 ug/L) Trichloroethene (0.28 ug/L)	(none)
	WITCTA021	Methylene chloride (0.29 ug/L) Trichloroethene (0.43 ug/L) Vinyl chloride (9.9 ug/L)	Vinyl chloride (9.9 ug/L)
	WITCTA022	cis-1,2-Dichloroethene (0.55 ug/L) Isopropylbenzene (1.1 ug/L) Methylene chloride (0.62 ug/L) n-Butylbenzene (0.44 ug/L) sec-Butylbenzene (0.39 ug/L) Trichloroethene (2.1 ug/L) Trichlorofluoromethane (5.5 ug/L)	(none)
	WITCTA026	Methylene chloride (0.45 ug/L)	(none)
	WITCTA027	Methylene chloride (0.62 ug/L) Trichloroethene (0.25 ug/L)	(none)
	WITCTA028	Methylene chloride (0.91 ug/L)	(none)

Table 5-10. Volatile Organic Compounds (VOCs) Detected Above Practical Quantitation Limits (PQLs) and Risk Reduction Standard 2 (RRS 2) Sanitary Sewer System RFI April 1997 (continued)

Area	Location	Detections Above PQL	Detections Above RRS2
East	WITCTA031	cis-1,2-Dichloroethene (0.69 ug/L) Methylene chloride (0.29 ug/L) Vinyl chloride (2.2 ug/L)	Vinyl chloride (2.2 ug/L)
	WITCTA032	Methylene chloride (0.76 ug/L) p-Isopropyltoluene (1 ug/L) sec-Butylbenzene (0.66 ug/L)	(none)
	WITCTA033	Methylene chloride (0.73 ug/L) p-Isopropyltoluene (10 ug/L)	(none)
	WITCTA034	Methylene chloride (0.63 ug/L) Tetrachloroethene (0.46 ug/L)	(none)
	WITCTA035	cis-1,2-Dichloroethene (0.37 ug/L) Methylene chloride (0.28 ug/L) Vinyl chloride (4.8 ug/L)	Vinyl chloride (4.8 ug/L)
	WITCTA036	1,1,1-Trichloroethane (28000J ug/L) 1,2,4-Trimethylbenzene (750000 ug/L) 1,3,5-Trimethylbenzene (190000 ug/L) 2-Methylnaphthalene (200000J ug/L) Ethylbenzene (120000 ug/L) n-Propylbenzene (94000 ug/L) Naphthalene (320000 ug/L) o-Xylene (230000 ug/L) Toluene (180000 ug/L)	1,1,1-Trichloroethane (28000J ug/L) 1,2,4-Trimethylbenzene (750000 ug/L) 1,3,5-Trimethylbenzene (190000 ug/L) Ethylbenzene (120000 ug/L) n-Propylbenzene (94000 ug/L) Naphthalene (320000 ug/L) o-Xylene (230000 ug/L) Toluene (180000 ug/L)
	WITCTA037	cis-1,2-Dichloroethene (8.4 ug/L) Methylene chloride (1.9 ug/L) Trichloroethene (58 ug/L)	Trichloroethene (58 ug/L)
Landfill	WITCTA039	cis-1,2-Dichloroethene (230 ug/L) Methylene chloride (7.8 ug/L) Trichloroethene (39 ug/L) Vinyl chloride (22 ug/L)	cis-1,2-Dichloroethene (230 ug/L) Methylene chloride (7.8 ug/L) Trichloroethene (39 ug/L) Vinyl chloride (22 ug/L)

Figure 5-2 and Figure 5-3 show the extent of the TCE and cis-1,2 DCE plumes for the October sampling event. The general extent of these plumes has remained fairly consistent throughout the year and is characterized by a north and south lobe. AFP 4 is a known source of TCE to the Base and is the reason for extending the contours towards the West. Ongoing investigations, in addition to the quarterly monitoring, are characterizing the nature and extent of the TCE plume, also known as AOC 2 (CH2M Hill, 1997c). Other potential and known on-site sources within the area of highest concentration in the south lobe of the plume are being investigated as well (HGL, 1997c).

The highest concentrations occur within the closed contours of both the north and south lobes. The highest concentrations of TCE correspond to the highest concentrations of its daughter products. Ten of the thirteen NAS Fort Worth JRB basewide monitoring wells that detected TCE or DCE also detected VC; indicating that the process of natural biodegradation may be at work.

A consistently sharp concentration gradient associated with hot spots for both the TCE and cis-1,2 DCE plumes exists along the southern edge of the south lobe in the Landfill Area. This sharp gradient is likely due to a hydrogeologic heterogeneity and/or an on-site source of TCE such as drums removed from SWMU 24 in January 1991 (HGL, 1997h). A gravel layer which has been recently mapped along the tributary in the area correlates with the approximate extent of the plume. The presence of this gravel layer could cause dilution within the plume and account for a rapid change in concentration as well. In addition, a pump and treat system installed in the vicinity of SWMU 24 in 1993, currently utilizes at least three groundwater recovery wells (HGL, 1997h). The sharp gradient could be a result of these wells pulling the contamination into the plume, resulting in a rapid decline of concentration cross-gradient of the recovery wells.

The delineation of the north and south lobe is based on a dominant, off-site source interpretation and the belief that the lobes are a result of hydrogeological preferred flow paths (CH2M Hill, 1997c). However, more comprehensive sampling within the area between the two lobes would provide greater assurance of the actual extent of the plume, and would verify the occurrence of the two lobes. This sampling is expected to be conducted in 1998 as part of the RCRA Facility Investigation (RFI) for AOC 2 (CH2M Hill, 1997c).

In the North Lobe, concentration trends of TCE and cis-1,2 DCE are similar throughout the year. Figure 5-4 show the change in concentration for these two contaminants for selected wells. Both TCE and cis-1,2-DCE were detected at their highest concentrations during the April 1997 sampling event which corresponds to the wet season for Texas. As TCE concentrations drop in July and October, so do cis-1,2-DCE concentrations.

In the South Lobe, concentrations trends of TCE and cis-1,2-DCE are variable. Figure 5-5 shows a time-series plot for three selected wells which depict the variability of TCE and DCE that is exhibited in different wells in this area. The trend in monitoring well LF05-19 is similar to the trend exhibited in the North Lobe monitoring wells; however, the trends in monitoring wells LF05-02 and WP07-10B are distinctly different. This may indicate that the south lobe is influenced by more than one source of TCE and/or the geochemical conditions are variable and may affect the process of biodegradation.

Figure 5-4. TCE and cis-1,2-DCE Concentrations Over 1997 for Selected Wells in the North Lobe

