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FINAL WORK PLAN DATA GAP INVESTIGATION FOR SOUTHERN LOBE TRICHLOROETHENE GROUNDWATER PLUME NAS FORT WORTH TX
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FORT WORTH JRB
CARSWELL FIELD
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ADMINISTRATIVE RECORD
COVER SHEET

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HYDRO GeoLogic INC.

FINAL
WORK PLAN
DATA GAP INVESTIGATION
OF THE SOUTHERN LOBE TCE PLUME
NAS FORT WORTH JRB, TEXAS

Prepared for

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

Contract Number F41624-95-D-8005
Delivery Order 0019

August 2000

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FINAL WORK PLAN DATA GAP INVESTIGATION OF THE SOUTHERN LOBE TCE PLUME NAS FORT WORTH JRB, TEXAS

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August 2000

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This document presents the Final Work Plan for the Data Gap Investigation at the Southern Lobe Trichloroethene (TCE) Plume at NAS Fort Worth JRB, Texas. The Work Plan presents detailed procedures for the investigation required to delineate the southern boundary of the TCE plume, examine the potential relationship between contaminant pathways and the aqueduct which underlies the runway and flightline, evaluate the underlying Goodland/Walnut confining unit and the Paluxy Aquifer, and define aquifer characteristics at the NAS Fort Worth JRB and former Carswell AFB boundary.

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PREFACE

HydroGeoLogic, Inc. (HydroGeoLogic) was contracted to perform a Focused Feasibility Study (FFS) at the Naval Air Station Fort Worth Joint Reserve Base (NAS Fort Worth JRB), Former Carswell Air Force Base, Texas. This Work Plan addresses the Data Gap Investigations of the Southern Lobe trichloroethene (TCE) Plume. Work will be conducted under Contract Number F41624-95-D-8005, Delivery Order (DO) Numbers 0019 and 0036. Data gap activities include:

- Installation of 7 monitoring wells for TCE plume delineation
- Installation of 6 paleochannel delineation wells
- Installation of 3 Paluxy monitoring wells for aquifer characterization
- An aqueduct assessment
- Aquifer testing at the NAS Fort Worth JRB/former Carswell Air Force Base (AFB) boundary

Responsible key HydroGeoLogic personnel are as follows:

Jim Costello, P.G.	Program Manager
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This contract will be administered by the Defense Contracts Management Command, 10500 Battleview Pkwy, Suite 200, Manassas, Virginia, 22110. The Contracting Officer will be Mr. David Miller. The Contracting Officer's Representative will be Mr. Don Ficklen (210/536-5290), located at the U.S. Air Force Center for Environmental Excellence (AFCEE)/Environmental Restoration Division (ERD), 3207 North Road, Brooks AFB, Texas 78235-5363.

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LIST OF ACRONYMS AND ABBREVIATIONS

1,1,1-TCA	1,1,1-trichloroethane
AFB	Air Force Base
AFCEE	U.S. Air Force Center for Environmental Excellence
AFP 4	Air Force Plant 4
AGE	aerospace ground equipment
bgs	below ground surface
BRAC	Base Realignment and Closure
cm/sec	centimeters per second
DRMO	Defense Reutilization and Marketing Office
EPA	U.S. Environmental Protection Agency
ERA	Environmental Restoration Account
ERD	Environmental Restoration Division
ESE	Environmental Science and Engineering Incorporated
°F	degrees Fahrenheit
FFS	Focus Feasibility Study
FSP	Field Sampling Plan
ft/d	feet per day
GC	gas chromatograph
gpd/ft^2	gallons per day per square foot
HSP	Health and Safety Plan
HydroGeoLogic	HydroGeoLogic, Inc.
IS	internal standard
JP-4	jet propulsion grade 4 fuel
JRB	Joint Reserve Base
MEK	methyl ethyl ketone
MS	matrix spike
MSD	matrix spike duplicate
NAS	Naval Air Station
NGVD	National Geodetic Vertical Datum

LIST OF ACRONYMS AND ABBREVIATIONS

NPL	National Priorities List
OWS	oil/water separator
PID	photoionization detector
PVC	polyvinyl chloride
QC	quality control
Radian	Radian Corporation
RCRA	Resource Conservation and Recovery Act
RFI	RCRA facility investigation
RI/FS	remedial investigation/feasibility study
SAC	Strategic Air Command
SWMU	solid waste management unit
TCE	trichloroethene
TNRCC	Texas Natural Resource Conservation Commission
USACE	United States Army Corps of Engineers
USAF	United States Air Force
VOC	volatile organic compound

TAB

Work Plan

FINAL WORK PLAN
DATA GAP INVESTIGATION
OF THE SOUTHERN LOBE TCE PLUME AT
NAS FORT WORTH JRB, TEXAS

1.0 INTRODUCTION

The following sections briefly describe the objectives of the United States Air Force (USAF) and the rationale for implementing this Work Plan.

1.1 BACKGROUND

Carswell Air Force Base (AFB) (Figure 1.1) was officially closed on September 30, 1993. A parcel of the former base now known as Naval Air Station Fort Worth Joint Reserve Base (NAS Fort Worth JRB), has been transferred from USAF to U.S. Navy management. Before complete property transfer can be accomplished, required environmental investigations of potential contamination related to Air Force activities occurring prior to September 30, 1993 at the NAS Fort Worth JRB property are to be complete, and contaminated sites are to be remediated.

The focus of this investigation is the collection of additional data from the area comprising the southern lobe of the trichloroethene (TCE) plume in support of an ongoing Focused Feasibility Study (FFS). The objective of the FFS is to develop and evaluate remedial options that focus on the release of federal land located to the southeast of the current NAS Fort Worth JRB (i.e., surrounding Carswell Golf Course) as depicted in Figure 1.2. This land was originally part of the former Carswell AFB. Currently, this property is controlled by the Base Realignment and Closure (BRAC) program, which is focused on releasing the land for suitable public use. This Work Plan outlines the rationale and procedures for the collection of data that will fill existing gaps that impede the successful completion of the FFS.

This investigation will be funded by the USAF under the Environmental Restoration Account (ERA), the BRAC program, and Aeronautical Systems Center. The project will be managed through the USAF under ERA. The primary regulatory agencies that govern the FFS are the Environmental Protection Agency (EPA) and the Texas Natural Resource Conservation Committee (TNRCC). The EPA is the lead regulatory agency for activities to be conducted at the subject site. The site is currently regulated by the Air Force Plant 4 (AFP 4) Record of Decision under the Comprehensive Environmental Response, Compensation, and Liability Act. This Work Plan has been prepared using guidance documents from the EPA, the TNRCC, and the AFCEE. The Work Plan for this project consists of the following documents:

The Work Plan, which describes the work to be performed, explains project objectives and presents the rationale for conducting specific project activities. The Work Plan describes the

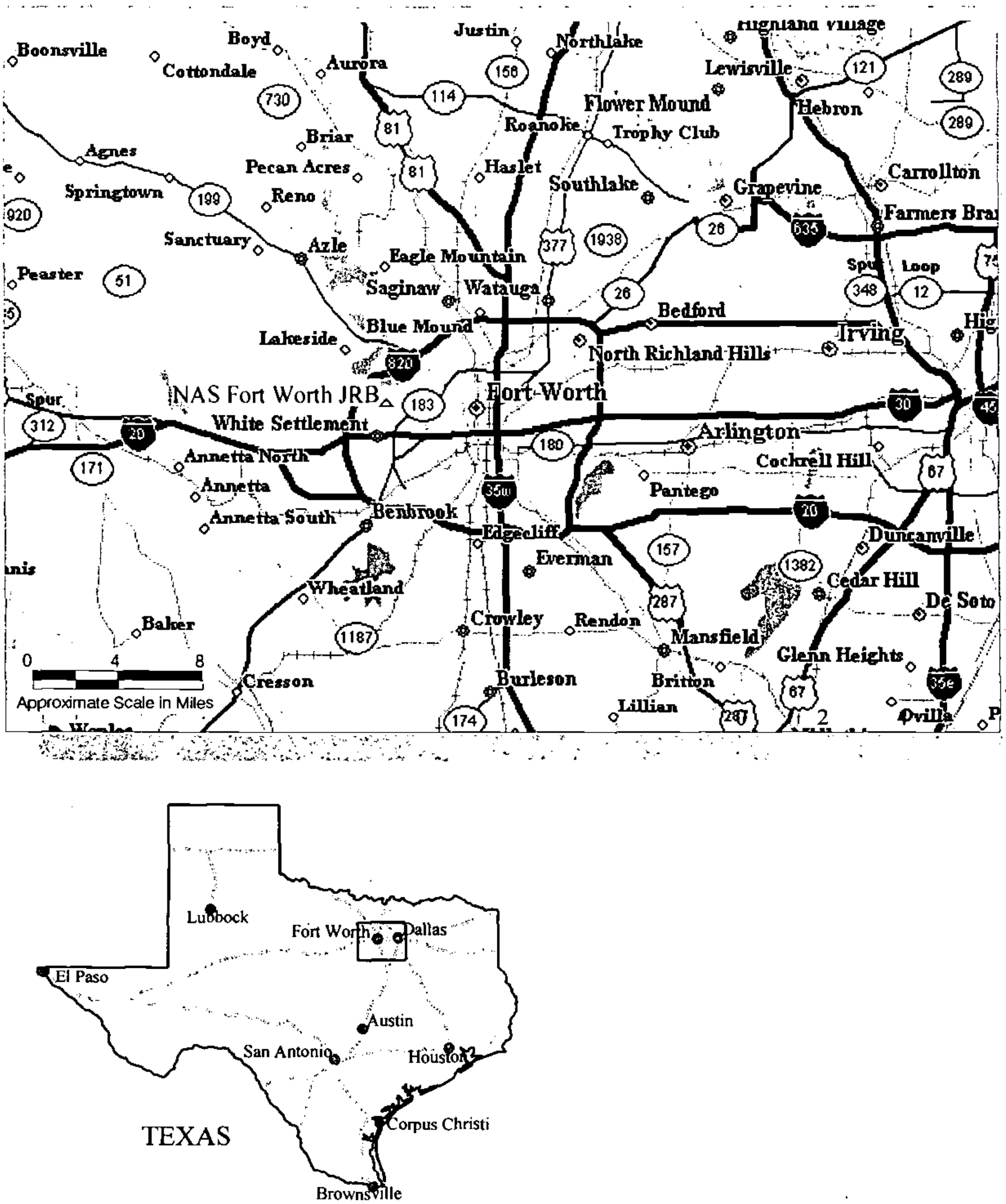

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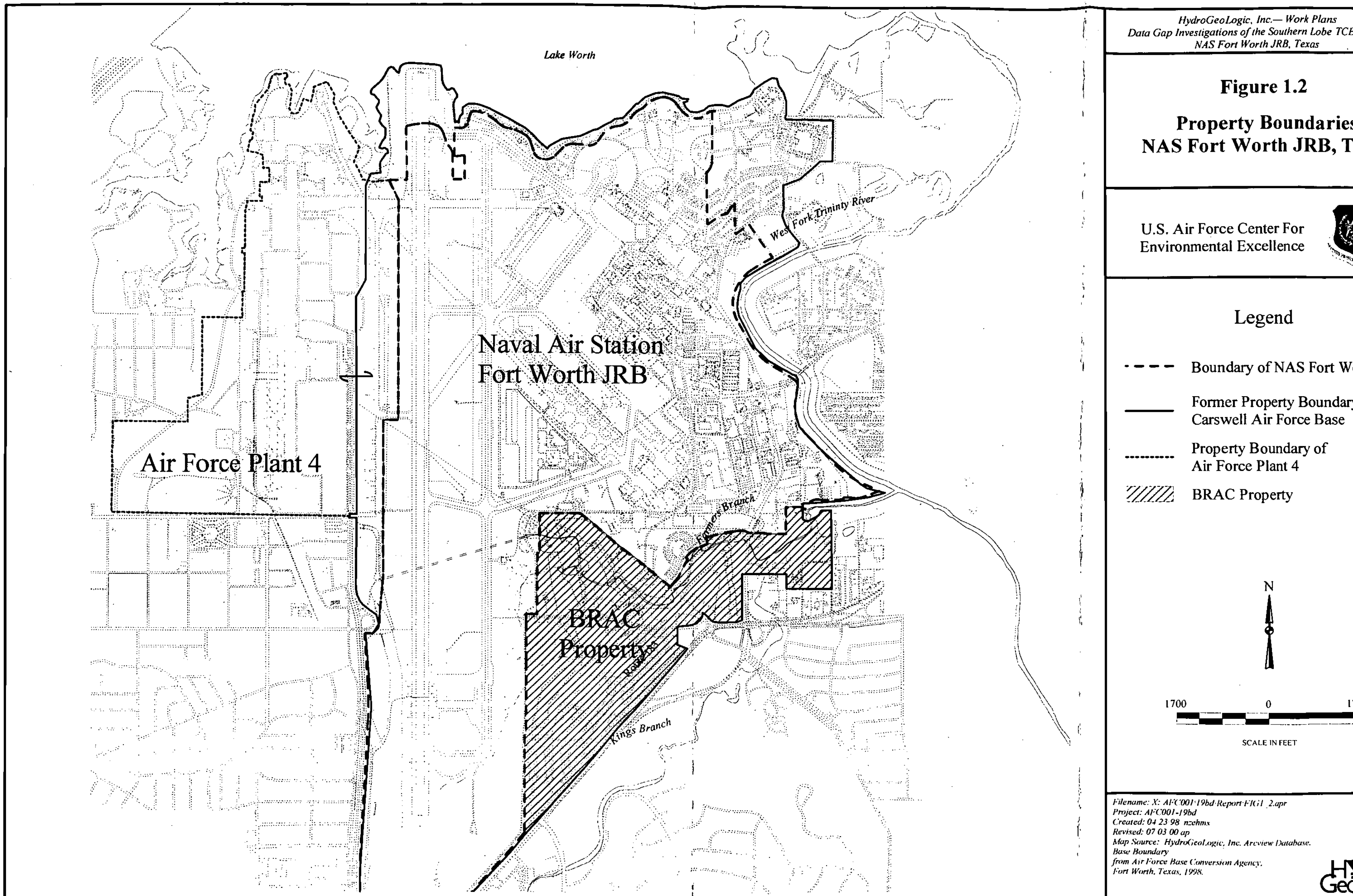
Figure 1.1

Site Location Map
NAS Fort Worth JRB, Texas

Figure 1.2

Property Boundaries
NAS Fort Worth JRB, Texas

U.S. Air Force Center For
Environmental Excellence



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Map Source: HydroGeoLogic, Inc. Arcview Database.
Base Boundary
from Air Force Base Conversion Agency,
Fort Worth, Texas, 1998.

HydroGeoLogic Inc.

site history and setting and provides a summary of environmental investigations that have been completed at the base. A description of the data gap investigative area, data needs, and the proposed sampling program is included in this Work Plan. Technical reports and presentation formats are also discussed in the Work Plan.

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

The Health and Safety Plan (HSP) provides guidance and procedures to satisfy health and safety regulations and procedures. The HSP describes required monitoring procedures, personal protection, and site safety protocols. Medical surveillance procedures, site control, and emergency response procedures are also described. In addition, potential health and safety risks for the investigation are identified.