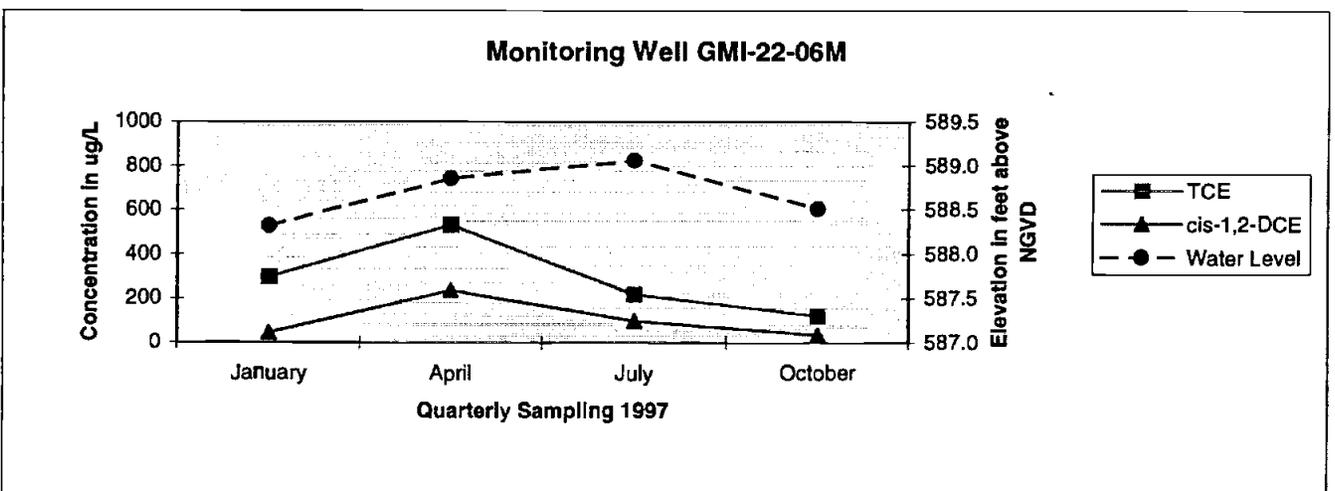
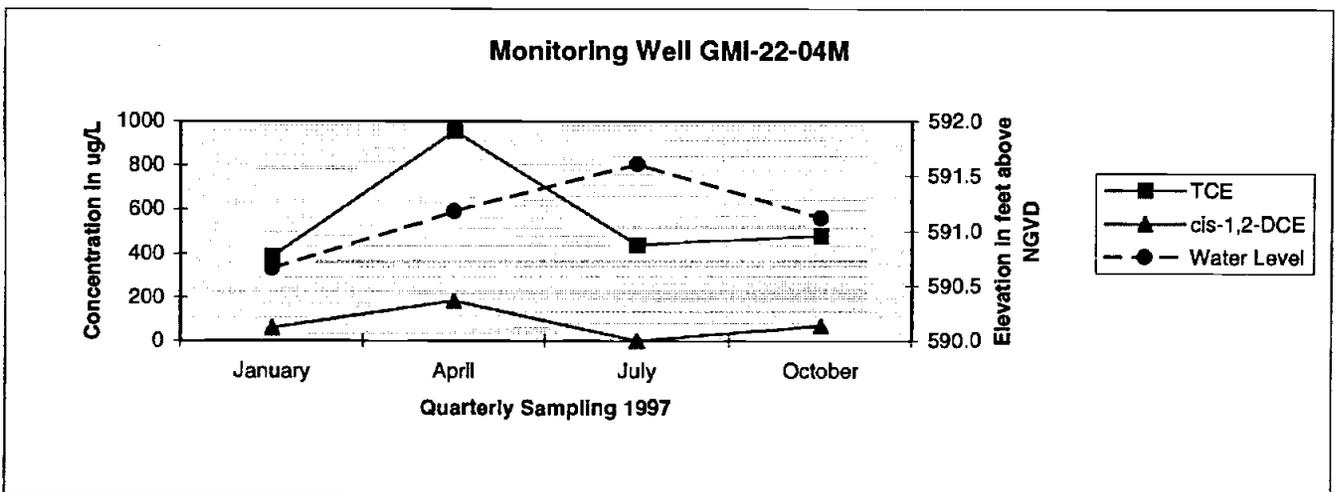
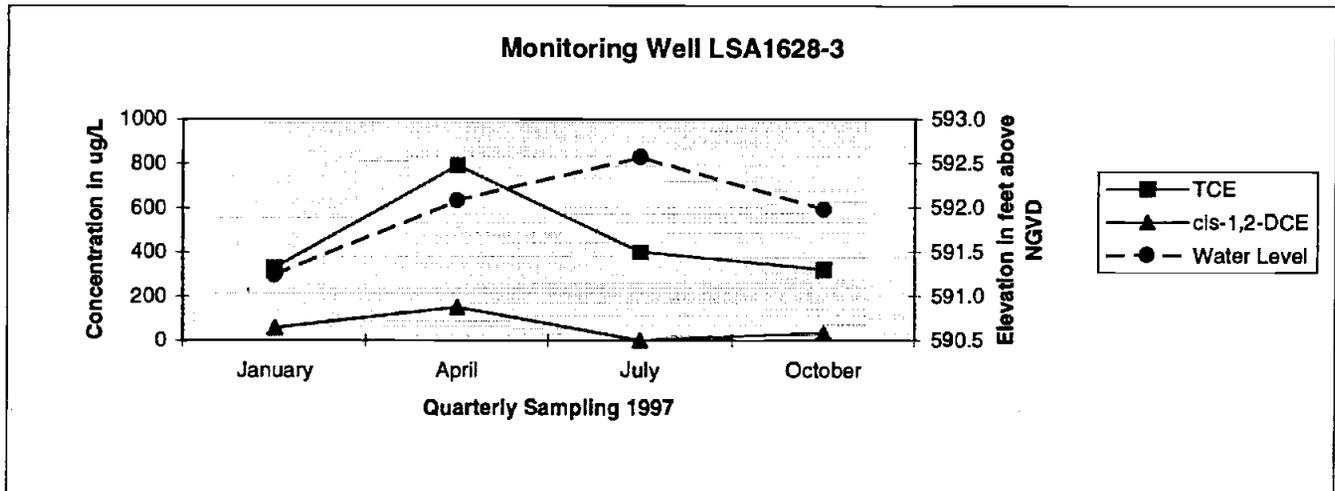
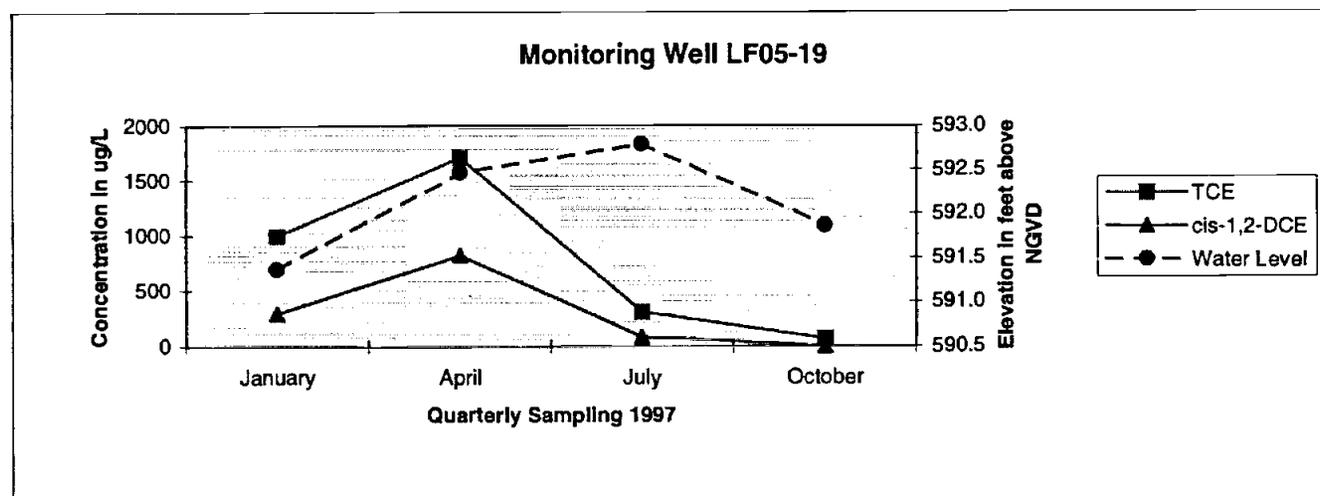
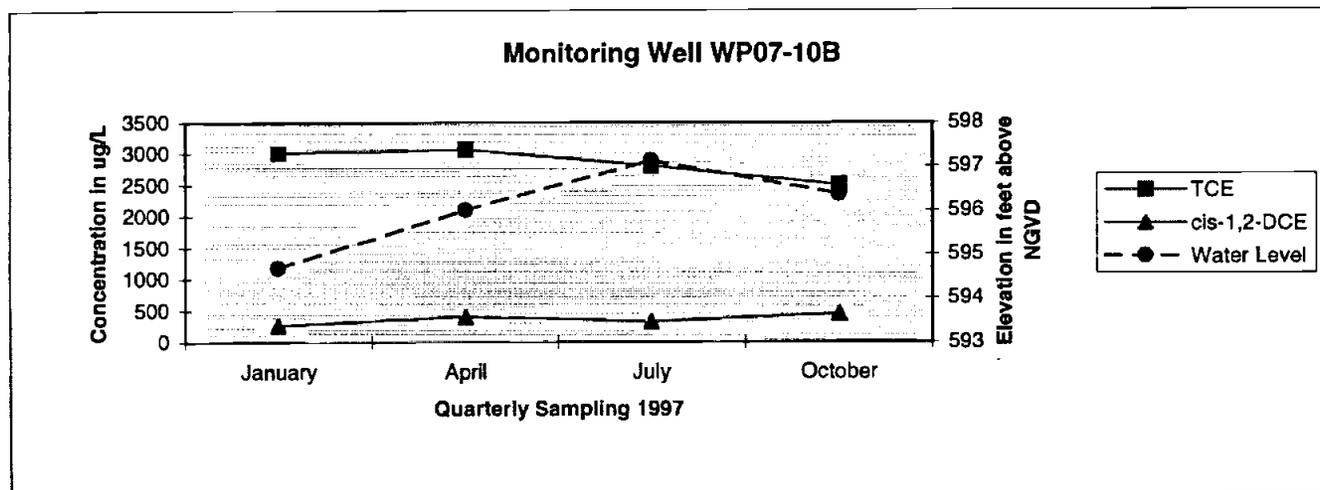
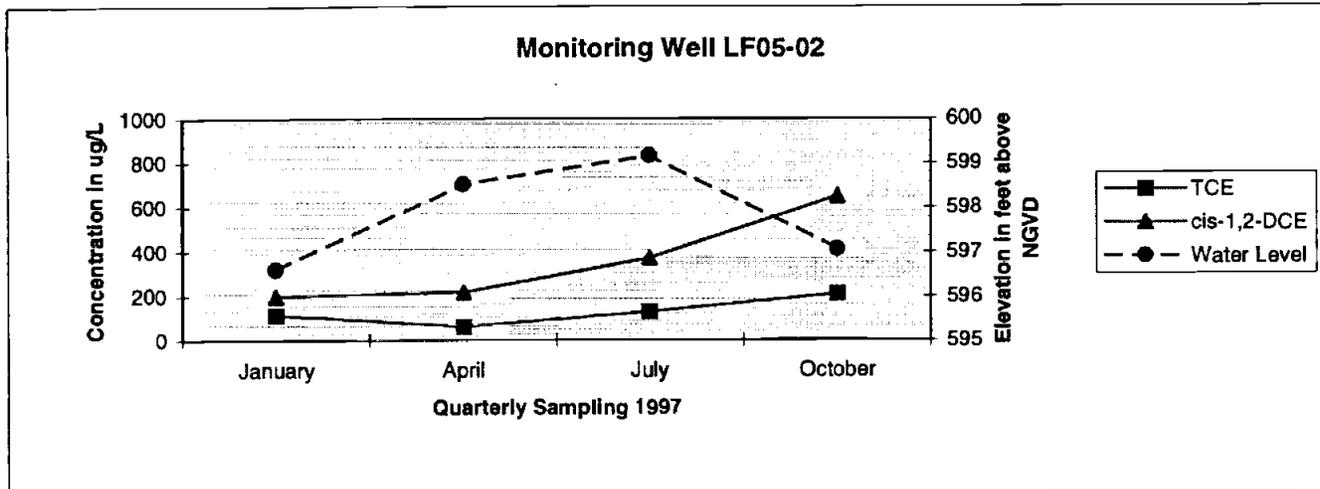


Figure 5-5. TCE and cis-1,2-DCE Concentrations Over 1997 for Selected Wells in the South Lobe



5.5.2 BTEX Compounds

The BTEX compounds include benzene, toluene, ethyl benzene, and total xylenes (usually measured as o-, m-, and p-xylene isomers). BTEX compounds were detected above RRS 2 values in eight wells. All of these wells, except for LF05-5G, are associated with known gasoline spills in the East Area. The characterization of these BTEX plumes in the East Area are presented in Remedial Action Plan for SWMU 64, 67, 68, and AOC 7 (Parsons, 1997) and the Corrective Action Plans for AOC 1 (IT Corporation, 1997a, 1997b). Long-term monitoring (LTM) requirements (LTM) for these SWMU/AOCs in 1998 will continue to ensure a thorough delineation of the nature and extent of the BTEX contamination in this area. Section 5.6 discusses the evidence for natural attenuation of these BTEX plumes as indicated by the data collected during the 1997 basewide quarterly sampling events.

Figure 5-6 shows the most recent depiction of the extent of BTEX compounds as measured during the October sampling event. Total BTEX concentrations for all wells are provided in Table 5-11. Eight Landfill Area monitoring wells, including LF05-5G, detected BTEX compounds above PQLs. One sample from LF05-5G detected benzene, toluene, and ethylbenzene (total BTEX = 15,554 $\mu\text{g/L}$) above the RRS 2 values during the January sampling event. Four Flightline Area wells detected BTEX compounds above PQLs also. However, none of the samples collected from these wells had concentrations that exceeded the RRS 2 values for the BTEX compounds.

5.5.3 Other Petroleum-Related Compounds

Other petroleum-related compounds detected above PQLs during 1997 NAS Fort Worth JRB basewide sampling include N-Propylbenzene, Naphthalene, p-Isopropyltoluene, sec-Butylbenzene, tert-Butylbenzene, Isopropylbenzene, n-Butylbenzene, n-Propylbenzene, 1,2,4-Trimethylbenzene, 1,3,5-Trimethylbenzene (Table 5-4). These compounds were generally associated with the wells that also showed detections of BTEX compounds. Twelve wells detected other petroleum-related compounds above their respective PQLs. Ten of these wells also detected at least one of the BTEX compounds. Three of the 12 wells are located in the Flightline Area and are associated with AOC 4. Five of the 12 wells are located in the East Area and are associated with SWMUs 64, 67, and 68 and AOCs 1 and 7 (ST14/SD13 area) and SWMU 28 (Landfill 1), and four of the 12 wells are located in the Landfill Area and are associated with SWMU 22 (Landfill 4), SWMU 23 (Landfill 5), and SWMU 24 (Waste Pile 7).

5.5.4 Other Solvents

Other solvents which include Chloroform, 1,2-Dichlorobenzene, Chlorobenzene, 1,2,3-Trichloropropane, 1,3-Dichlorobenzene, 1,4-Dichlorobenzene, 1,1,1-Trichloroethane, 1,2-Dichloroethane, 1,1-Dichloroethane have been detected above their respective PQLs in 21 monitoring wells across the Base (2 in the Flightline Area, 11 in the East Area, 8 in the Landfill Area). These solvents, in particular 1,2-Dichlorobenzene, are typical of chemical waste dump leachates and related to extractants, industrial solvents and/or chemical intermediates. Only one detection of 1,2-Dichlorobenzene exceeded the RRS 2 value of 600 $\mu\text{g/L}$ in monitoring well MW-1, which is associated with AOC 1. The occurrence of these contaminants is sporadic and should be monitored under unit-specific remedial actions and/or LTM requirements.

This page was intentionally left blank.

Figure 5-6
TOTAL BTEX CONCENTRATIONS
OCTOBER 1997
NAS Fort Worth JRB

AIR FORCE CENTER FOR
 ENVIRONMENTAL EXCELLENCE
 BROOKS AFB, TEXAS

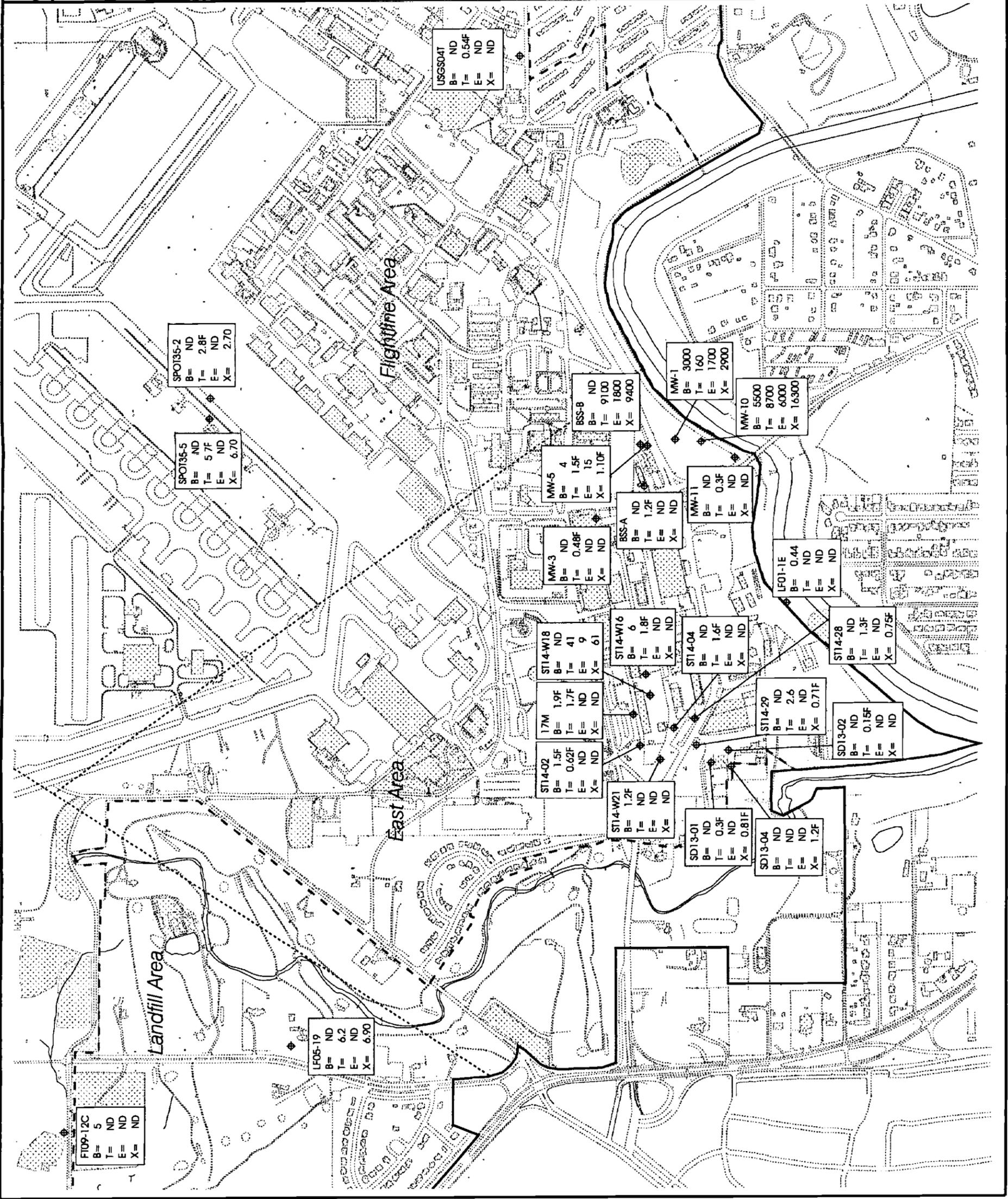
LEGEND

- - - - - NAS Ft. Worth JRB (Carswell Field)
- Former Carswell Property Boundary
- △ Approximate Groundwater Management Areas

NAS Fort Worth JRB
 Base-wide Monitoring Wells

LF01-1A	B= 12
	T= 13
	E= 240
	X= 1300

Benzene
 Toluene
 Ethylbenzene
 Xylenes



**Table 5-11. Total and Average Total BTEX Concentrations
NAS Fort Worth Basewide Groundwater Sampling 1997**

Location	Total BTEX Concentration (ug/L)				
	January 1997	April 1997	July 1997	October 1997	Year Average
17M	-- ¹	4.27	2.11	3.6	3.3
BSS-A	ND	ND	ND	1.2	1.2
BSS-B	-- ¹	14930	19200	20300	18100
FT09-12C	ND	0.81	3	5	3
GMI-04-01M	-- ¹	-- ¹	ND	ND	ND
GMI-22-02M	ND	ND	ND	ND	ND
GMI-22-04M	0.39	ND	ND	ND	ND
GMI-22-05M	ND	ND	6.9	ND	6.9
GMI-22-06M	ND	0.71	ND	ND	0.71
GMI-22-07M	ND	ND	ND	ND	ND
LF01-1B	ND	ND	5.25	ND	5.25
LF01-1C	ND	ND	ND	ND	ND
LF01-1D	ND	ND	2.29	ND	2.29
LF01-1E	ND	0.26	ND	0.44	0.35
LF04-10	ND	0.69	ND	ND	0.69
LF04-4F	36	ND	ND	ND	ND
LF05-02	ND	ND	ND	ND	ND
LF05-18	ND	0.44	ND	ND	0.44
LF05-19	ND	ND	ND	13.1	13.1
LF05-5G	26600	ND	ND	ND	26600
LSA1628-3	ND	ND	ND	ND	ND
MW-1	15100	6560	8240	7760	7520
MW-10	34970	33000	31100	35500	33200
MW-11	ND	ND	7.8	0.3	4.1
MW-12	ND	ND	1.07	ND	1.07
MW-3	ND	ND	1.38	0.48	0.93
MW-5	133	2.06	465	21.6	163
MW-8	ND	6.73	2.16	ND	4.45
MW-9	ND	ND	ND	ND	ND
OT-15C	ND	ND	1.5	ND	1.5
SD13-01	23.3	0.87	1.8	1.11	1.3
SD13-02	4.28	10.3	ND	0.15	5.2
SD13-04	-- ¹	8.8	5.13	1.2	5.0
SD13-06	-- ¹	ND	2.23	ND	2.23
SPOT35-2	2.37	2.49	ND	5.5	4.0
SPOT35-4	0.17	0.16	ND	ND	0.2
SPOT35-5	3.45	5.87	ND	12.4	9.14
ST14-02	ND	0.91	6.1	2.12	3.0
ST14-03	0.52	0.4	0.14	ND	0.3
ST14-04	28.1	2.01	1.86	1.6	1.8
ST14-14	ND	ND	ND	ND	ND
ST14-24	ND	ND	ND	ND	ND
ST14-26	ND	ND	ND	ND	ND

**Table 5-11. Total and Average Total BTEX Concentrations
NAS Fort Worth Basewide Groundwater Sampling 1997 (continued)**

Location	Total BTEX Concentration (ug/L)				
	January 1997	April 1997	July 1997	October 1997	Year Average
ST14-28	19	4.76	2.52	2.05	3.1
ST14-29	28.1	1.5	1.65	3.21	2.1
ST14-W16	64.3	6.83	7.13	7.8	7.3
ST14-W18	14.2	8.03	4.83	111	41.3
ST14-W21	22.3	2.53	10.2	1.2	4.6
ST14-W31	7.44	ND	1.08	ND	1.08
USGS04T	ND	ND	1	0.54	1
WP07-10B	0.32	6.71	ND	ND	6.7
WP07-10C	1.6	0.88	ND	ND	0.9

Notes:

¹BTEX compounds not sampled during this quarterly event.

5.6 NATURAL ATTENUATION OF BTEX COMPOUNDS

Natural attenuation parameters were collected from the BTEX plume wells in the East Area groundwater to demonstrate that natural attenuation of compounds is occurring. The data collected during the four quarterly events in 1997 helped to confirm natural attenuation processes, that were also evaluated by Parsons (1997) as part of their Remedial Action Plan for SWMUs 64, 67, and 68, and AOC 7. The availability of these data from both impacted and nonimpacted wells allowed a comparison of parameters under non-contaminated conditions to parameters in wells where benzene and other BTEX compounds were present. Natural attenuation parameters will continue to be collected as part of the long-term monitoring requirements for these sites.

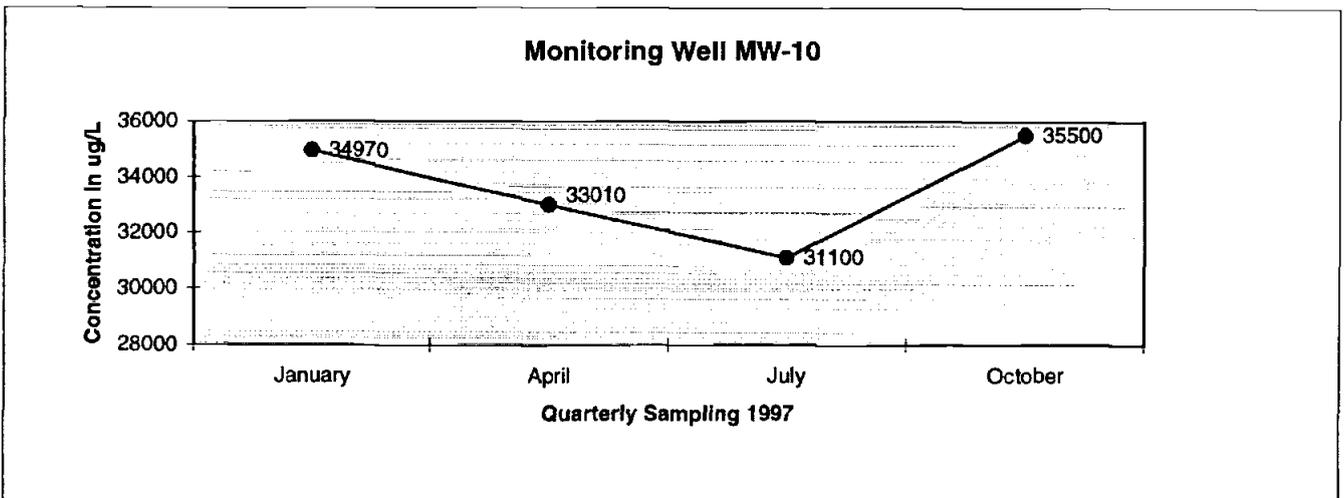
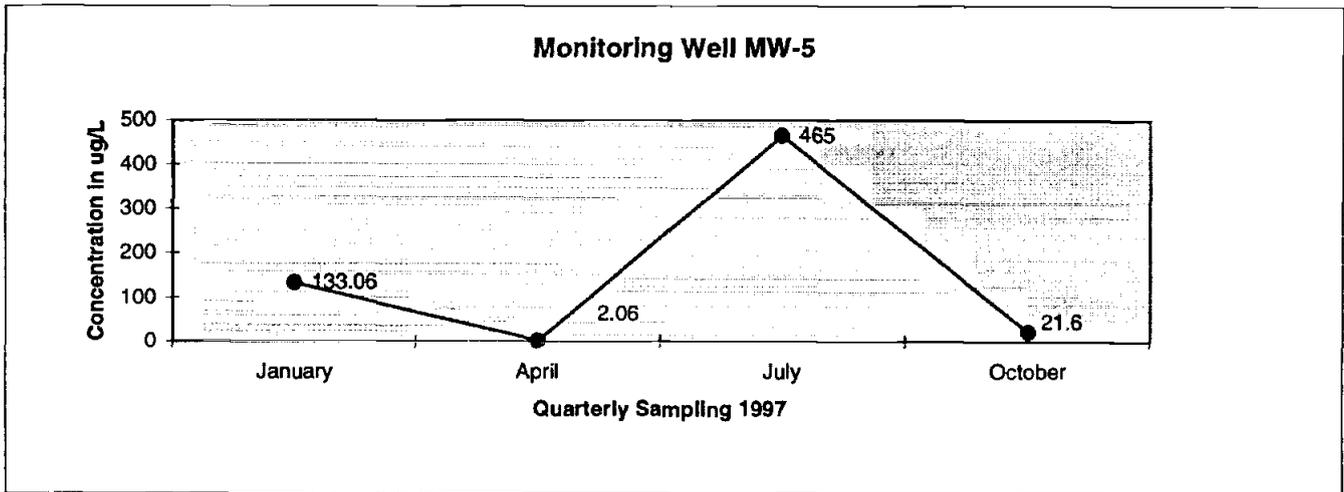
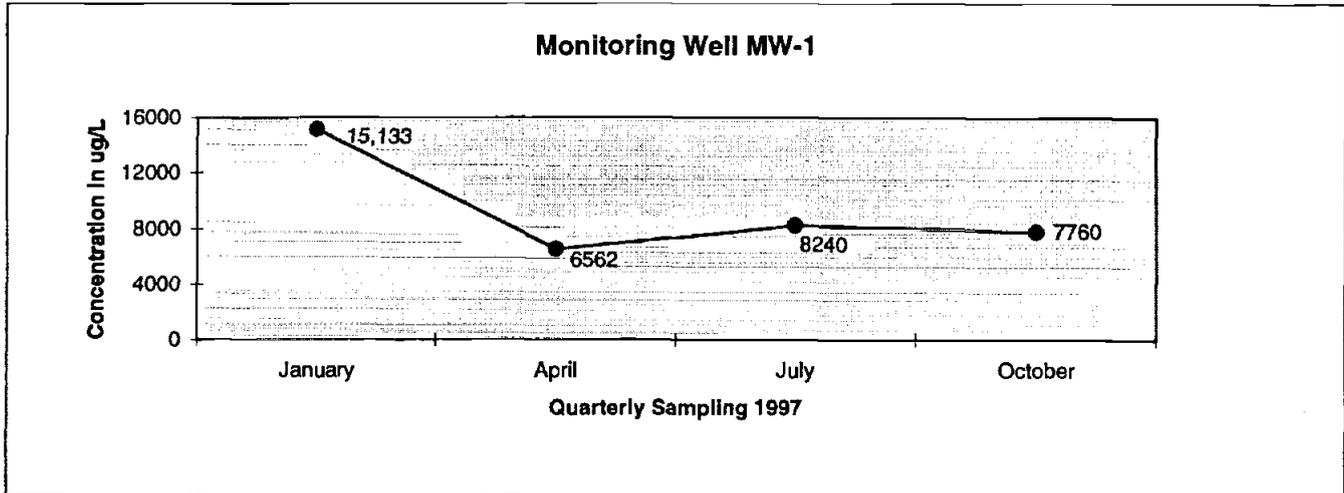
At least two lines of evidence are available to support the case for natural attenuation of BTEX in the East Area: a loss of contaminants, and trends in natural attenuation parameters that indicate both aerobic and anaerobic biodegradation of the BTEX compounds. Three areas of high BTEX concentrations were monitored for natural attenuation parameters during each quarterly monitoring as well as for specific remedial actions (Parsons, 1997; IT Corporation, 1997a, 1997b). The data collected during the quarterly monitoring are consistent with the data collected and interpreted by the remedial actions. One area of high concentrations of BTEX is associated with AOC 1, and the other two are associated with SWMUs 64, 67, and 68 and AOC 7 (ST14/SD13 area). The extent of the detections of BTEX compounds is provided in Figure 5-6. All of the BTEX plumes will continue to be monitored under LTM requirements in 1998.