1.2 HISTORY OF PAST WORK AT THE INSTALLATION

This section describes the location, operational history, and previous environmental investigations at the NAS Fort Worth JRB and AFP 4.

1.2.1 Installation Description

NAS Fort Worth JRB is located on 2,555 acres of land in Tarrant County, Texas, 8 miles west of downtown Fort Worth (Figure 1.1). It consists of the main base and two noncontiguous parcels (the Instrument Landing System marker beacon and the Weapons Storage Area) 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, the city of River Oaks, and the city of Westworth Village to the east; other urban areas of Fort Worth to the northeast and southeast; the city of White Settlement to the west and southwest; and AFP 4 to the west.

AFP 4 occupies 602 acres and employs people in various positions pertaining to aircraft manufacturing and associated processes. The area surrounding NAS Fort Worth JRB that is not used for Department of Defense operations is mostly suburban. Land use in the immediate vicinity of the base is industrial, commercial, residential, and recreational (A.T. Kearney, 1989).

1.2.2 Installation History and Present Mission

Prior to the initial base construction in 1941, the area that is now occupied by the NAS Fort Worth JRB consisted of woods and pasture in an area called White Settlement. The NAS Fort Worth JRB started as a modest dirt runway built to service the aircraft manufacturing plant formerly located at AFP 4□s current location. Figure 1.2 presents the geographic relationship between AFP 4 and the NAS Fort Worth JRB. In August 1942, the base was opened as Tarrant Field Airdrome and was used to train pilots to fly B-24 bombers under the jurisdiction of the Gulf Coast Army Air Field Training Command. In May 1943, the field was re-designated as Fort Worth Army Air Field with continued use as a training facility for pilots. The Strategic Air Command (SAC) assumed control of the installation in 1946, and the base served as the headquarters for the Eighth Air Force. It was renamed Carswell Air Force Base in 1948, and the 7th Bomber Wing became the base host unit. The Headquarters 19th Air Division was relocated to Carswell AFB in 1951, where it remained until September 1988 (A.T. Kearney, 1989).

The SAC mission remained at Carswell AFB until 1992, when the Air Combat Command assumed control of the base upon disestablishment of SAC. In October 1994, the U.S. Navy assumed responsibility for much of the facility, and its name was changed from Carswell AFB to NAS Fort Worth JRB. The NAS Dallas and elements of Glenview and Memphis NASs were combined and joined to NAS Fort Worth JRB to streamline naval operations into one central area. The principal activities on the base have been maintaining and servicing bombers, fuel tankers, and fighter jet aircraft (A.T. Kearney, 1989).

AFP 4 became operational in 1942 when Consolidated Aircraft began manufacturing the B-24 bomber for national defense during World War II. In 1953, General Dynamics took over operation of the manufacturing facility. Since 1953, AFP 4 has produced B-36, B-58, and F-111 aircraft. The plant currently produces F-16 aircraft. In addition to F-16 aircraft, AFP 4 produces spare parts, radar units, and missile components. On March 1, 1993, Lockheed, Forth Worth Company, took over operations of AFP 4 as a successor to General Dynamics.

1.2.3 Site Operational History

A summary of past and current industrial activities and waste disposal operations conducted at the NAS Fort Worth JRB and AFP 4 is presented in the following sections.

1.2.3.1 <u>Industrial Activities</u>

Major industrial operations that have been performed at the NAS Fort Worth JRB include the following: maintenance of jet engines, aerospace ground equipment (AGE), fuel systems, weapons systems, pneudraulic systems, and general and special purpose vehicles; aircraft corrosion control; and non-destructive inspection activities. Most of the liquid wastes that have been generated by industrial operations can be characterized as waste oils, recoverable fuels, spent solvents, and spent cleaners (CH2M HILL, 1984).

Waste oils generally refer to lubricating fluids/oils and, to a lesser extent, hydraulic fluids. Recoverable fuels refer to fuels drained from aircraft tanks and other base vehicles, such as jet propulsion grade 4 fuel (JP-4) and unleaded gasoline. Spent solvents and cleaners refer to stripping liquids used for degreasing and cleaning of the following: aircraft, aircraft systems and parts, electronic components, and vehicles. Spent solvents and cleaners include PD-680 (petroleum naphtha) and various chlorinated organic compounds. Specific types of degreasing solvents used by the USAF have changed over the years. Carbon tetrachloride was commonly used in the 1950s until it was replaced by TCE around 1960. Since then, TCE and 1,1,1-trichloroethane (1,1,1-TCA) have been used, although TCE usage has decreased in favor of 1,1,1-TCA. Today, PD-680 (Type II), 1,1,1-TCA, and to a limited extent, TCE are used. Waste paint solvents and strippers are also generated on-site from corrosion control activities. Typical paint solvents include the following compounds: isobutyl acetate, toluene, methyl ethyl ketone (MEK), isopropanol, naphtha, and xylene. Paint strippers generally contain such compounds as methylene chloride, toluene, ammonium hydroxide, and phenolics. Servicing and maintaining the engines and equipment of the B-52 and KC-135 aircraft generated the majority of waste liquids at NAS Forth Worth JRB (CH2M HILL, 1984).

Manufacturing operations at AFP 4 have resulted in the generation of various hazardous wastes that include waste oils, fuels, spent solvents, paint residues, and spent process chemicals. Throughout most of the plant's history, waste oil, solvents, and fuels were disposed at on-site landfills or were burned during fire training exercises. Chemical wastes were initially discharged to the sanitary sewer system and treated by the City of Fort Worth's treatment system. In the 1970's, chemical process wastes were treated on site at a newly constructed chemical waste treatment system prior to being discharged to the sanitary sewer system. Currently, a contractor disposes waste oils and solvents, and burning of these wastes has been discontinued. Chemical wastes continue to be treated on site. AFP 4 was placed on the National Priorities List (NPL) in August 1990.

1.2.3.2 Waste Disposal Operations

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

1942–1970: The majority of waste oils, recovered fuels, spent solvents, and cleaners were burned at the fire department training areas during practice exercises. Some waste oils and spent solvents were disposed of through contractor removal, while some waste paints (contaminated with thinners and solvents), waste oils, and PD-680 are suspected of having been disposed of in the base landfills. Some waste oils, recovered fuels, spent solvents, and cleaners were also discharged to sanitary and storm sewers. These discharges occurred primarily at the washracks. In 1955, an oil/water separator (OWS) (Facility 1190) was installed to recover waste materials discharged from the washracks. Non-aqueous materials from OWSs were pumped out and disposed of through contractor removal. Aqueous discharge from OWSs was, and still is, pumped into the sanitary sewers.

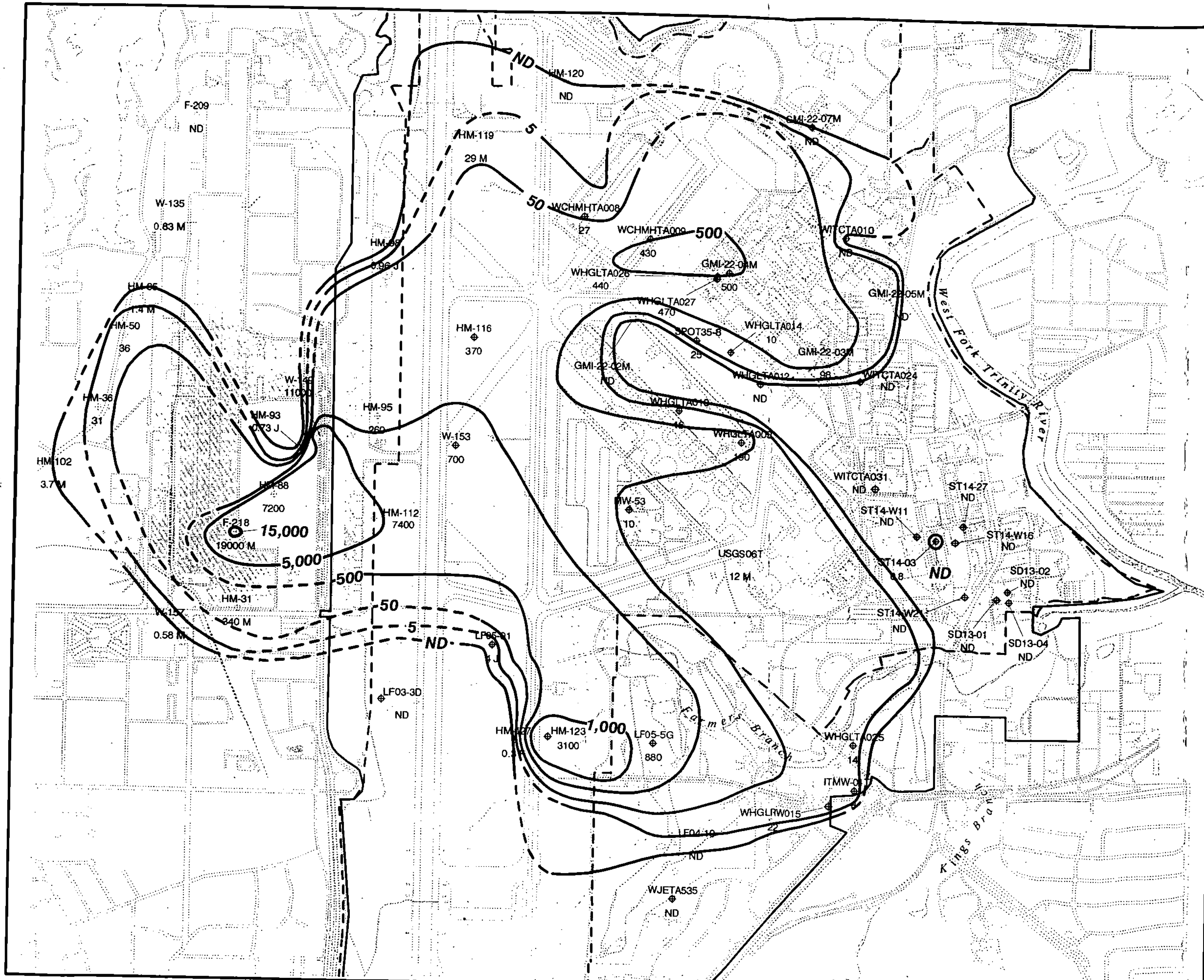
1971–1975: During this period, most waste oils, spent solvents, and cleaners were disposed of by contractor removal. A private contractor would pump the materials from OWSs, 55-gallon drums, and bowsers. Recovered JP-4 continued to be stored at the fire training areas and burned in practice exercises. Recovered JP-4 was also reused in AGE operations. Some waste paints (contaminated with thinners and solvents), waste oils, and PD-680 are suspected of having been disposed of in the base landfills. Some waste oils, solvents, and cleaners were discharged into sanitary sewer drains, primarily at the washracks that discharge to the Facility 1190 OWS. This OWS was routinely pumped out by a private contractor, and the recovered materials were removed from the base by the contractor.

1976–1982: The majority of waste oils, spent solvents, and cleaners were disposed of through services contracted either directly or through the Defense Reutilization and Marketing Office (DRMO). Recovered JP-4 was stored at the fire department training areas and burned during practice exercises. Recovered JP-4 was also used in AGE operations. PD-680 used at the washracks was discharged to the Facility 1190 OWS, which discharged to the sanitary sewers.

1983–Present: Waste oils, solvents, and cleaners are collected in 55-gallon drums and temporarily (less than 90 days) stored at 12 hazardous waste accumulation points located throughout the base. They are subsequently disposed of by contractor removal through DRMO. Recovered JP-4 and other fuels (mogas and unleaded gasoline) are stored at the fire department training area for subsequent burning in practice exercises or reuse in AGE operations. Waste paint solvents or thinners and strippers such as toluene, isobutyl acetate, MEK, isopropanol, naphtha, and xylene are also temporarily stored prior to removal. Removal of waste oils and PD-680 (Type II) from OWSs is also handled by off-base contractors through DRMO.

1.3 DESCRIPTION OF CURRENT STUDY

The primary area of interest for this Data Gap Investigation consists of the area comprising the boundary of the NAS Fort Worth JRB and extending into the remaining extent of former Carswell AFB in the vicinity Southern Lobe TCE Plume. The TCE plume is depicted in Figure 1.3. This area is located in the southeastern corner of former Carswell AFB and consists primarily of the former Carswell AFB golf course and base housing area. This area is under consideration for transfer to the Westworth Redevelopment Authority under the BRAC program. This investigation will also examine the aqueduct, which is located within the NAS Fort Worth JRB, that acts as a subterranean conduit for Farmers Branch Creek. The aqueduct is located beneath the runway and flightline area, south of AFP 4, and transects the property in a generally east-west direction. The general locations of the five investigations are depicted in Figure 1.4.



HydroGeoLogic, Inc.—Work Plans
Data Gap Investigations of the Southern Lobe TCE Plume
NAS Fort Worth JRB, Texas

Figure 1.3

Trichloroethene Concentrations Terrace Alluvium April 2000

U.S. Air Force Center For Environmental Excellence

Legend

- - - NAS Fort Worth JRB (Carswell Field)

—— Former Carswell Air Force Base

–500– TCE Concentration Contour (μg/L)

MW-53 ⊕ 89 — NAS Fort Worth JRB Basewide Sampling Well; TCE Concentration (μg/L)

WHGLTA901 ⊕ 81 — Monitoring well data collected as part of other investigations during March and April 2000. TCE Concentration (μg/L)

HM-119 ⊕ 30 — AFP 4 Semi-Annual Monitoring Well; TCE Concentration (μg/L)

F = The analyte was positivily identified but the associated numberical value is below the PQL.

J = The analyte was positivily identified, the quantitation is an estimate.

M = Possible matrix interference.

ND = Not Detected at Laboratory Method Detection Limit of 0.5μg/L

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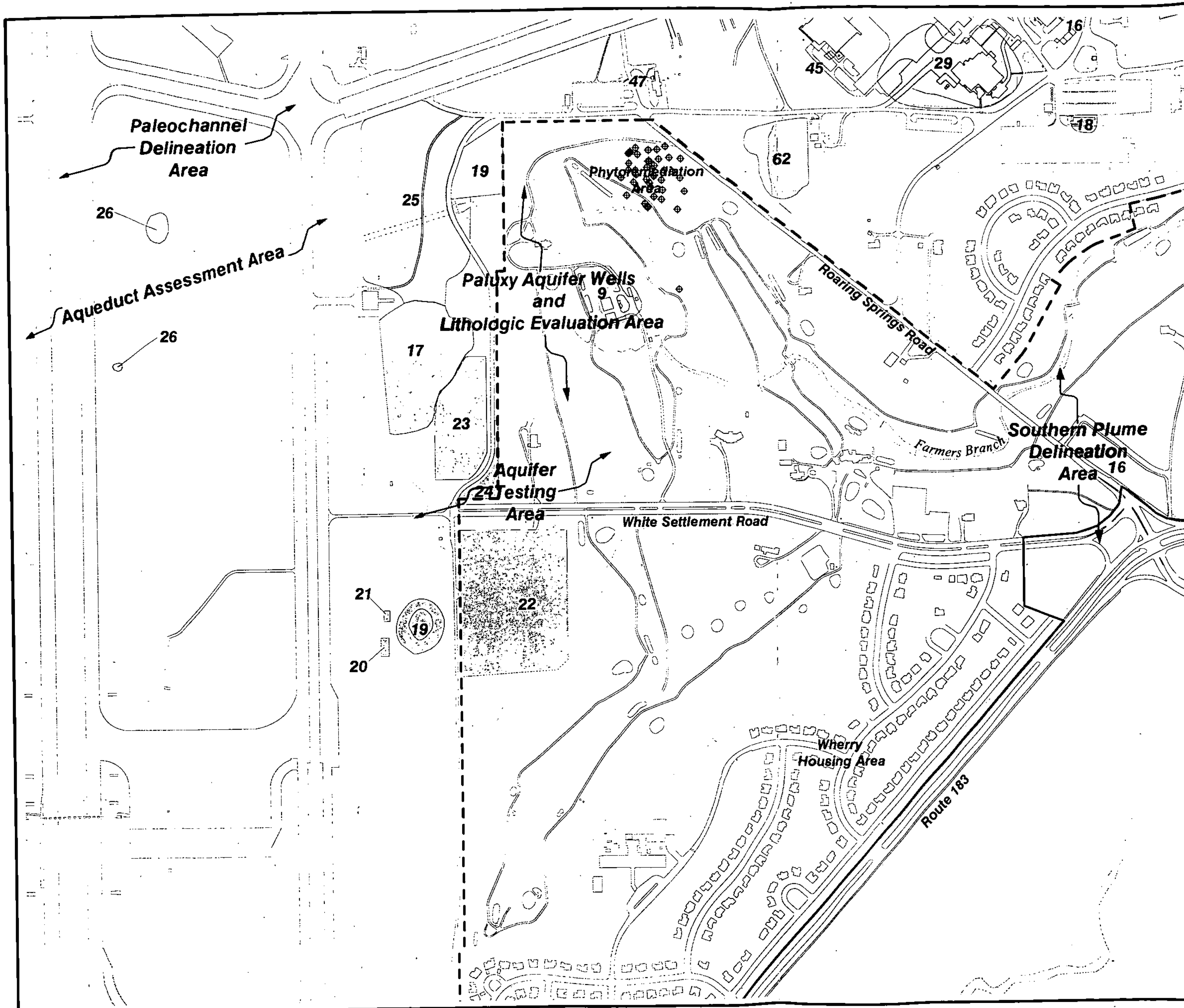

Figure 1.4

Data Gap Investigation Areas
NAS Fort Worth JRB

U.S. Air Force Center For
Environmental Excellence

Legend

- NAS Fort Worth JRB Boundary (Carswell Field)
- Former Carswell Air Force Base Boundary
- Phyto Remediation Well
- Test Area: General Location of Designated Field Investigation

Area of Concern

5 Grounds Maintenance Yard
9 Golf Course Maintainence Yard
13 O/W Separator
16 Family Camp
18 Suspected Former Fire Training Area
19 Suspected Former Fire Training Area

Solid Waste Management Unit

16 Building 1060 Waste Accumulation Area
17 Landfill No. 7
19 Fire Training Area No. 2
20 Waste Fuel Storage Area
21 Waste Oil Tank
22 Landfill No. 4
23 Landfill No. 5
24 Waste Burial Area
25 Landfill No. 8
26 Landfill No. 3
45 Building 1027 Waste Oil Tank Vault at the Aircraft Washing Hangar
47 Building 1015 Jet Engine Test Cell Oil/Water Separator
62 Landfill No. 6

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Map Source: HGL ArcView GIS Database

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The overall objective of this investigation is to fill data gaps resulting from previous investigations of the Southern Lobe TCE plume. The collection of data described within this Work Plan is required to complete an ongoing FFS that is being prepared for the BRAC property. The data collection activities that are outlined in this Work Plan are necessary to complete the following objectives:

- delineate the TCE plume in the vicinity of Farmers Branch Creek and along the southeastern extent of the plume;
- determine the lithologic and hydraulic properties of the paleochannel that influences TCE migration at the former Carswell AFB;
- determine the competency of the Goodland Walnut Formations as an aquitard within the BRAC property;
- determine the hydrogeologic characteristics of the Terrace Alluvium in the vicinity of the NAS Fort Worth JRB property line; and
- determine if the aqueduct influences contaminant migration in surface water (i.e., Farmers Branch Creek).

These primary objectives are discussed in greater detail in Section 3.2 of the Work Plan.

2.0 SUMMARY OF EXISTING INFORMATION

The climate, physiography, geology, hydrology, biology, and demographics of the NAS Fort Worth JRB area are described in the following sections. This data has been primarily derived from the Summary of Remediation Projects at AFP 4 Carswell AFB (Environmental Science and Engineering, Inc. [ESE], 1994) and the Remedial Investigation/Feasibility Study (RI/FS) reports (Radian, 1989a, 1991).

2.1 INSTALLATION ENVIRONMENTAL SETTING

2.1.1 Physiographic Province

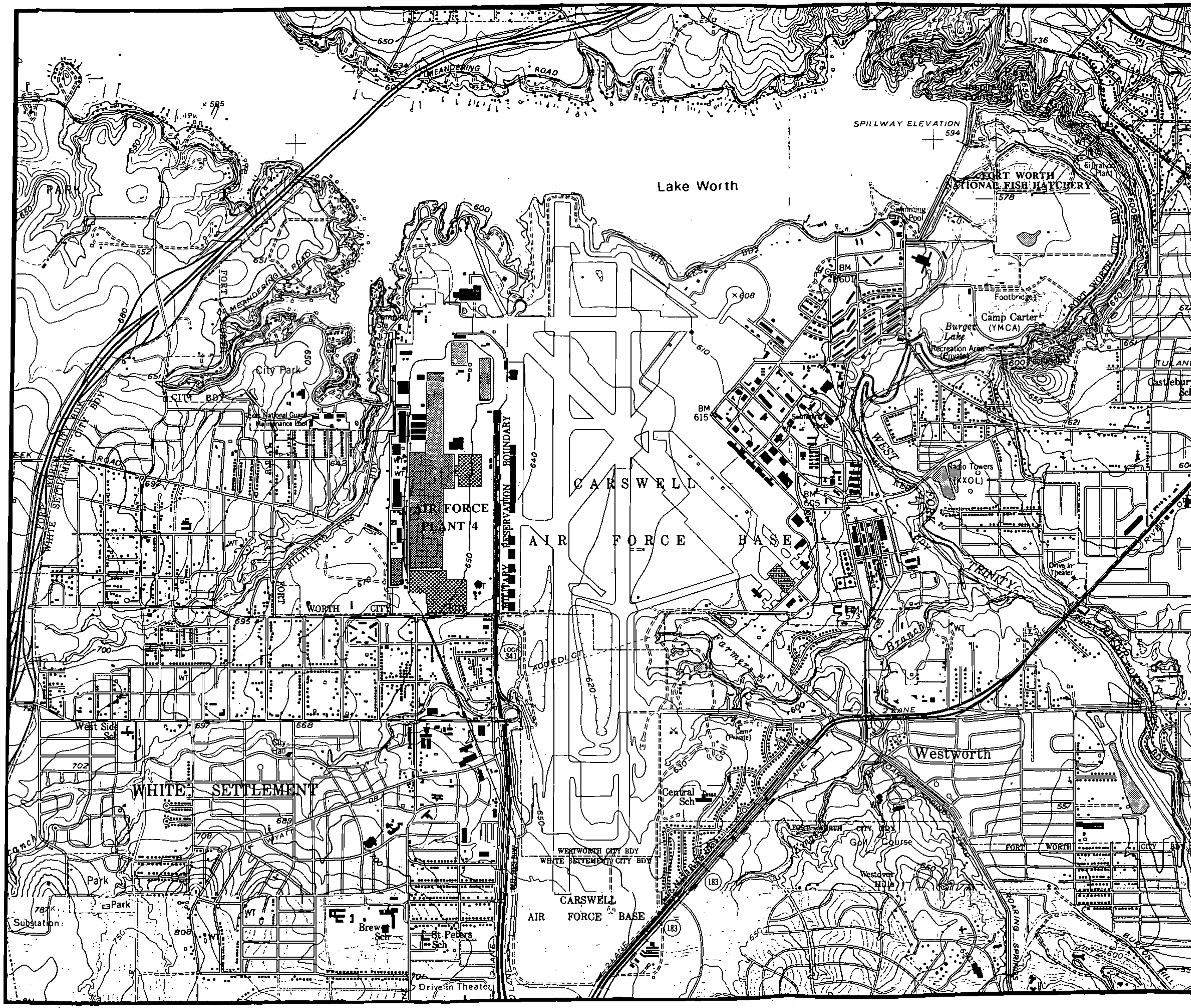
NAS Fort Worth JRB is located along the border zone between two physiographic provinces. The southeastern part of the base is situated within the Grand Prairie section of the Central Lowlands Physiographic Province. Most of NAS Fort Worth JRB is located within this province. This region is characterized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

2.1.2 Regional Geology

The geologic units of interest for the region, from youngest to oldest, are as follows: (1) the Quaternary Alluvium (including fill material and terrace deposits), (2) the Cretaceous Goodland Limestone, (3) the Cretaceous Walnut Formation, (4) the Cretaceous Paluxy Formation, (5) the Cretaceous Glen Rose Formation, and (6) the Cretaceous Twin Mountains Formation. A generalized cross section of the geology beneath NAS Fort Worth JRB is presented in Figure 2.2 and 2.3 (Radian, 1989). The areal limits of surface exposure of these units at NAS Fort Worth JRB are shown in Figure 2.4. The regional dip of the stratigraphic units beneath NAS Fort Worth JRB is between 35 and 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.

2.1.3 Groundwater

The water-bearing geologic formations located in the NAS Fort Worth JRB area may be divided into the following five hydrogeologic units, listed from the shallowest to the deepest:



HydroGeoLogic, Inc.—Work Plans
Data Gap Investigation of the Southern Lobe TCE Plume
NAS Fort Worth JRB, Texas

Figure 2.1

NAS Fort Worth JRB Regional Topographic Map

Air Force Center for Environmental Excellence
Brooks AFB, Texas

Legend

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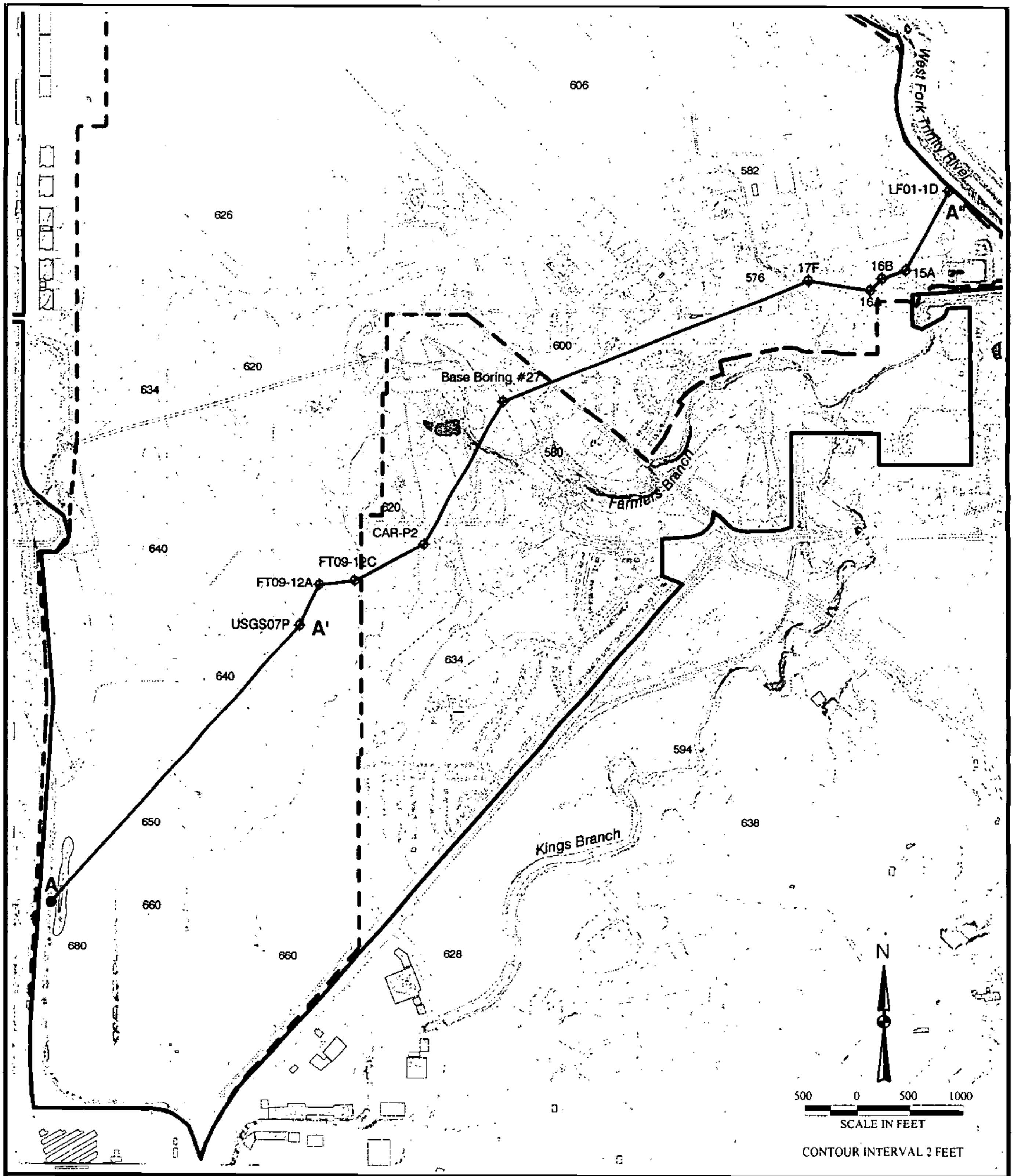

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Source: HydroGeoLogic, Inc—GIS Database

HYDRO GeoLogic INC

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- NAS Fort Worth JRB Boundary
- Former Carswell AFB Boundary
- SWMU 27 Location
- 660 Topographic Contour

Figure 2.2
Cross Section Location
A-A'-A"