5.6.1 Changes in Contaminant Mass

In the BTEX plume associated with AOC 1, three wells were significantly impacted with dissolved BTEX constituents. The average 1997 total BTEX concentrations in these wells were: 150 $\mu\text{g/l}$ in MW-5; 9,424 $\mu\text{g/l}$ in MW-1; and 32,368 $\mu\text{g/l}$ in MW-10. Of these wells, MW-1 and MW-5 exhibited a generally declining trend in total BTEX concentration over the year, as shown in Figure 5-7. Total BTEX concentrations at MW-10 remained more consistent and were two orders of magnitude higher than concentrations at MW-5 during the year (Figure 5-7).

Most of the wells in the BTEX plumes associated with SWMUs 64, 67, and 68 and AOC 7 (ST14/SD13 area) had very low average concentrations and declining trends in benzene concentrations (less than 1 $\mu\text{g/L}$) and total BTEX concentrations (less than 10 $\mu\text{g/L}$) during the year. Three of the monitoring wells exhibited low yearly concentrations of benzene ST14-02 (2.03 $\mu\text{g/L}$), ST14-W16 (19.6 $\mu\text{g/L}$), and ST14-W21 (7.73 $\mu\text{g/L}$). Declining trends in benzene concentration were observed in ST14-W16 and ST14-W21. Only ST14-02 (January - not detected, April - 1 $\mu\text{g/l}$, July - 6 $\mu\text{g/l}$, October - 2 $\mu\text{g/l}$) exhibited an increasing trend in benzene concentration over the year. Elevated levels of average Total BTEX concentrations were observed at two monitoring wells, ST14-W16 (21.5 $\mu\text{g/L}$) and ST14-W18 (34.52 $\mu\text{g/L}$), during the year. Total BTEX concentration at ST14-W18 increased over the year and decreased at ST14-W21 over the year.

Figure 5-7. Total BTEX Concentrations Over 1997 for Selected Wells in the East Area



5.6.2 Evidence of Intrinsic Bioremediation

Intrinsic bioremediation parameters such as DO, nitrate, iron, sulfate, methane, and oxygen reduction potential (ORP or Eh) are known to be indicators of bioremediation activity. Oxygen is the preferred oxidant for microbial activity since it has the greatest amount of energy available. Aerobic microbial activity quickly depletes groundwater oxygen supplies leading to anaerobic conditions. As described by Buscheck et al. (1993), a depressed DO concentration within a plume is an indication that microorganisms are present. It should be noted that aerobic biodegradation of petroleum hydrocarbons is significant where DO is greater than 1-2 milligrams per liter (mg/L); however, when DO levels fall below 1 mg/L, anaerobic activity is the dominant mechanism of biodegradation (McAllister and Chiang, 1994).

Under anaerobic conditions, different bacteria use other compounds as oxidants (electron acceptors). While oxygen is the electron acceptor for aerobic metabolism, compounds such as nitrate, ferric iron (Fe^{3+}), sulfate, and carbon dioxide serve as electron acceptors under anaerobic conditions. The transfer of electrons releases energy which is used by the microbes to grow and reproduce. ORP is a measure of the biochemical energy available to microbes from alternative electron acceptors. The microbial reaction preference for each electron acceptor is presented in Table 5-12 in order of decreasing energy and relative ORP.

The reduction of nitrate produces free nitrogen and carbon dioxide. The reduction of ferric iron produces the more soluble Fe^{2+} increasing ferrous iron in the groundwater. In the final steps under anaerobic conditions sulfate is converted to hydrogen sulfide and carbon dioxide is converted into methane. As available oxygen is depleted from the aquifer system by this microbial activity, the ORP decreases.

Table 5-13 presents intrinsic bioremediation parameters collected from BTEX impacted wells during 1997 in the three BTEX plumes. Monitoring well GMI-22-07M was chosen to represent background conditions since it has not historically been impacted by POL or chlorinated solvent contamination.

5.6.2.1 BTEX Plume Associated With AOC1

As previously noted, low and declining BTEX concentrations were observed at MW-5 during the year. DO concentrations increased from 0.6 mg/L in January to 1.24 mg/L in October. Concentrations of nitrate remained well below background (0.02 mg/L) while ferrous iron (1.44 mg/L) and sulfate (61.3 mg/L) concentrations increased to background levels. Methane concentrations remained slightly above background levels (135 $\mu\text{g/L}$) except for an anomalous jump in concentrations in July (3400 $\mu\text{g/L}$). ORP increased from -65.5mV to +15.8mV in July. All of these factors taken together indicated that biological activity in vicinity of MW-5 is in the process of changing from anaerobic to aerobic conditions where nitrate and oxygen are the primary electron acceptors. MW-5 is the most upgradient well within this plume BTEX.

In contrast, MW-1, located downgradient of MW-5, exhibited declining but relatively high BTEX concentrations during the year. DO concentrations were well below background and remained relatively constant at 0.47 mg/L for the year. Nitrate remained well below background levels at

Table 5-12. Preferred Reactions by Energy Potential

Electron Acceptor	Type of Reaction	Metabolic By-Product	ORP (pH=7, millivolts)	Reaction Preference
Oxygen	Aerobic	CO ₂	820	Most Preferred
Nitrate	Anaerobic	N ₂ , CO ₂	740	
Ferric Iron (solid)	Anaerobic	Ferrous Iron (dissolved)	- 50	
Sulfate	Anaerobic	H ₂ S	- 220	
Carbon dioxide	Anaerobic	Methane	- 240	Least Preferred

Source: Newell et al., 1995

Table 5-13. Indicators of Bioactivity

Indicator	Well	Status	January	April	July	October	1997 Avg.
Benzene (ug/L)	GMI-22-07M	nonimpacted	ND	ND	ND	ND	ND
	MW-1	impacted	1750	678	3200	3000	2200
	MW-5	impacted	29.7	2.06	65I	4.0	25
	ST14-02	impacted	ND	0.51F	6.1	1.5F	2.0
	ST14-W16	impacted	59.9	5.96J	6.6J	6.0	20
	ST14-W21	impacted	20.4	ND	9.3I	1.2F	7.7
BTEX (ug/L)	GMI-22-07M	nonimpacted	ND	ND	N	N	ND
	MW-1	impacted	15100	6560	8200	7800	9400
	MW-5	impacted	133	2.06	465	22	160
	ST14-02	impacted	ND	1	6.1	2.1	3
	ST14-W16	impacted	64.3	6.8	7.1	7.8	22
	ST14-W21	impacted	22	3	10	1.2	9
DO (mg/L) Most significant aerobic attenuation mechanism if sufficient DO is present DO > 1-2 mg/L.	GMI-22-07M	nonimpacted	2.5	3.3	2.57	3.45	3.0
	MW-1	impacted	0.4	0.9	0.14	0.42	0.5
	MW-5	impacted	0.6	1	1.24	NA	1
	ST14-02	impacted	0.5	0.9	11.92E	0.64	4
	ST14-W16	impacted	0.9	0.8	10.94E	0.54	3
	ST14-W21	impacted	1	0.9	NA	NA	1
Nitrate (mg/L) Lower values indicate anaerobic biological activity.	GMI-22-07M	nonimpacted	5.46	5.4	NA	4.8	5.2
	MW-1	impacted	ND	ND	NA	0.18	0.09
	MW-5	impacted	ND	0.02F	NA	0.083F	0.034
	ST14-02	impacted	ND	0.01F	NA	0.15	0.08
	ST14-W16	impacted	ND	ND	NA	0.18	0.09
	ST14-W21	impacted	ND	ND	NA	0.19	0.095
Ferrous Iron (mg/L) Elevated values indicate anaerobic biological activity.	GMI-22-07M	nonimpacted	ND	1.63	NA	1.45	1.5
	MW-1	impacted	0.42	6.52	7.45	11.45	6.5
	MW-5	impacted	0.74	0.56	0.24	1.44	0.75
	ST14-02	impacted	0	0.91	6.1	2.12	2.3
	ST14-W16	impacted	0.33	3.2	6.5	5.74	3.9
	ST14-W21	impacted	0.62	9.08	2.38	7.32	4.9
Sulfate (mg/L) Lower values indicate anaerobic biological activity.	GMI-22-07M	nonimpacted	71.2	91.3	85.4	61	77
	MW-1	impacted	0.17	7.89	0.94	0.71	2.4
	MW-5	impacted	25.1	30.3	1.2	61.3	29
	ST14-02	impacted	0.36	0.3	0.84	0.62	0.5
	ST14-W16	impacted	18.8	22.6	16.4	5.4	16
	ST14-W21	impacted	0.25	2.49	1.1	0.54	1.1
Methane (ug/L) Elevated values indicate anaerobic biological activity.	GMI-22-07M	nonimpacted	0.54	ND	0.18F	0.11FB	0.21
	MW-1	impacted	16200	8660	7500	3200	8890
	MW-5	impacted	231	ND	3400	170	950
	ST14-02	impacted	ND	1650	670	430B	690
	ST14-W16	impacted	1580	806	600	740B	930
	ST14-W21	impacted	2040	1820	690	720	1300
ORP (mV) Lower values indicate anaerobic biological activity.	GMI-22-07M	nonimpacted	0.54	1.53	0.18	0.11	0.59
	MW-1	impacted	-100.3	-171.6	6.4	-127.3	-98
	MW-5	impacted	-65.5	189.7	15.8	NA	46.7
	ST14-02	impacted	-89.9	-121.5	1.3	-123.9	-84
	ST14-W16	impacted	-179.5	-150.3	3.7	-123.9	-110
	ST14-W21	impacted	-135.8	-124.9	NA	NA	-130.4

Notes:

NA - Not Analyzed

E - anomalous value due to instrument or operator error

0.01 mg/L. Ferrous iron concentrations increased from 0.42mg/L to 11.45mg/L. Concentrations of sulfate (2.43 mg/L) remained well below background levels while methane levels were well above background (8890 µg/L) for the year. ORP values remained relatively constant at an average -98.20 for the year. All of these parameters indicate extreme anaerobic conditions predominate in the vicinity of MW-1.

MW-10 is the most downgradient monitoring well in the BTEX Plume associated with AOC-1 and exhibited the highest average yearly concentrations of BTEX. Although intrinsic remediation parameters were not monitored at MW-10 in 1997, it is assumed that extreme anaerobic groundwater conditions predominate.

5.6.2.2 BTEX Plumes Associated With SWMUs 64, 67, and 68 and AOC 7 (ST14/SD13 Area)

The BTEX plumes in the ST14/SD13 area were the subject of a Remedial Action Plan (Parsons, 1997) which involved an extensive study of intrinsic remediation parameters. This study concluded that benzene is biodegrading in saturated soils and groundwater in this area via oxygen reduction, nitrogen reduction, ferric iron reduction, sulfate reduction, and methanogenesis. The wells monitored for this study will continue to be monitored under LTM requirements.