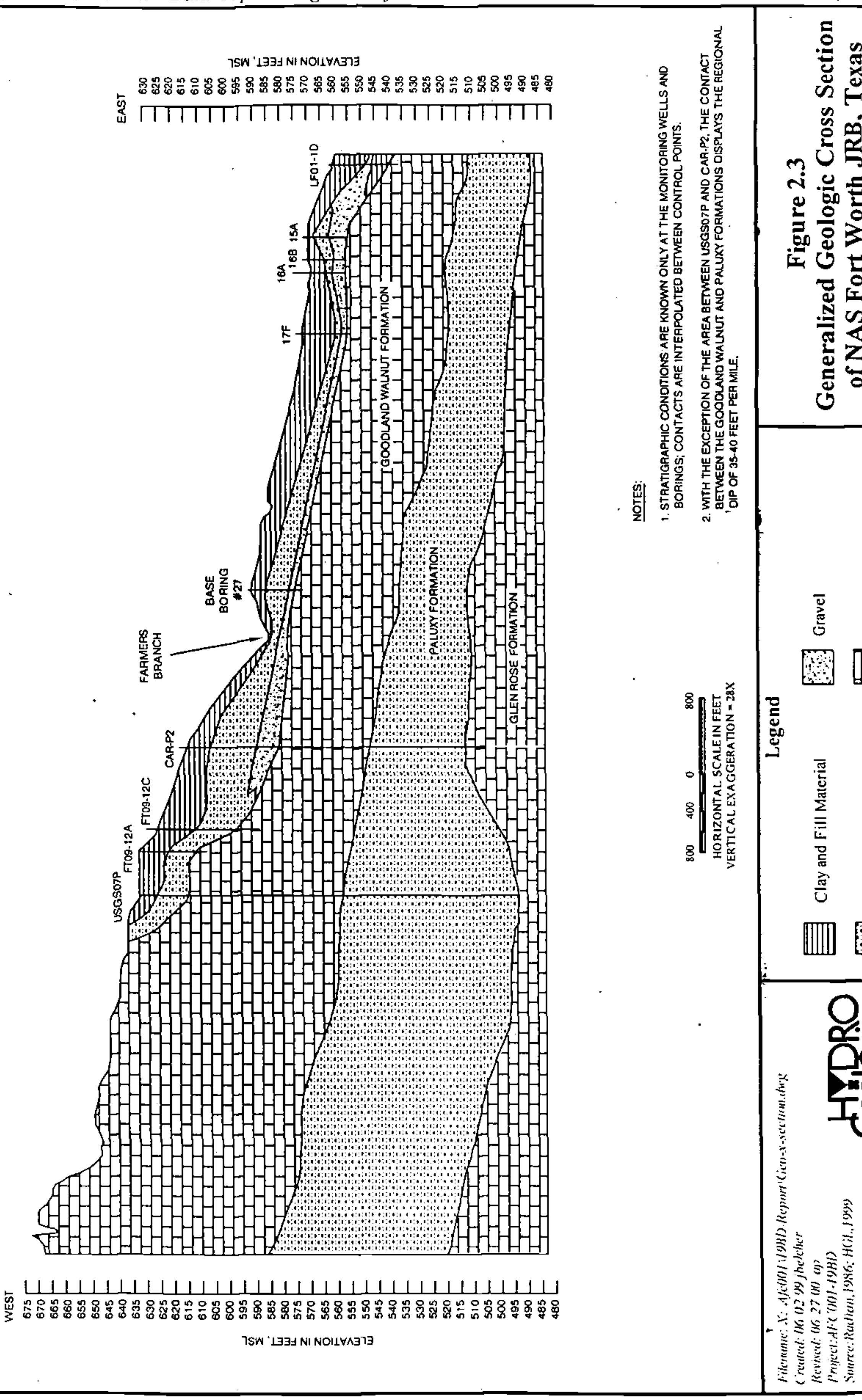

Figure 2.3
Generalized Geologic Cross Section of NAS Fort Worth JRB, Texas

HYDRO GEOLOGIC

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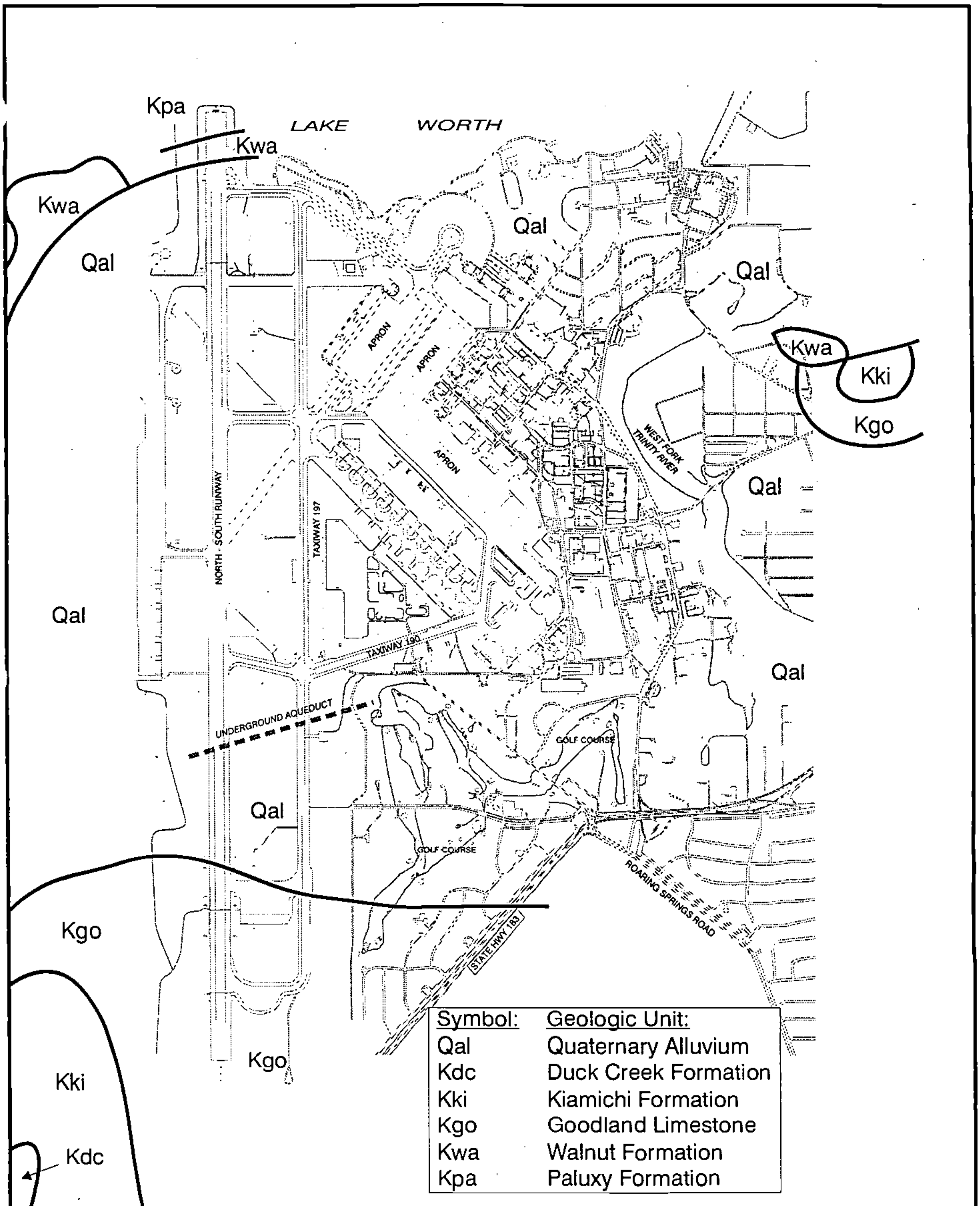

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Map Source: Radian, 1989

HYDRO GeoLogic INC

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Figure 2.4
Areal Distribution of Geologic Units
NAS Fort Worth JRB, Texas

(1) an upper water-bearing zone occurring in the alluvial terrace deposits associated with the Trinity River, (2) an aquitard of predominantly dry limestone of the Goodland and Walnut Formations, (3) an aquifer in the Paluxy Sand, (4) an aquitard of relatively impermeable limestone in the Glen Rose Formation, and (5) a major aquifer in the sandstone of the Twin Mountains Formation. Each of these units is examined more explicitly in the following paragraphs. The relationship between these hydrogeologic units and geologic units is illustrated in Figure 2.5 (Radian, 1989a).

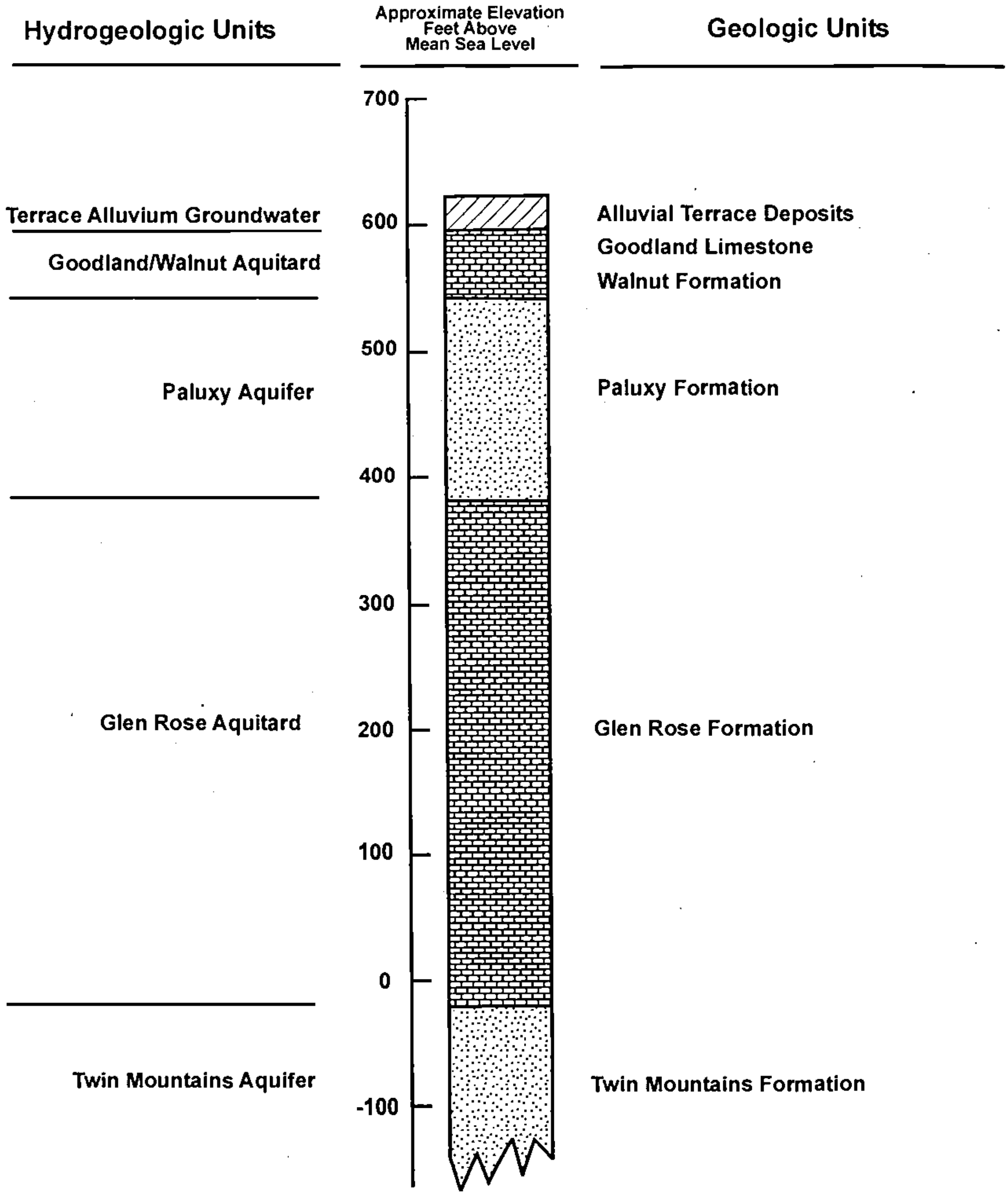
2.1.3.1 Alluvial Terrace Deposits

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

Recharge to the water-bearing deposits occurs through infiltration from precipitation and from surface water bodies. Extensive on-site pavement and construction restricts this recharge. Additional recharge, however, comes from leakage in water supply lines, sewer systems, storm drains, and cooling water systems. In 1991, this leakage was calculated to be in excess of approximately 115.5 million gallons for NAS Fort Worth JRB and AFP 4 (General Dynamics Facility Management, 1992). This inflow of water to the shallow aquifer effects local groundwater flow patterns and contamination transport, along with increasing hydraulic head, which acts as the force to potentially drive water into lower aquifer systems. The estimated hydraulic conductivity of the alluvial aquifer is 4.57 gallons per day per square foot (gpd/ft^2) (Radian, 1989).

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

A potentiometric surface map of NAS Fort Worth JRB and AFP 4 alluvial terrace groundwater is presented as Figure 2.6. The groundwater elevation data show an easterly trend in groundwater flow over the area of NAS Fort Worth JRB toward the West Fork of the Trinity River (HydroGeoLogic, Inc. [HydroGeoLogic], 1999a,b).



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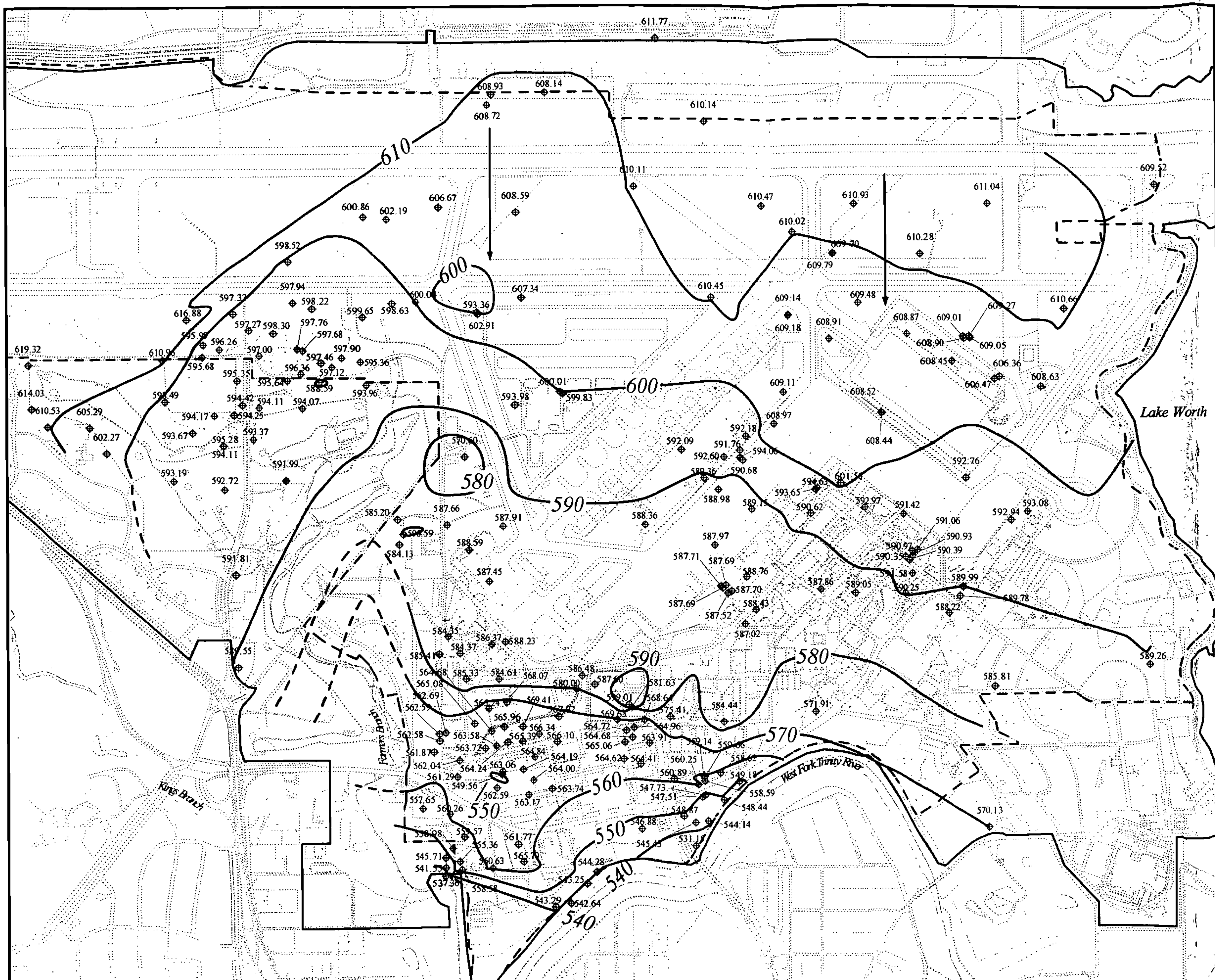
Revised: 06/30/00 cf
Project: AFC001-19BD
Map Source: Radian, 1989

Legend

- Alluvium
- Limestone
- Sandstone

Figure 2.5
Stratigraphic Column Correlating Hydrogeologic Units and Geologic Units



HydroGeoLogic, Inc.—Work Plans
Data Gap Investigations of the Southern Lobe TCE Plume
NAS Fort Worth JRB, Texas

Figure 2.6

Water Level Elevations
Terrace Alluvium
July 1999

U.S. Air Force Center For Environmental Excellence

Legend

- - - - NAS Fort Worth JRB (Carswell Field)

——— Former Carswell Air Force Base

-600- Groundwater Elevation Contour (Feet Above Mean Sea Level)

→ Generalized Groundwater Flow

N

0 500 1000 2000
SCALE IN FEET

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Project: AFC001-19BD
Created: 01/12/99 cf
Revised: 07/03/00 jb
Map Source: HydroGeoLogic, Inc. GIS Database

HYDRO GeoLogic INC.

2.1.3.2 Goodland/Walnut Aquitard

The groundwater within the terrace deposits is isolated from groundwater within the lower aquifers by the low permeability 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 flow rate that ranges between 1.16E-03 feet per day (ft/d) to 5.22E-03 ft/d (ESE, 1994).

At the AFP 4 area of breached aquitard, the Goodland/Walnut Aquitard is breached, and the alluvial terrace groundwater is in direct contact with the groundwater in the Paluxy Aquifer. Several wells and borings have been advanced at NAS Fort Worth JRB to the Goodland/Walnut Aquitard. There is no evidence that a similar window exists on the NAS Fort Worth JRB base property.

2.1.3.3 Paluxy Aquifer

The Paluxy Aquifer is an important source of potable groundwater for the Fort Worth area. Many of the surrounding communities, particularly White Settlement, obtain their municipal water supplies from the Paluxy Aquifer. Groundwater from the Paluxy is also used in some of the surrounding farms and ranches for agricultural purposes. Due to the extensive use of the Paluxy Aquifer, water levels have declined significantly over the years. Water levels in the NAS Fort Worth JRB vicinity have not decreased as much as in the Fort Worth area due to its proximity to the Lake Worth recharge area and the fact that the base does not obtain 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. In 1989, Radian estimated the hydraulic conductivity and transmissivity to be 130 to 140 gpd/ft^2 and 1,263 to 13,808 gpd/ft^2, respectively.

2.1.3.4 Glen Rose Aquitard

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

2.1.3.5 Twin Mountains Aquifer

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 out crops. Groundwater movement is eastward in the downdip direction. The Twin Mountains groundwater occurs under unconfined conditions in the recharge area and becomes confined as it moves downdip. Transmissivities in the Twin Mountains Aquifer range from 1,950 to 29,700 gpd/ft^2 and average 8,450 gpd/ft^2 in Tarrant County. Permeabilities range from 8 to 165 gpd/ft^2 and average 68 gpd/ft^2 in Tarrant County (CH2M HILL, 1984).

2.1.4 Surface Water

The topography of NAS Fort Worth JRB is fairly flat except for the lower lying areas along the tributaries of the Trinity River. The land surface slopes gently northeastward toward Lake Worth and eastward toward the West Fork of the Trinity River. Surface elevations range from about 690 feet above NGVD at the southwest corner of the base to approximately 550 feet above NGVD, along the eastern side of the base.

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

Surface drainage is mainly east towards the West Fork of the Trinity River. The base is partly drained by Farmers Branch Creek, a tributary of the West Fork of the Trinity River. Farmers Branch Creek begins within the community of White Settlement and flows eastward. Just south of AFP 4, Farmers Branch flows under the runway within two large culverts commonly referred to as the "aqueduct". Most of the base drainage is intercepted by a series of storm drains and culverts, directed to OWSs, 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.

NAS Fort Worth JRB currently has three storm water discharge points that are subject to National Pollution Discharge Elimination System requirements. Each discharge point is monitored weekly for chemical oxygen demand, oil and grease, and pH. The permit has been violated on numerous occasions. In 1979, these violations prompted the EPA to formally demand a corrective action (CH2M HILL, 1984). Several additional sampling points were established to determine the flow of pollutants onto and off of the base. Samples were collected for a variety of parameters (spills, fish kills, odors, and oil sheen) as circumstances dictated (Radian, 1989a,b).

2.1.5 Air

The climate in the Fort Worth area is classified as humid subtropical with hot summers and dry winters. Tropical maritime air masses control the weather during much of the year, but the passage of polar cold fronts and continental air masses can create large variations in winter temperatures. The average annual temperature in the area is 66 degrees Fahrenheit (°F), and monthly mean temperatures vary from 45°F in January to 86°F in July. The average daily minimum temperature in January is 35°F, and the lowest recorded temperature is 2°F. The average daily maximum temperature in July and August is 95°F, and the highest temperature ever recorded at the base was 111°F. Freezing temperatures occur at NAS Fort Worth JRB an average of 33 days per year (TNRCC, 1996d).

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 2 to 3 days per year. The maximum precipitation ever recorded in a 24-hour period is 5.9 inches. On the average, measurable snowfall occurs 2 days per year (TNRCC, 1996d).

Lake evaporation near NAS Fort Worth JRB is estimated to be approximately 57 inches per year. Evapotranspiration over land areas may be greater or less than lake evaporation depending on vegetative cover type and moisture availability. Average net precipitation is expected to be equal to the difference between average total precipitation and average lake evaporation, or approximately minus 25 inches per year. Mean cloud cover averages 50 percent at NAS Fort Worth JRB, with clear weather occurring frequently during the year. Some fog is present an average of 83 days per year. Wind speed averages 7 knots; however, a maximum of 80 knots has been recorded. Predominant wind direction is from the south-southwest throughout the year (TNRCC, 1996d).

Air quality in the Dallas-Fort Worth area meets EPA National Ambient Air Quality Standards for carbon monoxide, nitrogen dioxide, sulfur dioxide, and respirable particulate matter. However, ozone levels exceed national standards, and the ozone pollution level in the area has a Federal classification of moderate. During 1996, ozone measurements showed an arithmetic mean concentration of 0.033 parts per million in North Tarrant County. Actual exceedances of the national standards for ozone concentrations was calculated to be 2 days for the measurement station in North Tarrant County. Additional control measures are being implemented as a result of 1990 Federal Clean Air Act mandates to bring the area into compliance with the national standard (TNRCC, 1996d).

2.1.6 Biology

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

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

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

2.1.7 Demographics

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

2.1.7.1 Regional Demographics

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

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

2.1.7.2 Site-Specific Demographics

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

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

2.2 SITE-SPECIFIC ENVIRONMENTAL SETTING

The following sections describe the site-specific environmental conditions in and around the BRAC property that is currently being evaluated in an ongoing FFS.

2.2.1 Site-Specific Geology

The majority of NAS Fort Worth JRB is covered by alluvium deposited by the Trinity River during flood stages. The alluvium is composed of gravel, sand, silt, and clay of varying thicknesses and lateral extent. The thickness of these materials ranges from 0 to 60 feet. Fill material is also included within these deposits where landfills, waste pits, excavation sites, and other construction activities have altered the original land surface. This fill material is made up of clay, silt, sand, and gravel mixtures, but may also contain debris and other waste (Radian, 1989). Paleochannels created by the ancestral Trinity River are present within the alluvial sediments underlying AFP 4 and the former Carswell AFB. These paleochannels are typical of erosional surfaces modified by fluvial processes and are filled with sand and gravel deposits ranging in thickness from 15 to 35 feet (CH2M HILL, 1996b; HydroGeoLogic, 2000). The sediments within these paleochannels are more transmissive than the surrounding sediments; consequently, they provide preferential flow pathways for the migration of contaminants.

Below the alluvial terrace deposits are the Cretaceous-age Goodland and Walnut Formations, which form the bedrock surface beneath NAS Fort Worth JRB. Both formations consist of interbedded, fossiliferous, hard limestone and calcareous shale. The upper formation, the Goodland Limestone, is exposed on the southern portion of the base, south of White Settlement Road. The Goodland is a chalky-white, fossiliferous limestone and marl. The thickness of the Goodland Limestone ranges from 20 to 25 feet. Below the Goodland Formation is the Walnut

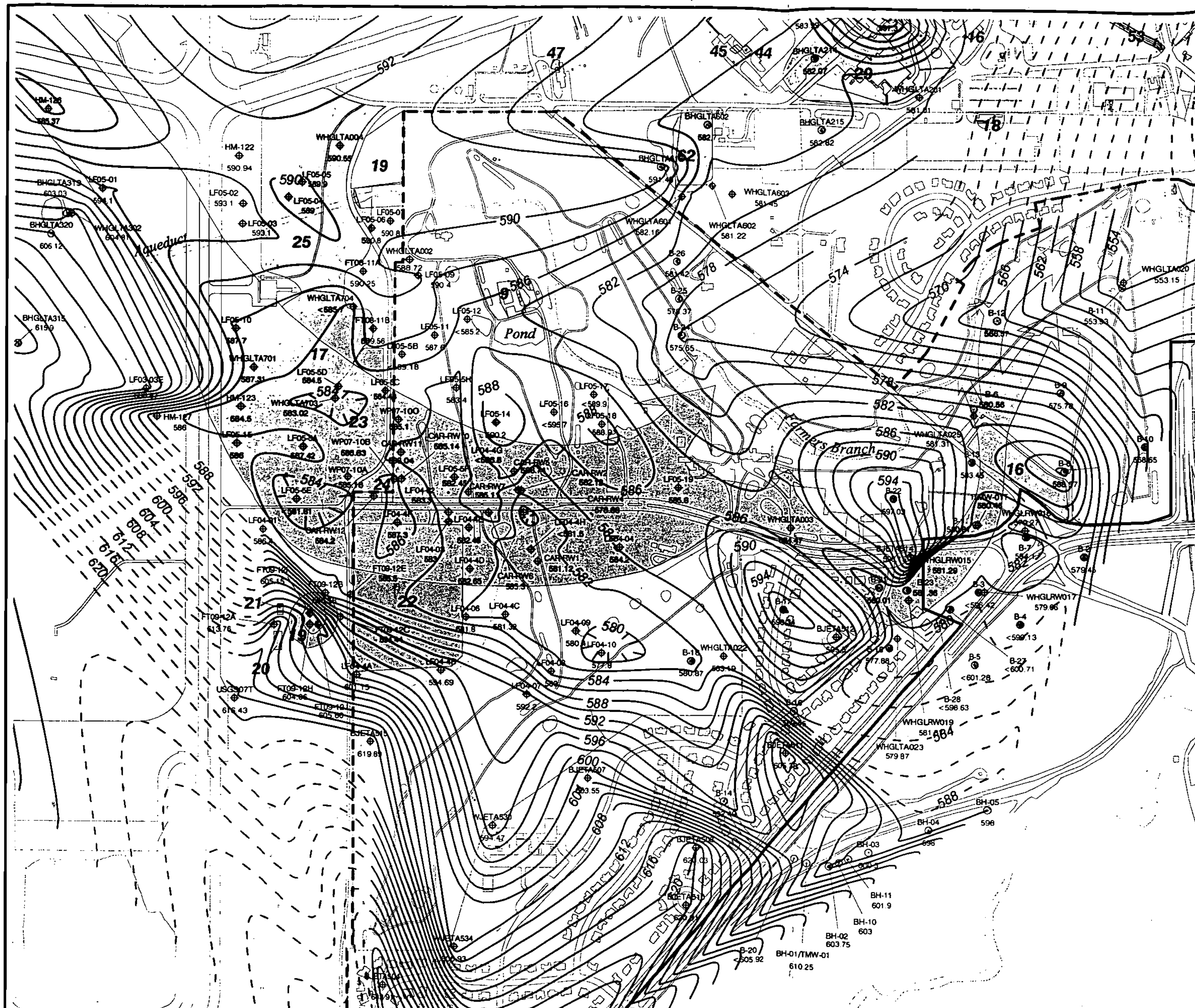
Formation (or Walnut Clay). The Walnut Formation is exposed in a small area along the shores of Lake Worth and Meandering Road Creek. This formation is a shell conglomerate limestone with varying amounts of clay and shale. It ranges in thickness from 25 to 35 feet throughout the site except where erosion has produced a few thinner areas. Subsurface investigations have located troughs that have been eroded into the top of the bedrock at NAS Fort Worth JRB. These troughs correspond to the paleochannels in the overlying alluvial sediments, which were created by the ancestral Trinity River.

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

2.2.2 Groundwater Contamination

AFP 4 was placed on the NPL in August 1990 because of a large release of TCE arising from past disposal practices at AFP 4. While the source area is currently being remediated, the plume migration path is to the east of AFP 4 and extends under NAS Fort Worth JRB. The regional TCE plume as depicted in Figure 1.3 can be subdivided into northern and southern lobes. The northern lobe is migrating primarily eastward from the AFP 4 source area. The southern lobe is migrating southeast from the AFP 4 source area, along a former paleochannel of the West Fork Trinity River (Parsons, 1998; HydroGeoLogic, 2000). This paleochannel acts as a preferred pathway for groundwater flow and subsequent contaminant migration and is depicted in Figure 2.7. The paleochannel crosses the flightline and landfill areas of NAS Fort Worth JRB before turning east along White Settlement Road. The location of the paleochannel is based primarily off of borings and depth to bedrock information collected.