Table 5-13 compares and contrasts the intrinsic bioremediation parameters for three selected wells located in the BTEX plumes associated with the ST14/SD13 area. Concentrations of DO are lower than background; nitrate levels are depressed; ferrous iron concentration levels are elevated; Sulfate concentration levels are significantly below background; methane concentration levels are elevated except at ST14-02; and ORP values are negative. All of these parameters show anaerobic activity and decreasing energy supplies for microbial activity from ST14-02 (low BTEX concentrations) to ST14-W16 and ST14-W21 (moderate BTEX concentrations).

5.7 ANALYTICAL RESULTS FOR METALS SAMPLING

Twenty monitoring wells (sixteen wells in the East Area, two wells in the Flightline Area, and two wells in the Landfill Area) were sampled for metals during the NAS Fort Worth JRB quarterly sampling events in 1997. Fourteen of the sampled wells are perimeter wells and were sampled for metals to identify potential off-site migration of metal contamination. Six of the sampled wells, associated with SWMUs 64, 67, and 68 and AOC 7 (ST14/SD13 area), were sampled for metal analyses and natural attenuation parameters to determine whether the occurrence of metals had any influence on the values of the natural attenuation parameters. Metals included in the analyses were: aluminum, antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc. Figure 5-8 and Figure 5-9 show the highest concentration detected for each metal for each well sampled. Table 5-14 and Table 5-15 provide concentrations of metals above background and RRS 2, respectively.

In general, concentrations of metals in Base groundwater monitoring wells fluctuated over the year. Overall, the greatest concentrations of metals occurred in the April 1997 sampling event.

Figure 5-9

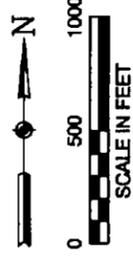
MAXIMUM METAL CONCENTRATIONS
DETECTED ABOVE RRS 2 IN 1997
FLIGHTLINE AREA
NAS Fort Worth JRB

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

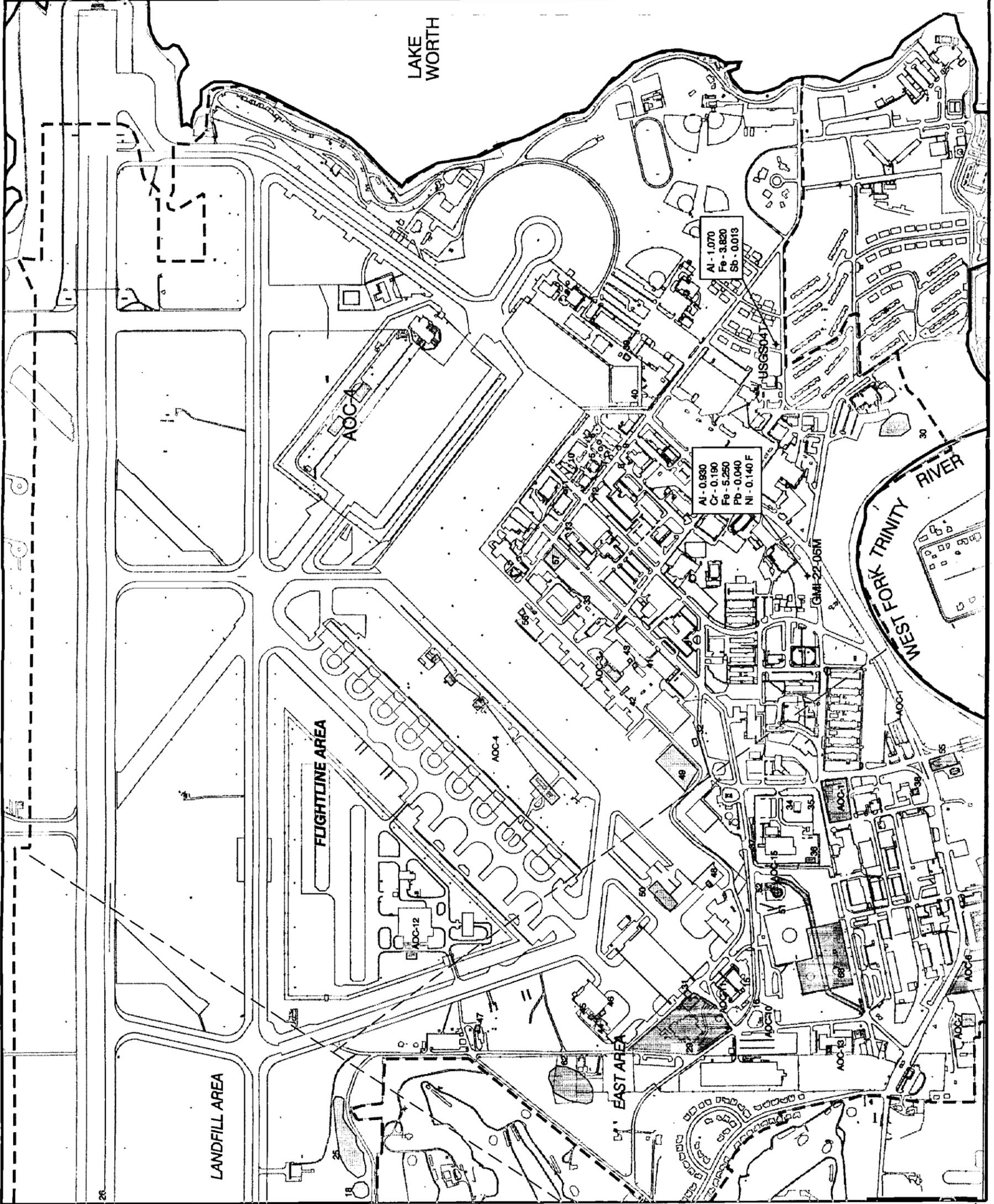
LEGEND

- Approximate Groundwater Management Areas
- - - Approximate NAS Ft. Worth JRB Site Boundary
- Approximate NAS Ft. Worth JRB Site Boundary
- 40 AOC-4
- ★ GMI-22-04M Well Identification

Concentrations in mg/L



Filename: AFCEE\NAS Ft Worth\Annual\flightline.dwg
 Revised: 04/06/98
 Project: AFCC001 07G8B
 Map Source: Jacobs, 1996



**Table 5-14. Metals Detected Above Background Concentrations
NAS Fort Worth JRB Basewide Groundwater Sampling 1997**

Area	Location	January 1997	April 1997	July 1997	October 1997
Flightline	GMI-22-05M	Chromium (43.35F ug/L) Cobalt (15.15F ug/L) Copper (12.73F ug/L) Iron (2812.6 ug/L) Lead (5.4 ug/L) Manganese (462.01 ug/L) Nickel (39.45F ug/L)	Chromium (190 ug/L) Copper (60 ug/L) Iron (5250 ug/L) Lead (40 ug/L) Manganese (320 ug/L) Molybdenum (20F ug/L) Nickel (140F ug/L)	Copper (7F ug/L) Iron (280 ug/L)	Iron (880 ug/L)
	USGS04T	Antimony (12.53F ug/L) Copper (4.18F ug/L) Iron (359.7J ug/L) Manganese (360.71 ug/L)	Chromium (10F ug/L) Copper (40F ug/L) Iron (3820 ug/L) Lead (9.3 ug/L) Manganese (300 ug/L)	Copper (5.3F ug/L) Iron (610 ug/L) Manganese (250 ug/L)	Iron (1300 ug/L)
East	LF01-1B	Aluminum (2839 ug/L) Chromium (74.18 ug/L) Copper (10F ug/L) Iron (2794 ug/L) Lead (4.49F ug/L) Manganese (1510.8 ug/L) Nickel (54.47F ug/L)	Chromium (10F ug/L) Cobalt (70 ug/L) Copper (10F ug/L) Iron (260 ug/L) Lead (5.57 ug/L) Manganese (890 ug/L)	Aluminum (12800 ug/L) Antimony (4.6F ug/L) Chromium (1400 ug/L) Cobalt (70 ug/L) Copper (41F ug/L) Iron (18400 ug/L) Lead (8.1 ug/L) Manganese (2300 ug/L) Molybdenum (250 ug/L) Nickel (1300 ug/L) Silver (4.1 ug/L) Vanadium (25F ug/L)	Copper (25F ug/L) Iron (1200 ug/L) Lead (6.8F ug/L) Manganese (1800 ug/L) Zinc (120 ug/L)
	LF01-1C	Arsenic (25.1F ug/L) Copper (4.28F ug/L) Iron (12086J ug/L) Manganese (1696.3 ug/L)	Arsenic (10 ug/L) Copper (10F ug/L) Iron (8660 ug/L) Lead (10 ug/L) Manganese (2100 ug/L)	Arsenic (22 ug/L) Copper (5.3F ug/L) Iron (12000 ug/L) Manganese (1700 ug/L)	Arsenic (26F ug/L) Copper (3.4F ug/L) Iron (13500 ug/L) Manganese (1300 ug/L) Selenium (8.4F ug/L)

**Table 5-14. Metals Detected Above Background Concentrations
NAS Fort Worth JRB Basewide Groundwater Sampling 1997 (continued)**

Area	Location	January 1997	April 1997	July 1997	October 1997
East	LF01-1D	Chromium (8.89F ug/L)	Cobalt (9.79F ug/L)	Copper (4.3F ug/L)	Copper (3.2F ug/L)
		Copper (7.51F ug/L)	Copper (80 ug/L)	Iron (2900 ug/L)	Iron (3200 ug/L)
		Iron (3672.1J ug/L)	Iron (1780 ug/L)	Manganese (490 ug/L)	Manganese (300 ug/L)
		Lead (3.48F ug/L)	Lead (10 ug/L)		
		Manganese (433.04 ug/L)	Manganese (660 ug/L)		
	LF01-1E	Antimony (16.07F ug/L)	Copper (10F ug/L)	Copper (4.1F ug/L)	Copper (3.5F ug/L)
		Iron (237.91J ug/L)	Lead (10 ug/L)	Iron (260 ug/L)	Iron (1200 ug/L)
		Manganese (3932.6 ug/L)	Manganese (12800 ug/L)	Manganese (3800 ug/L)	Manganese (3300 ug/L)
	MW-10	Copper (7.57F ug/L)	Arsenic (10 ug/L)	Arsenic (19 ug/L)	Arsenic (23F ug/L)
		Iron (8725.34 ug/L)	Cobalt (10F ug/L)	Copper (4.7F ug/L)	Iron (6900 ug/L)
		Lead (9.15 ug/L)	Copper (10F ug/L)	Iron (6300 ug/L)	Lead (6.4F ug/L)
		Manganese (6396 ug/L)	Iron (7620 ug/L)	Lead (5 ug/L)	Manganese (5400 ug/L)
		Lead (6.6 ug/L)	Manganese (5900 ug/L)		
MW-11	Chromium (23.43F ug/L)	Manganese (6060 ug/L)			
	Iron (798.26J ug/L)	Chromium (10F ug/L)	Copper (5.2F ug/L)	Iron (1500 ug/L)	
	Lead (3.11F ug/L)	Copper (30F ug/L)	Iron (250 ug/L)	Manganese (800 ug/L)	
	Manganese (391.07 ug/L)	Lead (20FD ug/L)			
	Copper (13F ug/L)	Mercury (0.104F ug/L)			
MW-12	Lead (1.84F ug/L)	Calcium (272000 ug/L)	Calcium (294000 ug/L)	Copper (3.9F ug/L)	
		Chromium (10F ug/L)	Copper (5.1F ug/L)	Iron (1600 ug/L)	
		Copper (10F ug/L)			
MW-9	Copper (6.58F ug/L)	Lead (10 ug/L)	Copper (3.9F ug/L)	Arsenic (5.1F ug/L)	
	Iron (5080.1J ug/L)	Copper (8.51F ug/L)	Iron (3300 ug/L)	Copper (3.1F ug/L)	
	Lead (1.92F ug/L)	Iron (3660 ug/L)	Manganese (3700 ug/L)	Iron (4000 ug/L)	
	Manganese (3756.8 ug/L)	Lead (20 ug/L)		Manganese (3100 ug/L)	
OT-15C	Copper (10.84F ug/L)	Manganese (3070 ug/L)	Copper (5.2F ug/L)	Copper (3.9F ug/L)	
		Chromium (7.97F ug/L)		Iron (930 ug/L)	
		Copper (6.36F ug/L)			
		Iron (350 ug/L)			