In 1991, buried drums, some of which contained TCE, were discovered in a landfill area designated as solid waste management unit (SWMU) 24, otherwise known as Waste Burial Area No. 7 (WP-7). SWMU 24 is located directly above the paleochannel containing the southern lobe of the regional TCE plume. Excavation activities to remove the drums were initiated by the US Army Corps of Engineers (USACE) in October 1991. A total of thirty-four 55-gallon drums and ten 5-gallon buckets were removed and disposed of during the excavation. These drums and buckets contained a total of 131 gallons of TCE and 169 gallons of TCE-contaminated liquid. Contaminated soils and liquids were properly disposed at offsite facilities (USACE, 1992). Extensive soil sampling was conducted by HydroGeoLogic between 1997 and 2000 as part of an Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) at SWMU 24. Analytical results from these soil sampling activities indicate that soils within SWMU 24 are not a continuing source of TCE contamination in groundwater. The Final RFI report for SWMU 24 is scheduled for submittal in Summer 2000.



HydroGeoLogic, Inc.—Work Plans
Data Gap Investigations of the Southern Lobe TCE Plume
NAS Fort Worth JRB, Texas

Figure 2.7
Bedrock Elevations and Preferential Groundwater Pathways NAS Fort Worth JRB

U.S. Air Force Center For Environmental Excellence

Legend

- NAS Fort Worth JRB (Carswell Field)
- Former Carswell Air Force Base
- —586— Bedrock Elevation (ft msl)
- LF04-01 Monitoring Well ID
- 586.50 Bedrock Elevation (ft msl)
- FT09-12J Soil Boring ID
- 586.50 Bedrock Elevation (ft msl)
- Preferential Flow Pathway
- Solid Waste Management Unit (SWMU)
- Area of Concern (AOC)

Note: < indicates bedrock was not encountered, the elevation is the end of the boring

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Project: AFC001-19CD
Created: 03/22/00 jbelcher
Revised: 08/11/00 jb
Map Source: HydroGeoLogic GIS Database

HYDROGEOLOGIC INC.

Previous field activities conducted by HydroGeoLogic to further define the southern lobe of the basewide TCE plume were completed in three stages: (1) initial screening investigation, (2) well installation and lithological investigation, and (3) three bi-monthly groundwater sampling events of the newly installed wells and two bi-monthly sampling rounds of active recovery wells (HydroGeoLogic, 2000). In addition, quarterly groundwater monitoring activities were performed basewide during the same time frame. The results of these investigations further refined the nature and extent of VOC contamination within the former Carswell AFB, including the property that is being considered for public release by the BRAC program.

Based on the recent field investigations completed within the former Carswell AFB and historical investigations conducted at AFP 4, the highest TCE concentrations in groundwater occur within AFP 4. In this area, TCE concentrations exceed 20,000 ug/L near identified source areas. Within the federal property that is currently being addressed in the ongoing FFS (i.e., the BRAC property), TCE concentrations range from 680 ug/L at the NAS Fort Worth property boundary to nondetectable levels along the southeastern boundary of the plume. Because the TCE concentrations exceed the Federal maximum contaminant level (MCL) of 5 μg/L for public drinking water, the FFS must focus on remedial alternatives for groundwater.

2.2.3 Surface-Water Contamination

Farmers Branch Creek is the primary surface water drainage system in the central and southern portions of NAS Fort Worth JRB. It flows in an easterly direction to through the base and converges with the West Fork Trinity River approximately 1.5 miles after exiting NAS Fort Worth JRB Property. An underground aqueduct, which is approximately 2,800 feet in length and is oriented in an west-east direction, diverts surface water from the former riverbed of Farmers Branch Creek under and through the NAS Fort Worth JRB Flightline area. This aqueduct bisects the southern lobe of the regional TCE plume into two distinct northern and southern sub-lobes.

TCE has not been detected historically in surface water sampled in the western "upstream" section of the aqueduct; however, TCE has been detected in the eastern "downstream" section of the aqueduct. Clearly, TCE contamination is entering the aqueduct somewhere along its reach. It should be noted that the aqueduct crosses the paleochannel containing the regional TCE plume in the vicinity of Taxiway Foxtrot. Because the aqueduct intersects the saturated area of the flightline in many places, it is possible that groundwater containing TCE may be entering the aqueduct through cracks in the structure. It is also possible that the TCE may be entering the aqueduct through underground drainage systems connecting AFP 4 and NAS Fort Worth JRB to the aqueduct.

Concentrations of TCE in surface water sampled by HydroGeoLogic in 1997 range from 0.027 J mg/L at UHGLTA001-09, located at the eastern end of the aqueduct, to a high of 0.061 mg/L at UHGLTA006-04, which is located just downstream of an un-named tributary of Farmers Branch Creek. This un-named tributary drains surface water from the southern portion of the NAS Fort Worth JRB Flightline area. It is intermittent in its uppermost reaches;

however, along the stretch parallel to White Settlement Road, a steady flow of water appears as the tributary cuts sharply to the north to converge with Farmers Branch Creek (HGL, 1997).

Surface water samples colleted from the tributary revealed TCE concentrations of 0.18 mg/L UHGLTA010-01 to the north and 0.2 mg/L at UHGLTA017-02 to the south of White Settlement Road. White Settlement Road parallels the axis of the southern lobe of the regional TCE plume. Springs and seeps draining groundwater from the regional TCE plume are the most likely source of the TCE detected in surface water samples collected from the un-named Tributary (HGL, 1997).

3.0 PROJECT TASKS

The following sections present the proposed field investigation tasks.

3.1 IDENTIFICATION OF DATA NEEDS

The objective of this investigation is to collect additional physical and chemical hydrogeologic data to fill data gaps remaining from previous investigations. The collected data will be used in conjunction with all existing data to develop a FFS that will support the decision making process related to the groundwater TCE plume under the BRAC property.

Five primary objectives have been identified for this project, and are summarized below. These objectives are as follows:

- Fill data gaps with respect to plume delineation. This will be accomplished by installing seven monitoring wells at selected locations, primarily in the vicinity of Farmers Branch Creek, to more closely define the periphery of the TCE plume near Farmers Branch and at the eastern boundary of the TCE Plume.

- Delineate the location of the paleochannel. Six monitoring wells will be installed 2 to 3 feet into bedrock along the suspected location of the Paleochannel. This delineation will assist in identifying the preferred flow path for the Southern Lobe TCE plume and possibly aid in the selection of a remedial alternative, if needed. These wells will be flow-tested to determine the hydraulic conductivities within the paleochannel.

- Perform aquifer characterization at the NAS Fort Worth JRB and former Carswell AFB property boundary. An existing recovery well at this location will be evaluated for hydraulic conductivity, transmissivity, and specific yield. Dedicated temporary monitoring points will be installed to augment existing monitoring wells for providing pumping drawdown data.

- Evaluate the lithologic characteristics of the Goodland/Walnut confining units underlying the unconsolidated alluvium. Three borings will be advanced through the Terrace Alluvium, the Goodland/Walnut confining units, and into the Paluxy aquifer. Continuous rock cores will be collected from the Goodland/Walnut units and from the Paluxy Formation. Coring will terminate after approximately 15 feet of penetration into the saturated portion of the Paluxy aquifer. The rock cores will be described per the FSP. Monitoring wells will be installed in the borings and screened only within the Paluxy aquifer. Groundwater sampling of the Paluxy aquifer wells will determine whether contaminated groundwater has infiltrated from the Terrace Alluvium.

- Perform an aqueduct assessment. The assessment will consist of evaluating the following: aqueduct construction, subsurface setting, and condition of the aqueduct including possible contaminant entry points (e.g. storm sewers, AFP 4 surface water, groundwater infiltration). The assessment will be performed by a physical examination of the aqueduct consisting of a walk-through and surrounding site survey.

3.2 FIELD INVESTIGATION TASKS

The proposed field tasks described in the following sections will be conducted to achieve the investigation objectives listed in Section 3.1. The field tasks described in the following sections were selected based on the type of data needed to complete the data collection process.

The following section provides a reference to all historic investigative activities performed in relation to the Southern Lobe TCE plume and all investigative activities proposed by HydroGeoLogic, Inc. Suggested monitoring well locations may shift due to localized site-specific conditions such as utilities, fences, and structures encountered during the field implementation.

Mobilization to the field is expected to begin as soon as the Work Plan is approved. Several basic requirements for conducting field activities have already been established. Contractor photographic identification badges have been obtained for lead personnel who will escort subcontractors to and from restricted areas. The field office and primary staging area for field equipment and supplies will be located at 6560 White Settlement Road, NAS Fort Worth JRB, Texas.

3.2.1 Additional Plume Delineation

Seven additional monitoring wells will be installed within the Southern Lobe TCE Plume to provide a comprehensive delineation of the extent of the VOC plume in the vicinity of Farmers Branch Creek and along the southeastern boundary of the plume. The proposed boring locations are illustrated on Figure 3.1. Six of the wells will be installed within the boundaries of the Former Carswell AFB. All monitoring wells will be installed to bedrock [approximately 35 feet below ground surface (bgs)] and screened within the Terrace Alluvium. Six of the wells will be installed near areas of bedrock lows and generally north of Farmers Branch Creek. The bedrock lows appear to correspond with the paleochannel and represent a potential preferred pathway for groundwater flow and also dissolved contaminant transport. The remaining monitoring well will be installed outside the Former Carswell AFB property at the junction of Route 183, White Settlement Road, and Roaring Springs Road. This is thought to correspond with the downgradient, southeastern extent of the TCE plume. A wooded area prohibits the monitoring well to be located directly off the property boundary. Therefore, the well will be placed in the right-of-way to White Settlement Road instead. All monitoring well locations are pictured in an attachment to the FSP. Soil samples will only be collected is visible staining or high photoionization detector (PID) readings are noted. Any soil sample collected will be submitted for VOC analysis by Method 8260B.

The monitoring wells will be installed as 2-inch polyvinyl chloride (PVC) wells with 10 feet of screen set at bedrock. The wells will be developed after installation then purged (low flow)

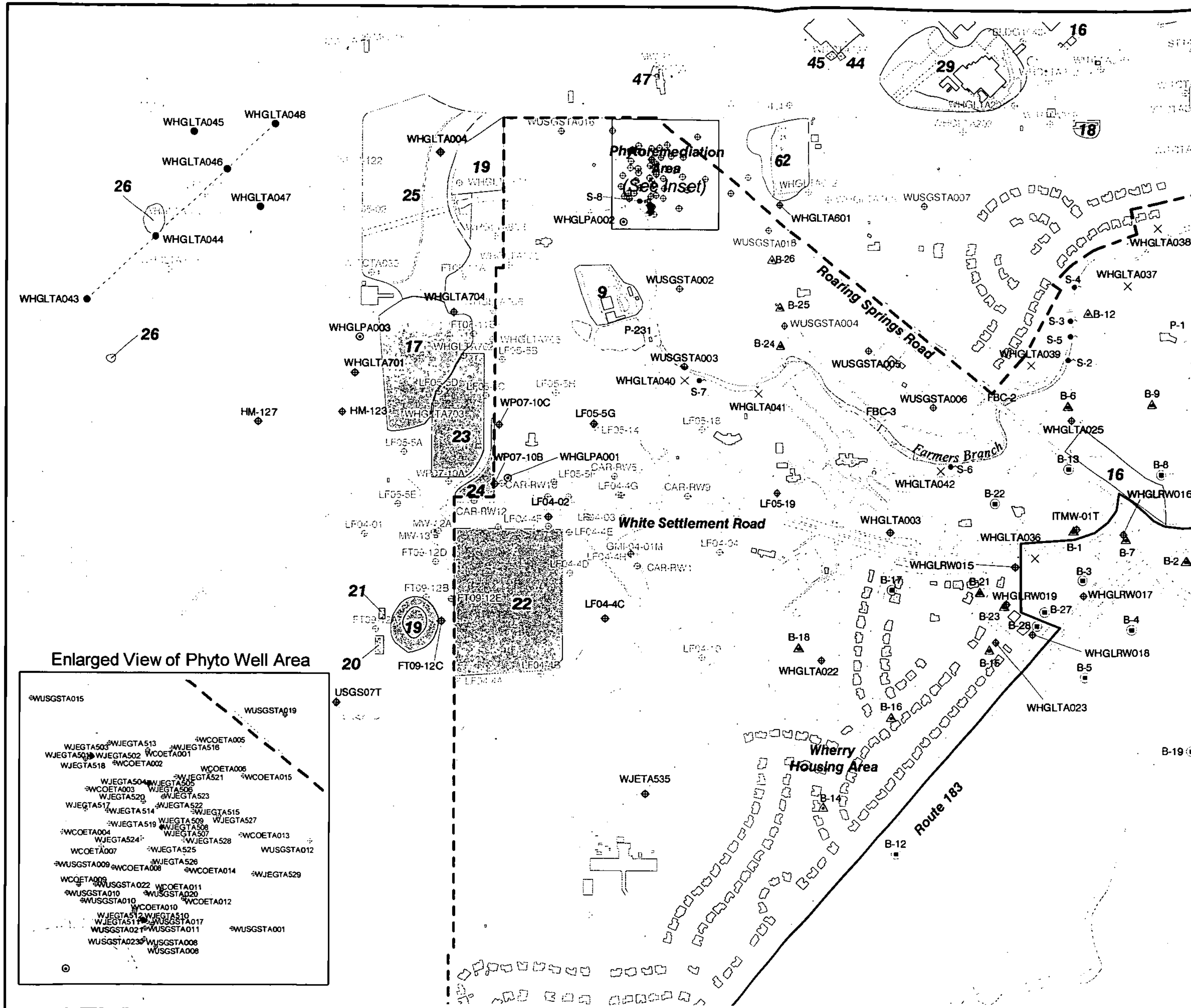

Figure 3.1

Proposed Well Locations NAS Fort Worth JRB

U.S. Air Force Center For Environmental Excellence

Legend

- NAS Fort Worth JRB Boundary (Carswell Field)
- Former Carswell Air Force Base Boundary
- Plume Monitoring Wells
- Monitoring Wells Installed in 1999 for the Southern Lobe TCE Plume Delineation
- Phyto Remediation Monitoring Wells
- Other Monitoring Wells
- Proposed TCE Delineation Wells
- Proposed Paluxy Wells
- Proposed Paleochannel Wells
- 1998 Boring Locations
- 1998 Boring/Temporary Piezometer Locations
- Seep/Spring Locations
- Area of Concern
- Solid Waste Management Unit

400 0 400 800
SCALE IN FEET

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Created: 01/11/00 jbelcher
Revised: 08/15/00 jb
Map Source: HGL ArcView GIS Database

HYDRO GeoLogic INC.

and sampled for VOCs in groundwater by Method 8260B. The wells will be sampled a second time approximately 2 months after the initial sampling.

3.2.2 Paleochannel Delineation and Aquifer Flow Testing

Six paleochannel monitoring wells will be installed along the suspected trace of the buried paleochannel. The locations of the paleochannel wells are illustrated on Figure 3.1. The wells will be set to a depth of approximately 35 feet bgs and will penetrate two to three feet into the underlying bedrock. The wells will be installed as 2-inch PVC wells screened throughout the entire thickness of the saturated portion of the Terrace Alluvium and extending 3 feet into the underlying bedrock. Soil samples will be collected and analyzed for VOCs only if visible staining or high photoionization detector readings (>50 ppm) are measured above the water table. Following well installation and development, the wells will be purged and sampled (low flow) for VOCs in groundwater by Method 8260B. The wells will be sampled a second time approximately 2 months after the initial sampling.