**Table 5-14. Metals Detected Above Background Concentrations
NAS Fort Worth JRB Basewide Groundwater Sampling 1997 (continued)**

Area	Location	January 1997	April 1997	July 1997	October 1997
East	SD13-06	(not sampled)	Arsenic (4200 ug/L) Chromium (10F ug/L) Copper (50F ug/L) Iron (3000 ug/L) Lead (30 ug/L)	Copper (24F ug/L) Iron (1600 ug/L)	Arsenic (7.7F ug/L) Copper (4.6F ug/L) Iron (8400 ug/L) Manganese (710 ug/L)
	ST14-02	Iron (11593 ug/L) Lead (1.72F ug/L) Manganese (293.45 ug/L)	Arsenic (8.9 ug/L) Copper (10F ug/L) Iron (10700 ug/L) Lead (7.5 ug/L) Manganese (270 ug/L)	Arsenic (7.8 ug/L) Iron (11200 ug/L) Manganese (270 ug/L) Silver (0.8 ug/L)	Arsenic (11F ug/L) Iron (9700 ug/L) Manganese (220 ug/L)
	ST14-14	Chromium (13.91F ug/L) Copper (5.03F ug/L) Iron (2277.5 ug/L) Lead (2.03F ug/L) Manganese (256.34 ug/L) Iron (744.11 ug/L)	Copper (10F ug/L) Iron (1770 ug/L) Manganese (230 ug/L)	Iron (1500 ug/L) Manganese (240 ug/L)	Iron (1800 ug/L)
	ST14-24		Copper (70 ug/L)	Copper (4.8F ug/L) Iron (1100 ug/L)	Iron (780 ug/L)
	ST14-26	Copper (5.81F ug/L) Iron (2298.7FD ug/L) Vanadium (22.39F ug/L)	Antimony (10F ug/L) Copper (8.2F ug/L) Iron (390 ug/L)	Copper (3.8F ug/L)	Copper (3.3F ug/L) Iron (1900 ug/L) Lead (2.1F ug/L) Silver (0.33F ug/L) Vanadium (18F ug/L)
	ST14-W18	Aluminum (1847.2 ug/L) Arsenic (64.52F ug/L) Chromium (33.68F ug/L) Copper (6.15F ug/L) Iron (18308 ug/L) Lead (18.72F ug/L) Manganese (217.45 ug/L) Nickel (25.1F ug/L)	Antimony (10F ug/L) Arsenic (30 ug/L) Copper (10F ug/L) Iron (9430 ug/L)	Arsenic (58 ug/L) Copper (5.5F ug/L) Iron (14000 ug/L) Lead (14 ug/L) Manganese (210 ug/L)	Antimony (10F ug/L) Arsenic (70F ug/L) Copper (4.5F ug/L) Iron (13000 ug/L) Lead (20F ug/L) Manganese (180 ug/L) Selenium (10F ug/L)

**Table 5-14. Metals Detected Above Background Concentrations
NAS Fort Worth JRB Basewide Groundwater Sampling 1997 (continued)**

Area	Location	January 1997	April 1997	July 1997	October 1997
East	ST14-W21	Arsenic (141.56F ug/L) Iron (18323 ug/L) Lead (1.72F ug/L) Manganese (680.25 ug/L)	Antimony (10F ug/L) Arsenic (80 ug/L) Copper (7.8F ug/L) Iron (17600 ug/L) Manganese (630 ug/L)	Aluminum (3200 ug/L) Arsenic (47 ug/L) Copper (5.8F ug/L) Iron (10200 ug/L) Lead (3.5F ug/L) Manganese (630 ug/L)	Arsenic (68F ug/L) Chromium (8.8F ug/L) Copper (4.5F ug/L) Iron (8700 ug/L) Lead (2.8F ug/L) Manganese (440 ug/L)
Landfill	LF05-18	Antimony (12.58F ug/L) Chromium (13.35F ug/L) Copper (8.27F ug/L) Lead (1.91F ug/L) Mercury (0.11F ug/L)	Chromium (8F ug/L) Copper (20F ug/L) Lead (6.7 ug/L)	(none)	Iron (1100 ug/L)
	LF05-19	Antimony (13.48F ug/L) Copper (8.72F ug/L) Lead (2F ug/L)	Copper (30F ug/L) Iron (2300 ug/L) Lead (10 ug/L)	Copper (5.2F ug/L)	Iron (980 ug/L) Silver (0.41F ug/L)

**Table 5-15. Metals Detected Above Risk Reduction Standard 2 (RRS 2)
NAS Fort Worth JRB Basewide Groundwater Sampling 1997**

Area	Location	January 1997	April 1997	July 1997	October 1997
Flightline	GMI-22-05M	Aluminum (301.77F ug/L)	Aluminum (930 ug/L)	(none)	Iron (880 ug/L)
		Iron (2812.6 ug/L)	Chromium (190 ug/L)		
East	USGS04T	Iron (5250 ug/L)	Iron (5250 ug/L)		
		Lead (40 ug/L)	Lead (40 ug/L)		
	Nickel (140F ug/L)	Nickel (140F ug/L)			
	LF01-1B	Antimony (12.53F ug/L)	Aluminum (1070 ug/L)	Iron (610 ug/L)	Iron (1300 ug/L)
		Iron (359.7J ug/L)	Iron (3820 ug/L)		
	LF01-1C	Aluminum (2839 ug/L)	(none)	Aluminum (12800 ug/L)	Iron (1200 ug/L)
		Iron (2794 ug/L)		Chromium (1400 ug/L)	
	LF01-1D	Iron (12086J ug/L)	Aluminum (280F ug/L)	Iron (12000 ug/L)	Iron (13500 ug/L)
		Iron (3672.1J ug/L)	Iron (8660 ug/L)		
	LF01-1E	Antimony (16.07F ug/L)	Iron (1780 ug/L)	Iron (2900 ug/L)	Iron (3200 ug/L)
		Manganese (3932.6 ug/L)	Aluminum (290F ug/L)	Manganese (3800 ug/L)	Iron (1200 ug/L)
	MW-10	Iron (8725.34 ug/L)	Manganese (12800 ug/L)		Manganese (3300 ug/L)
		Manganese (6396 ug/L)	Iron (7620 ug/L)	Iron (6300 ug/L)	Iron (6900 ug/L)
	MW-11	Iron (798.26J ug/L)	Manganese (6060 ug/L)	Manganese (5900 ug/L)	Manganese (5400 ug/L)
(none)		Lead (20FD ug/L)	(none)	Iron (1500 ug/L)	
MW-12	(none)	(none)	(none)	Iron (1600 ug/L)	
	Iron (5080.1J ug/L)	Iron (3660 ug/L)	Iron (3300 ug/L)	Iron (4000 ug/L)	
MW-9	Manganese (3756.8 ug/L)	Lead (20 ug/L)	Manganese (3700 ug/L)	Manganese (3100 ug/L)	
	(none)	Manganese (3070 ug/L)			
OT-15C	(none)	Iron (350 ug/L)	Iron (1600 ug/L)	Iron (930 ug/L)	
	(not sampled)	Arsenic (4200 ug/L)	(none)	Iron (8400 ug/L)	
SD13-06	(not sampled)	Iron (3000 ug/L)			
		Lead (30 ug/L)			
ST14-02	Iron (11593 ug/L)	Iron (10700 ug/L)	Iron (11200 ug/L)	Iron (9700 ug/L)	
	Aluminum (419.45F ug/L)	Iron (1770 ug/L)	Iron (1500 ug/L)	Iron (1800 ug/L)	
ST14-14	Iron (2277.5 ug/L)				

Table 5-15. Metals Detected Above Risk Reduction Standard 2 (RRS 2)
 NAS Fort Worth JRB Basewide Groundwater Sampling 1997 (continued)

Area	Location	January 1997	April 1997	July 1997	October 1997
East	ST14-24	Iron (744.11 ug/L)	(none)	Aluminum (1100 ug/L) Iron (1100 ug/L)	Iron (780 ug/L)
	ST14-26	Aluminum (1036.5FD ug/L) Iron (2298.7FD ug/L)	Antimony (10F ug/L) Iron (390 ug/L)	(none)	Aluminum (460F ug/L) Iron (1900 ug/L)
	ST14-W18	Aluminum (1847.2 ug/L) Arsenic (64.52F ug/L) Iron (18308 ug/L) Lead (18.72F ug/L)	Antimony (10F ug/L) Iron (9430 ug/L)	Aluminum (590 ug/L) Arsenic (58 ug/L) Iron (14000 ug/L)	Antimony (10F ug/L) Arsenic (70F ug/L) Iron (13000 ug/L) Lead (20F ug/L)
	ST14-W21	Arsenic (141.56F ug/L) Iron (18323 ug/L)	Antimony (10F ug/L) Arsenic (80 ug/L) Iron (17600 ug/L)	Aluminum (3200 ug/L) Iron (10200 ug/L)	Aluminum (420F ug/L) Arsenic (68F ug/L) Iron (8700 ug/L)
Landfill	LF05-18	(none)	(none)	(none)	Iron (1100 ug/L)
	LF05-19	(none)	(none)	(none)	Iron (980 ug/L)

However, overall trends for each metal, or total metals in a given well, could not be established. Continued monitoring is needed to establish temporal and spatial trends and interpret the existing analytical data.

5.7.1 Comparison to Background and RRS 2 Values

To fully evaluate the extent of metals contamination, the analytical results for all metals detected in groundwater were compared to background concentrations (Jacobs, 1997). The background concentrations used for comparison are provided in Table 5-2. The metals detected above background concentrations for each quarterly sampling event included: antimony, chromium, cobalt, copper, iron, lead, and nickel in the Flightline Area; aluminum, antimony, arsenic, calcium, chromium, cobalt, copper, iron, lead, manganese, molybdenum and nickel in the East Area; and antimony, chromium, copper, iron, lead, mercury and silver in the Landfill Area. The concentrations of these metals for each quarter in which they exceeded the background concentrations are listed in Table 5-14.

The metals detected above RRS 2 levels for at least one well over the past four quarters included: aluminum, antimony, chromium, iron, lead, and nickel in the Flightline Area; aluminum, antimony, arsenic, iron, lead, manganese and nickel in the East Area; and iron in the Landfill Area. The concentrations of these metals for each quarter in which they exceeded RRS 2 values are listed in Table 5-15.

5.7.2 Other Base Sampling Programs for Metals

Several monitoring wells on NAS Fort Worth JRB property not included in the quarterly monitoring program are sampled for metals under two other programs, AFP 4 basewide quarterly sampling and an RFI for SWMU 66, the sanitary sewer system (IT Corporation, 1997c).

A summary of metals detected above background concentrations in the AFP 4 basewide sampling program is provided in Table 5-16. Aluminum, cadmium, chromium, copper, iron, lead, potassium and zinc were detected above background concentrations for groundwater. A summary of metals detected above RRS 2 levels in the AFP 4 basewide sampling program is given in Table 5-17. Aluminum, chromium, and iron were detected above RRS 2 levels for groundwater. Although the wells for the AFP 4 basewide sampling program were sampled on a quarterly basis, many of the wells were only sampled once or twice, rather than every quarter.

As part of the RFI for SWMU 66, 34 new wells were installed basewide and sampled in April 1997. In addition, six existing wells were sampled at that time. A summary of metals detected above background concentrations, and RRS 2 levels for monitoring wells included in this study is provided in Table 5-18. Antimony, arsenic, barium, beryllium, chromium, iron, lead, manganese, nickel, silver, sodium, and zinc were all detected above background concentrations for groundwater. Aluminum, antimony, and iron were detected above RRS 2 values.

**Table 5-16. Metals Detected Above Background Concentrations
AFP4 Basewide Groundwater Sampling 1997**

Area	Location	January 1997	April 1997	July 1997	October 1997
Flightline	MW-1T-02T	Chromium (153 ug/L)	Chromium (83.4 ug/L) Potassium (87400 ug/L)	Chromium (72.7 ug/L) Potassium (75200 ug/L)	Chromium (25.2F ug/L) Copper (3.7B ug/L) Iron (281 ug/L) Potassium (40200 ug/L) Zinc (216 ug/L)
	HM-110	Cadmium (2.7 ug/L)	(not sampled)	Iron (653 ug/L)	(not sampled)
	HM-111	(not sampled)	Iron (487 ug/L)	(not sampled)	Iron (761 ug/L)
Landfill	HM-112	(not sampled)	Aluminum (2920 ug/L) Chromium (30.1 ug/L) Iron (4340 ug/L)	(not sampled)	Chromium (28.8F ug/L) Iron (1460 ug/L)
	HM-113	Cadmium (4.2 ug/L) Iron (1250 ug/L) Lead (1.7 ug/L) Manganese (411 ug/L) Zinc (191 ug/L)	(not sampled)	Iron (2040 ug/L) Manganese (250 ug/L) Zinc (154 ug/L)	(not sampled)
	HM-114	(not sampled)	(not sampled)	Chromium (26.4 ug/L) Iron (308 ug/L)	(not sampled)
	LF05-19	Iron (2030 ug/L)	(not sampled)	(not sampled)	(not sampled)

**Table 5-17. Metals Detected Above Risk Reduction Standard 2 (RRS 2)
AFP4 Basewide Groundwater Sampling 1997**

Area	Location	January 1997	April 1997	July 1997	October 1997
Flightline Landfill	MW-IT-02T	Chromium (153 ug/L)	(none)	(none)	(none)
	HM-110	Aluminum (250 ug/L)	(not sampled)	Aluminum (461 ug/L) Iron (653 ug/L)	(not sampled)
	HM-111	(not sampled)	Aluminum (228 ug/L) Iron (487 ug/L)	(not sampled)	Aluminum (382F ug/L) Iron (761 ug/L)
	HM-112	(not sampled)	Aluminum (2920 ug/L) Iron (4340 ug/L)	(not sampled)	Aluminum (896 ug/L) Iron (1460 ug/L)
	HM-113	Aluminum (265 ug/L) Iron (1250 ug/L)	(not sampled)	Aluminum (1250 ug/L) Iron (2040 ug/L)	(not sampled)
	HM-114	(not sampled)	(not sampled)	Iron (308 ug/L)	(not sampled)
	LF05-19	Aluminum (1110 ug/L) Iron (2030 ug/L)	(not sampled)	(not sampled)	(not sampled)

**Table 5-18. Metals Detected Above Background Concentrations
and Risk Reduction Standard 2 (RRS 2)
Sanitary Sewer System RFI April 1997**

Area	Location	Detections Above Background	Detections Above RRS2
Flightline	GMI-22-05M	Antimony (24.5 ug/L) Iron (1340 ug/L) Manganese (404 ug/L) Mercury (0.11 ug/L)	Antimony (24.5 ug/L) Iron (1340 ug/L)
	LSA1628-3	Antimony (19.5 ug/L) Beryllium (0.56 ug/L) Manganese (825 ug/L)	Antimony (19.5 ug/L)
	WITCTA004	Iron (1470 ug/L) Manganese (977 ug/L) Sodium (177000 ug/L)	Iron (1470 ug/L)
	WITCTA005	Antimony (23.7 ug/L) Manganese (3400 ug/L)	Antimony (23.7 ug/L) Manganese (3400 ug/L)
	WITCTA006	Arsenic (28.2 ug/L) Iron (1740 ug/L) Manganese (1660 ug/L)	Aluminum (1210 ug/L) Iron (1740 ug/L)
	WITCTA007	Iron (1210 ug/L) Manganese (346 ug/L)	Aluminum (315B ug/L) Iron (1210 ug/L)
	WITCTA009	Manganese (675 ug/L) Silver (4.1 ug/L)	(none)
	WITCTA010	Iron (1280 ug/L) Manganese (954 ug/L)	Aluminum (661 ug/L) Iron (1280 ug/L)
	WITCTA011	Arsenic (24.4B ug/L) Iron (799 ug/L) Manganese (630 ug/L)	Aluminum (592 ug/L) Iron (799 ug/L)
	WITCTA012	Iron (3560 ug/L) Manganese (587 ug/L) Sodium (238000 ug/L)	Iron (3560 ug/L)
	WITCTA013	Iron (434 ug/L)	Iron (434 ug/L)
	WITCTA014	Iron (2720 ug/L)	Aluminum (423 ug/L) Iron (2720 ug/L)
	WITCTA016	Iron (249 ug/L)	(none)
	WITCTA017	Iron (954 ug/L) Silver (4.8 ug/L)	Aluminum (395 ug/L) Iron (954 ug/L)
	WITCTA020	Beryllium (0.51 ug/L) Iron (306 ug/L)	Iron (306 ug/L)
	WITCTA024	Iron (248 ug/L)	(none)
WITCTA025	Silver (3.7 ug/L)	(none)	
East	BGSMW01	Iron (2310 ug/L) Manganese (528 ug/L) Mercury (0.11 ug/L)	Iron (2310 ug/L)
	ST14-24	Antimony (19 ug/L)	Antimony (19 ug/L)

**Table 5-18. Metals Detected Above Background Concentrations
and Risk Reduction Standard 2 (RRS 2)
Sanitary Sewer System RFI April 1997 (continued)**

Area	Location	Detections Above Background	Detections Above RRS2
East	ST14-27	Beryllium (0.48 ug/L) Chromium (30.7 ug/L) Iron (2870 ug/L) Manganese (1440 ug/L) Nickel (28.4 ug/L)	Aluminum (771 ug/L) Iron (2870 ug/L)
	ST14-W05	Antimony (23.7 ug/L) Beryllium (0.49 ug/L) Iron (993 ug/L) Manganese (1150 ug/L)	Antimony (23.7 ug/L) Iron (993 ug/L)
	WITCTA019	Beryllium (0.51 ug/L) Manganese (315 ug/L)	(none)
	WITCTA021	Arsenic (24.7 ug/L) Manganese (2310 ug/L)	(none)
	WITCTA022	Beryllium (0.37 ug/L) Iron (444 ug/L)	Iron (444 ug/L)
	WITCTA027	Iron (2870 ug/L) Silver (4.6 ug/L)	Iron (2870 ug/L)
	WITCTA028	Iron (439 ug/L) Manganese (562 ug/L)	Iron (439 ug/L)
	WITCTA031	Arsenic (51.7 ug/L) Barium (1490 ug/L) Iron (5350 ug/L) Manganese (1720 ug/L)	Arsenic (51.7 ug/L) Iron (5350 ug/L)
	WITCTA032	Arsenic (35.8 ug/L) Iron (4880 ug/L) Manganese (663 ug/L)	Aluminum (278 ug/L) Iron (4880 ug/L)
	WITCTA033	Iron (781 ug/L)	Iron (781 ug/L)
	WITCTA035	Iron (1070 ug/L) Manganese (965 ug/L)	Iron (1070 ug/L)
	WITCTA037	Beryllium (0.36 ug/L)	(none)

5.7.3 Influence of Turbidity on Metals Concentrations

All metals samples collected as part of this basewide quarterly monitoring program were not field filtered. In cases where the groundwater had high turbidity (greater than 10 NTUs), metals concentrations in the sample may be higher than in a "theoretical" identical filtered sample, due to metals adsorbed to suspended particles in the water. High turbidity samples are often associated with cases in which the well was purged dry during sampling or in cases where the low-flow sample regime could not be maintained. Increased metals in an unfiltered sample may indicate metals contamination problems which would not be apparent in filtered samples. That is, by collecting unfiltered samples, a conservative approach to detecting possible metals contaminants is being taken.

One problem associated with collecting unfiltered samples is the reduction in comparability across sampling events and between monitoring wells. In several cases, it has been noted that an increase in turbidity between sampling events is accompanied by an increase in concentrations of metals, such as iron and lead. Turbidity levels should be taken into account when evaluating results, especially when comparing to regulatory limits. In cases where remediation or closure of sites is dependent upon these comparisons, filtering of samples should be considered.

5.7.4 Influence of Metals on Natural Attenuation Parameters

Per the sampling objectives stated in the 1997 GSAP, six wells were sampled for both metal and natural attenuation parameters to determine how the occurrence of metals influences with the natural attenuation parameters. Several processes that are indicated by the natural attenuation parameters are known to influence metal behavior. Consequently, a relationship between metal concentrations and natural attenuation parameters is likely to appear. For example, metal solubilities generally increase with decreasing pH, thereby influencing the intensity of reduction-oxidation reactions. Reduction of sulfate is a significant process in controlling metal solubility in areas of landfill leachate by providing an abundant source of sulfide, a potent precipitant for many heavy metals (Pohland et al., 1993).

Three out of the six wells had iron and/or aluminum as the only constituents detected above their RRS 2 values. The other three wells, in addition to iron and aluminum, also detected either antimony, arsenic, or lead. The only trend in the natural attenuation parameters that is common among the six wells is a generally low level of DO. However, this trend does not appear to be unique to only these six wells. Other wells in the area that were sampled for natural attenuation parameters show a similar trend. Consequently, based on the data obtained from the six wells, and without a control data set, a correlation can not be made between a trend in a natural attenuation parameter and the occurrence of metals. Further data collection is recommend on a site-by-site basis.

TAB

60

6.0 CONCLUSIONS

Both short and long-term monitoring objectives were specified in the 1997 GSAP to guide the monitoring activities for the quarterly sampling events conducted during the year. In 1997, a basewide groundwater sampling and analysis program was not a regulatory requirement, but was implemented to facilitate the development of remedial actions throughout the Base by providing a framework to develop a hydrogeologic conceptual model. This section discusses whether or not the objectives were fulfilled and determines whether the collected data was effective in characterizing the presence and extent of groundwater and potential surface water contamination.

6.1 SHORT-TERM OBJECTIVE

- **Identify potential impacts to off-site groundwater receptors**

Fifteen wells were designated as perimeter wells to monitor potential impacts to off-site receptors. The data collected from perimeter wells, located near the Base boundaries and immediately upgradient of surface water bodies where groundwater discharges to the surface water, provided adequate basewide coverage to fulfill the short-term objective to identify potential impacts to off-site groundwater receptors. These data, in conjunction with other plume-specific studies, identified key locations where groundwater contamination was potentially migrating off the Base in groundwater flow or where groundwater intersected with surface water bodies (AFP 4 sampling, LF01 workplan, Parsons, 1997).

No evidence of groundwater contamination was found in the Paluxy Aquifer, which is a drinking water source in the area. Exposure to groundwater from the Terrace Alluvium is not considered a potential exposure pathway, since this groundwater is not used as a drinking water source. However, in areas where groundwater is intercepted by surface water, potential exposure could occur. Data collected during quarterly monitoring in 1997 indicate that contaminants may be leaving the site by groundwater pathways. However, additional monitoring of surface water and study of the groundwater/surface water interaction in these areas is required.

6.2 LONG-TERM OBJECTIVES

- **Collect data to support closure of SWMU/AOCs**

SWMUs 64, 67, and 68 and AOC 7 (ST14/SD13 Area) and AOC 1 (Base Gas Station/Base Service Station) have moved into long-term monitoring (LTM) programs in 1998 as a result of regulatory-approved corrective action plans and remedial action plans (IT Corporation, 1997a, 1997b; Parsons, 1997). The data collected from the basewide groundwater sampling and analysis program provided additional evidence to support the interpretations and conclusions put forth by these plans. The basewide sampling program has also contributed additional preliminary data to a number of site studies, providing background data on existing contaminants and improving selection of locations for new boreholes and monitoring wells.

- **Provide additional source and plume delineation**

Wells around potential source areas, and within known plume boundaries, were sampled for VOCs and BTEX compounds to further delineate these areas. Figure 6-1 provides the approximate extent of the TCE, cis-1,2-DCE, and benzene plumes on NAS Fort Worth JRB property. This effort also identified areas where additional source and plume definition are necessary. Specifically, further characterization of the TCE, cis-1,2-DCE, and daughter product plumes is required in the area between the north and south lobes. Other potential sources of TCE need to be investigated in the Landfill Area. AOC 2 (TCE plume) monitoring, the NAS Fort Worth JRB basewide quarterly sampling, and AFP 4 basewide quarterly sampling are expected to provide the additional data necessary for further delineation of the plume. The BTEX plumes, represented by the extent of benzene on Figure 6-1, identified in the East Area have been adequately characterized, and monitoring will continue under LTM requirements in 1998.

In addition to monitoring wells to further delineate known contaminants and their sources, wells were selected for sampling which would cover areas where additional potential sources might exist. Based on the results of basewide sampling in 1997, no additional sources of contaminants were discovered.