The six paleochannel wells will be used for flowmeter testing following the first groundwater sampling event. Flowmeter testing will be conducted in the six newly installed wells to determine vertical hydraulic conductivity profiles for each well. An Electromagnetic Borehole Flowmeter will be used to determine the ambient flow profiles in the wells. The ambient flow profiles will be collected at 1-foot intervals within the wells over the saturated thickness of the aquifer. After the ambient profiles are obtained, a sustained rate pump test will be performed on the wells to determine the hydraulic conductivity and transmissivity of the Terrace Alluvium in the vicinity of the wells. The flow profiles and the hydraulic conductivity profiles will be used to develop and evaluate remedial alternatives during the ongoing FFS.

3.2.3 Aquifer Testing

An aquifer test will be performed at recovery well CAR-RW10 for purposes of evaluating the hydraulic characteristics of the paleochannel. The location of the aquifer test area is shown on Figure 3.2. Well CAR-RW10 is situated at the boundary of the NAS Fort Worth JRB, adjacent to the former Carswell AFB golf course. Well CAR-RW10 is located in an area of the southern lobe TCE plume which has historically been associated with the highest VOC concentrations. The TCE plume extends east of CAR-RW10, into a portion of the former Carswell AFB property falling under the BRAC program. As part of the ongoing FFS, groundwater remedies focused on mitigating the further release of VOCs onto the BRAC property will be developed. The results of the aquifer testing will support the selection of suitable technologies, the design of appropriate remedial alternatives, and the evaluation of remedial alternative effectiveness.

The data obtained during the test will be used to calculate the aquifer transmissivity (T) and specific yield (S). Several analysis methods will be applied to evaluate the aquifer test data including: the Neuman solution for unconfined aquifers, the Cooper-Jacob straight-line method, and the Theis solution. Three temporary monitoring wells will be installed at 15, 30,

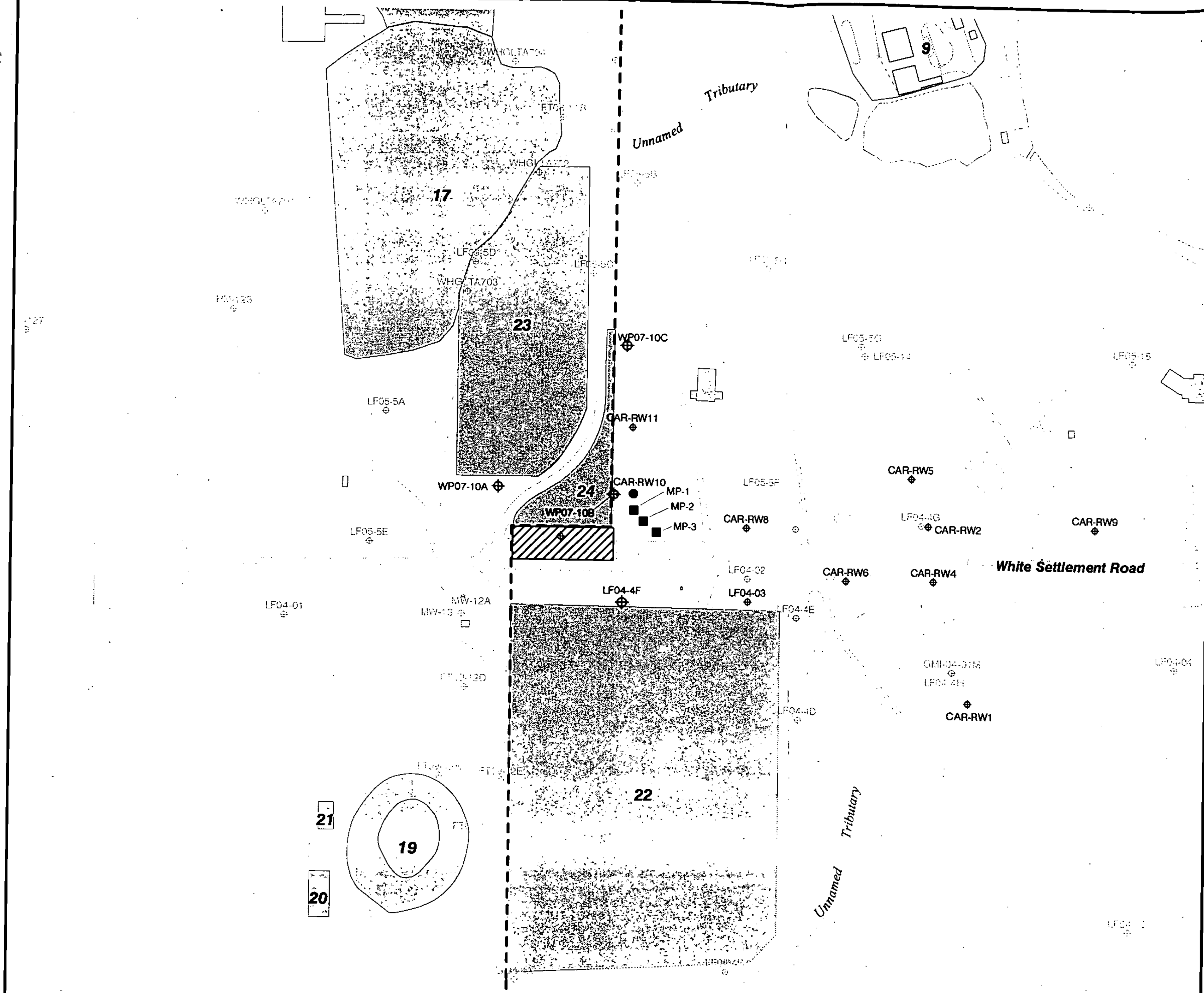

Figure 3.2

Aquifer Test Location
NAS Fort Worth JRB

U.S. Air Force Center For Environmental Excellence

Legend

- NAS Fort Worth JRB Boundary (Carswell Field)
- Former Carswell Air Force Base Boundary
- Pumping Well
- Aquifer Test Wells
- Other Recovery Wells
- Other Monitoring Wells
- Monitoring Point
- Groundwater Treatment System
- Area of Concern
  - 9 Golf Course Maintainence Yard
- Solid Waste Management Unit
  - 17 Landfill No. 7
  - 19 Fire Training Area No. 2
  - 20 Waste Fuel Storage Area
  - 21 Waste Oil Tank
  - 22 Landfill No. 4
  - 23 Landfill No. 5
  - 24 Waste Burial Area

N

100 0 100 200
SCALE IN FEET

Filename: X:\Afc001\36ac\Report\aquifer_test.apr
Project: AFC001-36AC
Created: 01/11/00 jbelcher
Revised: 08/07/00 jb
Map Source: HGL ArcView GIS Database

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and 45 feet from the pumping well to measure drawdown (i.e., the difference between ambient and stressed water levels) during the aquifer test (Figure 3.2). These monitoring wells will be installed to a depth of approximately 35 feet below grade using either a mud rotary or hollow stem auger drilling rig and will be screened across the entire saturated thickness of the aquifer. The only existing monitoring wells within the expected radius of influence are wells WP07-10A, WP07-10B, WP07-10C, and LF04-4F. Calculations will be performed prior to conducting the test. These wells are approximately 25 feet from CAR-RW10 and will be used in conjunction with the three dedicated monitoring points for drawdown observations. Using multiple observation wells provides greater opportunity for evaluating aquifer heterogeneity and/or anisotropy.

The aquifer test will consist of performing a 72-hour constant-rate pumping test using well CAR-RW10 as the pumping well. Prior to performing the constant rate test, a one-day variable-rate pumping test (i.e., step test) will be performed to determine the optimal pumping rate for the subsequent constant-rate test. During the step test, water will be withdrawn from well CAR-RW10 at three different rates. During each discrete step, the pumping rate will be maintained at a constant rate for 4 hours. At the end of the first two 4-hour time periods, the rate will be increased. The initial pumping rate that will be maintained during the first step will be approximately 5 gpm. The pumping rates for the following two time periods will be determined in the field. The pumping rate for the final step should be close to the maximum pumping rate that can be sustained in the pumping well. After the completion of the last 4-hour pumping period, the pump will be shut off and water levels will be allowed to recover. Groundwater drawdown in the pumping well and three dedicated monitoring points will be measured during the test and during the subsequent recovery period. The step test will be analyzed using the aquifer testing software, AqteSolve, which allows the evaluation of variable-rate pumping test data. In addition, the specific capacity of the well will be calculated. Based on these analyses, a target pumping rate will be selected for the constant-rate test.

Once a target pumping rate has been determined and water levels in the vicinity of well CAR-RW10 have recovered to ambient conditions, the constant-rate pumping test will be initiated. The pumping rate at CAR-RW10 will be set to the target pumping rate and allowed to continue uninterrupted at this rate for a period of 72 hours. The recovery well, the three temporary observation wells, and wells WP07-10A, WP07-10B, WP07-10C, and LF04-4F will be measured for changes in water levels as specified in the FSP. Pressure transducers capable of recording changes in groundwater levels will be used to monitor water levels in the pumping well and five observation wells. The pressure transducers will provide uninterrupted monitoring data throughout the duration of the variable-rate and constant-rate tests.

Prior to initiating the aquifer tests (i.e., variable-rate and constant-rate tests), at least 24-hours of background water levels will be collected in the pumping and observation wells. During this 24-hour period and during the aquifer tests, barometric pressure data will be collected in the vicinity of the test. If there is an existing weather station, located within 10-miles of the test site, then an attempt will be made to obtain data from this weather station for the test period. This will eliminate the need to measure and record barametric pressure during the aquifer tests. The background water-level and the barametric pressure data may be used to correct the aquifer test data for climatic changes that may occur during the test.

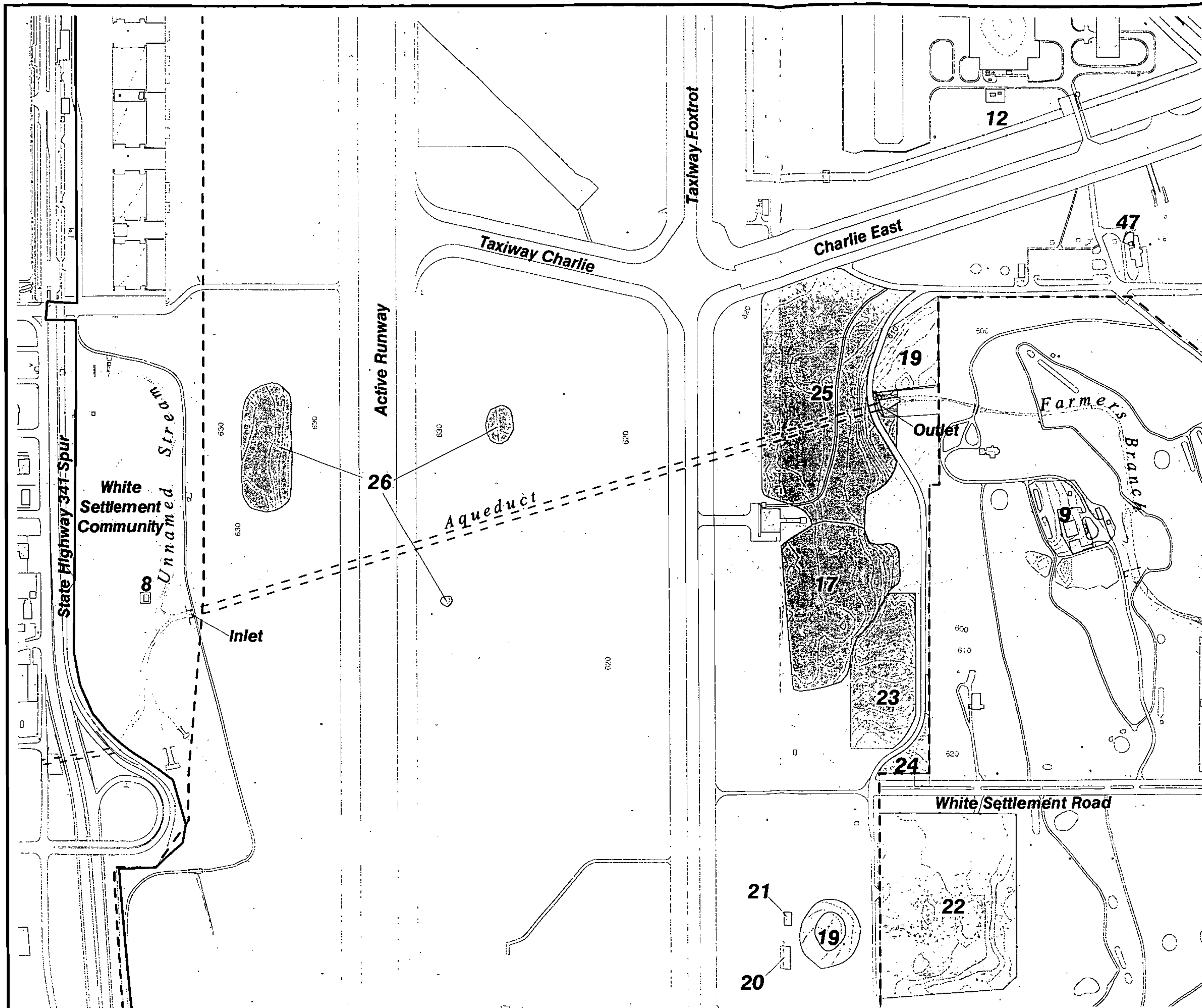
3.2.4 Lithologic Evaluation of Bedrock and Paluxy Aquifer Wells

The lithologic evaluation will consist of obtaining rock core from the entire thickness of the Goodland/Walnut confining units located beneath the Terrace Alluvium. The borings/core will continue 15 feet into the saturated portion of the underlying Paluxy Formation. The Goodland/Walnut and Paluxy cores will be collected from three borings located within the NAS Fort Worth JRB and Former Carswell AFB boundaries. The proposed core locations are illustrated on Figure 3.1. A description of the cores will be provided as specified in the FSP. Special emphasis will be placed on evaluating the competency of the Goodland/Walnut Formations in terms of their ability to restrict the flow of groundwater from the Terrace Alluvium Aquifer to the Paluxy Aquifer. Soil samples may be collected during the drilling of these wells if evidence of soil contamination is observed (e.g., soil staining, sheen, or elevated PID readings). If evidence of VOC contamination is found within a given boring, then one soil sample will be collected within that boring at a depth that corresponds with the highest PID reading. The sample will be analyzed for VOCs using Method 8260A. No chemical analyses will be performed on the rock cores.

The three borings will be completed as groundwater monitoring wells. The monitoring wells will be screened only within the Paluxy Formation. A metal outer casing will be advanced through the Terrace Alluvium and into the weathered upper portion of the Goodland/Walnut unit to seal the Paluxy wells from the alluvium groundwater. The monitoring wells will be installed as 2-inch PVC wells with approximately 15 feet of well screen. The wells will be developed after installation then purged (low flow) and sampled for VOCs in groundwater by Method 8260B. The wells will be sampled a second time approximately 2 months after the initial sampling.