- **Delineate NAPLs**

LNAPLs have been found at NAS Fort Worth JRB in several wells in the East Area. Well inspections conducted during the January 1997 sampling event identified three monitoring wells (17M, SD13-04, and SD13-07) which contained free product (LNAPL). These free product observations initiated a monthly free product inspection at these wells. During the final monthly inspection for this program on August 8, 1997, no wells contained a significant accumulation of free product (over 0.01 feet). However, monitoring well SD13-07 contained measurable free product during all four quarterly sampling events conducted during 1997. Consequently, groundwater samples were not taken from this well during 1997. These three wells will be sampled in 1998 as part of a Remedial Action Plan for SWMUs 64, 67, and 68 and AOC 7 (Parsons, 1997). Inspections for free product will continue for all wells as part of the basewide sampling and analysis program.

No evidence currently exists to suggest that DNAPLs are present at NAS Fort Worth JRB. Many of the monitoring wells are drilled into bedrock, so DNAPLs moving along the surface of the bedrock would be intercepted by the wells. In addition, none of the concentrations for TCE and cis-1,2-DCE, both potential DNAPLs, exceeded one percent of their solubility (i.e., 1,100 mg/L for TCE and 3,500 mg/L for cis-1,2-DCE). TCE and cis-1,2-DCE were found at maximum concentrations that are 0.4 percent ($TCE_{max} = 4,340 \mu\text{g/L}$) and 0.03 percent ($cis-1,2-DCE_{max} = 1,190 \mu\text{g/L}$) of their solubility in water. These findings indicate that these chlorinated solvents are not likely to be present as a DNAPL in the subsurface.

- **Monitor off-base or potential off-base contamination**

Wells established as perimeter wells for the 1997 basewide quarterly sampling program were sampled for VOCs and metals to determine which contaminants should be monitored for potential

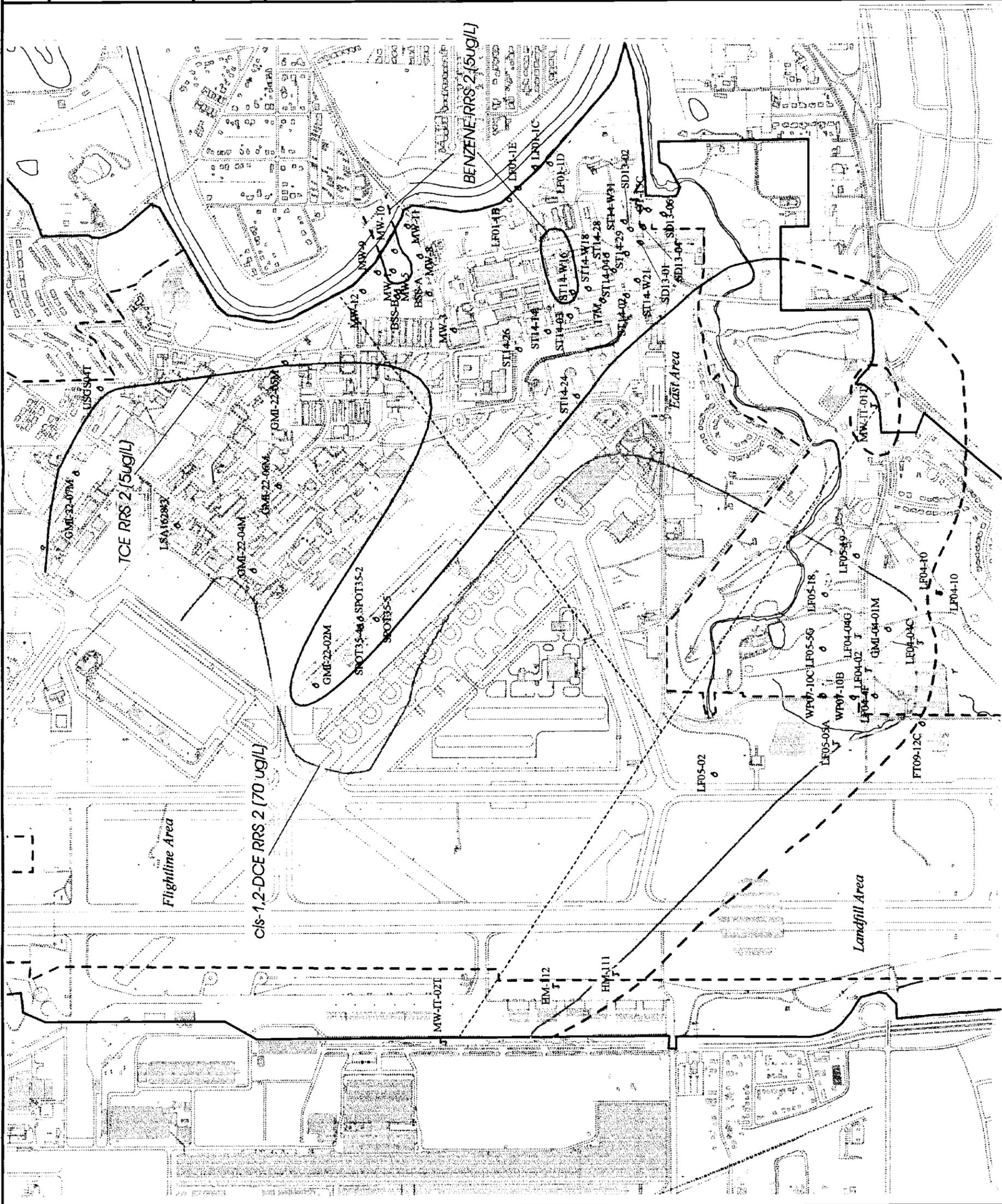
Figure 6-1

**TCE, cis-1,2-DCE, and BENZENE
 PLUMES FOR OCTOBER 1997
 NAS Fort Worth JRB**

**AIR FORCE CENTER FOR
 ENVIRONMENTAL EXCELLENCE
 BROOKS AFB, TEXAS**

LEGEND

- NAS Fort Worth JRB (Carswell Field)
- Former Carswell Property Boundary
- - - Approximate Groundwater Management Areas
- ~ Extent of cis-1,2-DCE Plume
- ~ Extent of Benzene Plume
- ~ Extent of TCE Plume
- LF01-1C ○ NAS Fort Worth JRB Basewide Monitoring Wells
- HM-112 T AFP 4 Basewide Monitoring Wells



offsite migration. Monitoring wells GMI-22-05M and USGS04T were selected as perimeter wells for the Flightline Area. The only analyte present in these wells above RRS 2 values in October 1997 was iron. These two wells should continue to be sampled to identify any additional analytes moving off-site. Eleven wells were sampled in the East Area in order to monitor off-site migration. Analytes found in these wells above RRS 2 values in October 1997 were fuel-related contaminants and iron. It is recommended that the number of wells sampled be reduced, since many of the wells contained similar contaminants at similar concentrations. The two perimeter wells selected in the Landfill Area contained iron, TCE, and cis-1,2-DCE above RRS 2 values during the October 1997 sampling event. It is recommended that newly installed wells closer to the Base boundary replace these wells as perimeter wells.

Data suggest that perimeter monitoring should to continue in order to more fully characterize potential off-site migration of TCE, especially near the main entrance of the Base in the area of the south lobe. Potential contaminant discharge into Farmer's Branch Creek will be monitored by AFP 4 sampling efforts (Jacobs, 1996). Potential contaminant discharge into the West Fork of the Trinity River, from the East Area benzene plumes, will be covered under LTM requirements. Monitoring of metals in selected wells should continue in the perimeter wells to assure that other metals found above RRS2 values on the Base do not migrate off-site.

- **Monitor bedrock contamination potential**

Four wells screened in the Paluxy aquifer (USGS01P, USGS05P, USGS06P, and USGS07P) were sampled during the January 1997 sampling event and analyzed for VOCs; all compounds were below method detection limits. Unless additional data indicate a need for continued sampling, sampling on a regular interval is not expected. Additional locations for bedrock wells are not considered necessary based on the data collected during the January 1997 sampling event.

- **Demonstrate the natural attenuation of BTEX in the East Area**

BTEX compounds and natural attenuation parameters were collected from wells in the East Area and near AOC 4 to evaluate natural attenuation of BTEX compounds at NAS Fort Worth JRB. As described in Section 5.6 of this document, the combination of BTEX compound decline and specific trends of natural attenuation parameters support the case for natural biodegradation of BTEX in the East Area. Although these trends have been well established through basewide sampling and various remedial action and closure plans, they will continue to be monitored under the LTM requirements. In addition, six wells studied for evidence of natural attenuation were also sampled for metals in an attempt to correlate the presence of metals with trends in the natural attenuation parameters. With additional data collection and analysis, these data can be used in the future for site-specific analyses to determine how the occurrence of metals influences natural attenuation parameters.

- **Compare contaminants to a regulatory level**

All VOCs and metals detected during the 1997 quarterly sampling events were compared to their respective RRS 2 values in order to identify areas of greatest risk to human health and the environment. When a RRS 2 value was not available in Appendix II of 30 TAC 335, one was

derived using the procedures specified in the regulations. Contaminants found in a significant number of wells above RRS 2 values were identified and discussed in the text and contaminant plumes were delineated (Figure 6-1), where appropriate.

- **Identify wells that should be closed**

The well inspections conducted during each quarterly sampling event provided a tentative list of wells that are either mechanically unable to serve as monitoring wells or are no longer needed for source or plume identification. The following wells were found destroyed or otherwise unable to serve as wells: MW-1A, USGS02T, and PI-U9. These wells will be included on the list of wells inspected in January 1998 to ensure that they were correctly identified and then considered for abandonment.

McAllister, P.M. and Chiang, C.Y., 1994. A Practical Approach to Evaluating Natural Attenuation of Contaminants in the Groundwater. Groundwater Monitoring and Remediation, Spring 1994.

Newell, C.J., Winters, J.A., Miller, R.N., Gonzales, J., Rifa, H.S., and Weidemeier, T.H., 1995. Modeling Intrinsic Remediation with Multiple Electron Receptors: Results From Seven Sites. In The Proceedings of the 1995 Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Prevention, Detection, and Remediation Conference and Symposium. November 29-December 1, 1995, Houston, TX.

Parsons Engineering Science, Inc., 1997. Remedial Action Plan for Risk-based Remediation of Site ST14 (swmu68), LPST Id 104819; the Former Base Refueling Area (AOC7); the French Underdrain System (SWMU64); and the North Oil/water Separator (SWMU67), Carswell AFB, NAS Fort Worth JRB, Texas. July 1997

Pohland, F.G., Cross, W.H., and Gould, J.P., 1993. Metal Speciation and Mobility as Influenced by Landfill Disposal Practices in Metals in Groundwater in Allen, H., Perdue, M., and Brown, D. (Eds.), Metals in Groundwater. Chelsea, MI: Lewis Publishers.

Radian Corporation, 1989, Installation Restoration Program RI/FS, Stage 2 Draft Final Technical Report, Carswell AFB.

Texas Natural Resource Conservation Commission (TNRCC), 1996, Texas Risk Reduction Program Concept Document 2.

TNRCC, 1995. Letter from Paul Lewis, TNRCC to Ohlen Long, AFBDA, "Determination of a Need for an RFI and Current Condition Report," March 2.

TNRCC, 1991. Permit # HW50289

U.S. Environmental Protection Agency (USEPA), 1992, Statistical Analysis of Ground-water Monitoring Data at RCRA Facilities: Addendum to Interim Final Guidance. Office of Solid Waste, Permits and State Programs Division, Washington, DC.

U.S. Environmental Protection Agency (USEPA), 1989a. RCRA Facility Assessment.

U.S. Environmental Protection Agency (USEPA), 1989b, Statistical Analysis of Ground-water Monitoring Data at RCRA Facilities: Interim Final Guidance. Office of Solid Waste, Permits and State Programs Division, Washington, DC. EPA/530-SW-89-026.

U.S. Geological Survey (USGS), 1996. Hydrogeology at Air Force Plant 4 and Vicinity and Water Quality of the Paluxy Aquifer, Fort Worth, Texas, Water Resources Investigations Report 96-4091.

Waste Policy Institute, 1997. New Compliance Plan Application, NAS Fort Worth JRB, Texas.

This page was intentionally left blank.

FINAL PAGE

ADMINISTRATIVE RECORD

FINAL PAGE

FINAL PAGE

ADMINISTRATIVE RECORD

FINAL PAGE