3.2.5 Aqueduct Assessment

An aqueduct assessment will be performed on the subterranean aqueduct located beneath the runway and main flightline area of NAS Fort Worth JRB (Figure 3.3). The aqueduct consists of two large drainage culverts buried beneath the flightline area. The aqueduct is located south of AFP 4 and bisects the NAS Fort Worth JRB runway in a generally east-west direction. The aqueduct allows Farmers Branch Creek to flow east from the White Settlement community, across the NAS Fort Worth JRB, through the proposed BRAC area, and ultimately to the West Fork of the Trinity River where the creek discharges. The majority of flow within Farmers Branch Creek is generated from surface runoff that discharges directly to the creek and from surface runoff that is collected by storm drains that discharge into the Aqueduct. The remaining flow within Farmers Branch is generated from groundwater recharge derived from the local Terrace Alluvium Aquifer. Farmers Branch Creek is also fed by intermittent, unnamed tributaries prior to its entrance into the aqueduct and after its emergence within the golf course area.



HydroGeoLogic, Inc.—Work Plans
Data Gap Investigations of the Southern Lobe TCE Plume
NAS Fort Worth JRB, Texas

Figure 3.3

Aqueduct Location
NAS Fort Worth JRB

U.S. Air Force Center For Environmental Excellence

Legend

- NAS Fort Worth JRB Boundary (Carswell Field)
- Former Carswell Air Force Base Boundary
- Elevation Contour (2ft. Contour)

Area of Concern

8 Aerospace Museum
9 Golf Course Maintainence Yard
12 Oil/Water Separator
19 Suspected Former Fire Training Area

Solid Waste Management Unit

17 Landfill No. 7
19 Fire Training Area No. 2
20 Waste Fuel Storage Area
21 Waste Oil Tank
22 Landfill No. 4
23 Landfill No. 5
24 Waste Burial Area
25 Landfill No. 8
26 Landfill No. 3
47 Building 1015 Jet Engine Test Cell Oil/Water Separator

N

300 0 300 600
SCALE IN FEET

Filename: X:\Afc001\19bd\Report\aqueduct.apr
Project: AFC001-19BD
Created: 06/30/00 jbelcher
Revised: 08/15/00 jb
Map Source: HGL ArcView GIS Database

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The aqueduct will be assessed to evaluate its potential contribution to the southern lobe TCE plume and its effect on local groundwater flow, if any. The assessment will include a literature search that will focus on obtaining the following information: 1) construction details; 2) hydraulic characteristics; 3) identification of breaks in the pipes; and 4) identification of features that may permit the flow of contaminated groundwater into the aqueduct. In addition to the completion of the literature search, an intrusive evaluation of the aqueduct will be completed. This will consist of walking through the two aqueduct pipes and video taping the entire section of the aqueduct. The literature search and aqueduct "walk through" may be used during the FFS to develop remedial alternatives that are focused on reducing contaminant concentrations in Farmers Branch Creek. The four storm sewer lines that feed into the aqueduct will be sampled as well as any areas where groundwater is infiltrating into the aqueduct.

4.0 DATA ASSESSMENT, RECORDS, AND REPORTING REQUIREMENTS

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

4.1 DATA ASSESSMENT

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

- **Sample Analysis Completeness** - Were all samples analyzed? Were samples analyzed for the parameters listed in the work plans?
- **Evaluation of Holding Times** - Were samples analyzed within the specified holding and extraction times?
- **Evaluation of QC**- Were standard curves within method control limits? Were preparation and method blanks contaminated? Were continuing calibration standards in control? Were matrix spikes (MSs) and matrix spike duplicates (MSDs) performed? How did field duplicates compare? Were corrective actions taken?
- **Establishment of Detection Limits** - Were detection limits met? If not, why?

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

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

If any data points are qualified, they will receive the data qualifiers described on Table 8.2-1 of the Base-Wide Quality Assurance Project Plan (HydroGeoLogic, 2000). The data associated with compounds/analytes that exhibit either poor response, poor percent difference, or relative percent difference in the initial calibration or continuing calibration standards, or poor recoveries in the laboratory control sample are considered quantitative estimates and are flagged (J, UJ, or R) accordingly. If the internal standard (IS) or surrogate fails criteria (after corrective action was taken), compounds associated with the IS or surrogates would be flagged (J, UJ, or R) as estimated. If sample analysis exceeded holding times, the data would be flagged as estimated (J, UJ, or R). If the method blank was contaminated with common laboratory chemicals or field contamination, any result less than or equal to 10 times that found in the blank would be flagged as estimated (U) (for common organics, less than or equal to 5 times for uncommon organics and for any inorganics). When data exhibit several deficiencies resulting in poor quality assurance and QC support, then the data is rejected, considered unusable, and flagged with an "R." Any MS/MSD data would be reviewed separately and qualified based on all the data available. Estimated data is not necessarily unusable data. All project-wide precision, accuracy, and completeness goals will be reviewed, and the data will be validated according to these goals. If these goals are not met, resampling and analysis may be necessary.

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

- **Field Record Completeness**: Were all field analyses performed as planned? Were all field samples collected as directed in the work plans? Were any problems encountered and how were they resolved? Were all field records complete?

- **Sampling and Decontamination Procedures Review**: Were all field duplicates collected? How did they compare? Were all rinsates collected? Did these rinsates show contamination? Were the trip blanks contaminated? Did samples arrive intact and in proper shipping protocol?

- **Identification of Valid Samples**: Were samples collected using the proper protocol? Were there probable sources of potential contamination during sampling?

- **Correlation of Field Test Data and Identification of Anomalous Field Test Data**: Did different methods of measurement for the same test correlate?

Review of the results of the field QC data such as rinsates, trip blanks, and duplicates can help in assessing sample integrity. The field data and laboratory data will be reviewed and evaluated to the established data quality objectives. Data quality evaluations will be performed on all NAS Fort Worth JRB samples (100 percent). However, formal data validation will only be conducted on 10 percent of the samples collected from each media of concern during this investigation.

4.2 RECORD KEEPING

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

4.3 REPORTING REQUIREMENTS

A draft report will be completed after all data gap activities identified in this Work Plan are accomplished. The information gathered during the data gap activities will be used to complete the Focused Feasibility Study and Risk Assessment for the BRAC property that surrounds the Carswell Golf Course. The conclusions of the data gap investigation will be presented to the regulatory community and will be summarized within the FFS.

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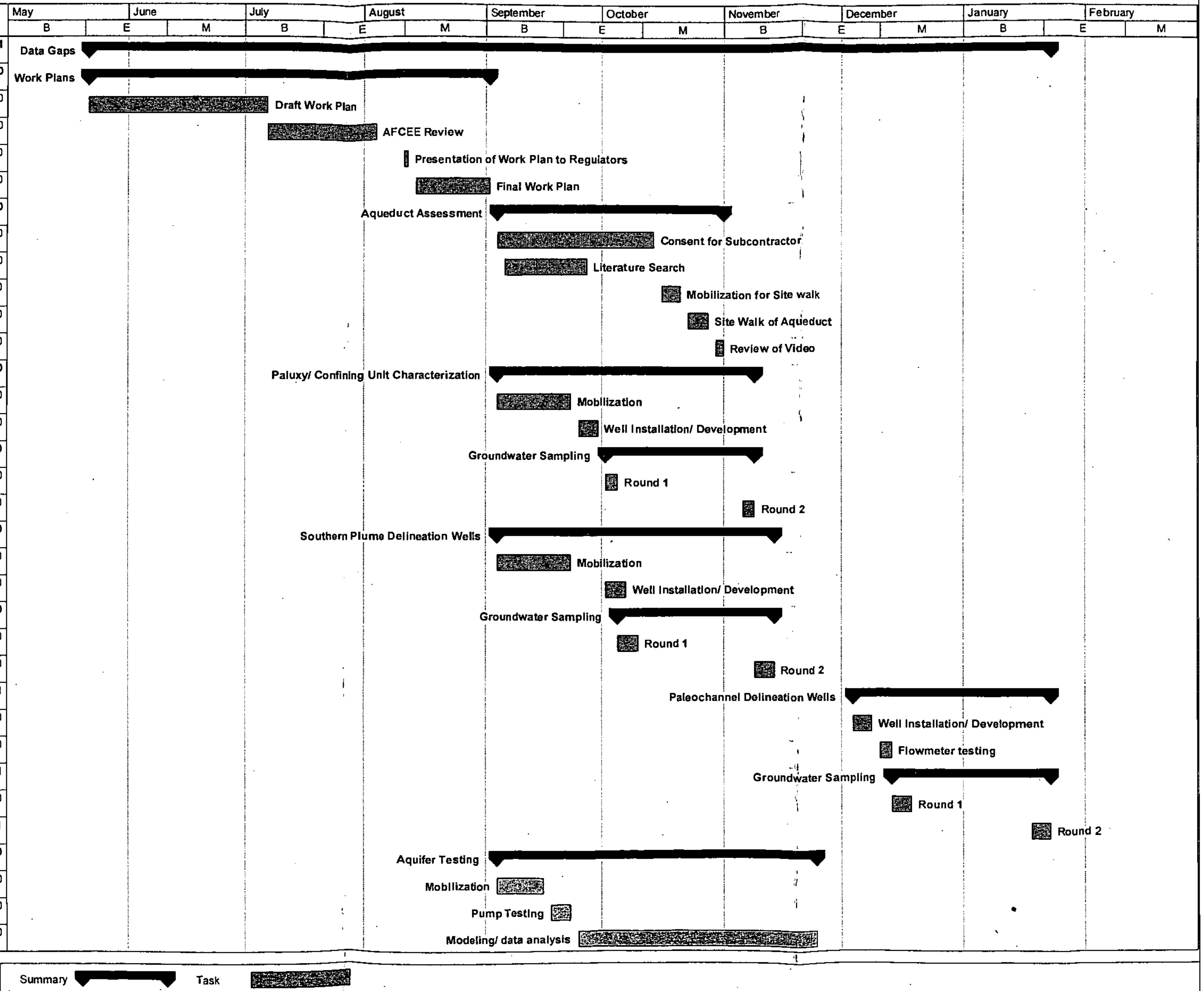
5.0 PROJECT SCHEDULE

The activities described in this Work Plan will be implemented in accordance with the schedule provided in Figure 5.1. The starting date for the field effort will be the date of agency concurrence of the Work Plan. If possible, this schedule will be accelerated with select activities (e.g., procurement of materials and supplies) occurring when resolution of technical issues, if any, is accomplished between NAS Fort Worth JRB and regulatory agencies.

Figure 5.1
Focused Feasibility Study Schedule

ID	Task Name	Duration	Start	Finish
1	**Data Gaps**	**176 days**	**5/22/00**	**1/22/01**
2	**Work Plans**	**75 days**	**5/22/00**	**9/1/00**
3	Draft Work Plan	34 days	5/22/00	7/6/00
4	AFCEE Review	20 days	7/7/00	8/3/00
5	Presentation of Work Plan to Regulators	1 day	8/11/00	8/11/00
6	Final Work Plan	15 days	8/14/00	9/1/00
7	**Aqueduct Assessment**	**42 days**	**9/4/00**	**10/31/00**
8	Consent for Subcontractor	30 days	9/4/00	10/13/00
9	Literature Search	15 days	9/6/00	9/26/00
10	Mobilization for Site walk	5 days	10/16/00	10/20/00
11	Site Walk of Aqueduct	5 days	10/23/00	10/27/00
12	Review of Video	2 days	10/30/00	10/31/00
13	**Paluxy/ Confining Unit Characterization**	**48 days**	**9/4/00**	**11/8/00**
14	Mobilization	15 days	9/4/00	9/22/00
15	Well Installation/ Development	5 days	9/25/00	9/29/00
16	**Groundwater Sampling**	**28 days**	**10/2/00**	**11/8/00**
17	Round 1	3 days	10/2/00	10/4/00
18	Round 2	3 days	11/6/00	11/8/00
19	**Southern Plume Delineation Wells**	**51 days**	**9/4/00**	**11/13/00**
20	Mobilization	15 days	9/4/00	9/22/00
21	Well Installation/ Development	5 days	10/2/00	10/6/00
22	**Groundwater Sampling**	**28 days**	**10/5/00**	**11/13/00**
23	Round 1	3 days	10/5/00	10/9/00
24	Round 2	3 days	11/9/00	11/13/00
25	**Paleochannel Delineation Wells**	**36 days**	**12/4/00**	**1/22/01**
26	Well Installation/ Development	5 days	12/4/00	12/8/00
27	Flowmeter testing	3 days	12/11/00	12/13/00
28	**Groundwater Sampling**	**28 days**	**12/14/00**	**1/22/01**
29	Round 1	3 days	12/14/00	12/18/00
30	Round 2	3 days	1/18/01	1/22/01
31	**Aquifer Testing**	**60 days**	**9/4/00**	**11/24/00**
32	Mobilization	10 days	9/4/00	9/15/00
33	Pump Testing	5 days	9/18/00	9/22/00
34	Modeling/ data analysis	45 days	9/25/00	11/24/00



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TAB

Field Sampling Plan

527 58

FINAL
FIELD SAMPLING PLAN
DATA GAP INVESTIGATION
OF THE SOUTHERN LOBE TCE PLUME
NAS FORT WORTH JRB, TEXAS

Prepared for

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

Contract Number F41624-95-D-8005

Prepared by

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

August 2000

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LIST OF ACRONYMS AND ABBREVIATIONS

3-D	three-dimensional
AFB	Air Force Base
AFCEE	U.S. Air Force Center for Environmental Excellence
AFP 4	Air Force Plant 4
ASTM	American Society for Testing and Materials
bgs	below ground surface
BRAC	Base Realignment and Closure
°C	degrees Celsius
CFR	Code of Federal Regulations
COC	chain-of-custody
DO	dissolved oxygen
DPT	direct push technology
EC	electrical conductivity
EPA	U.S. Environmental Protection Agency
ERPIMS	Environmental Restoration Program Information Management System
FFS	Focused Feasibility Study
FSP	Field Sampling Plan
gpm	gallons per minute
HSA	hollow stem auger
HSO	Health and Safety Officer
HSP	Health and Safety Plan
HydroGeoLogic	HydroGeoLogic, Inc.
IDW	investigative derived waste
IRP	Installation Restoration Program
IT	IT Corporation
JRB	Joint Reserve Base
L/min	liter per minute
MS	matrix spike
MSD	matrix spike duplicate

LIST OF ACRONYMS AND ABBREVIATIONS

NAS	Naval Air Station
NTU	nephelometric turbidity unit
ORP	oxidation-reduction potential
OVA	organic vapor analyzer
OVM	organic vapor monitor
PID	photoionization detector
PM	Project Manager
POC	point-of-contact
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
SVOC	semi volatile organic compound
TAC	Texas Administrative Code
TCE	trichloroethene
TNRCC	Texas Natural Resource Conservation Commission
USAF	United States Air Force
USCS	United Soil Classification System
VOC	volatile organic compound

FINAL
FIELD SAMPLING PLAN
DATA GAP INVESTIGATIONS
NAS FORT WORTH JRB, TEXAS

1.0 INTRODUCTION

The Field Sampling Plan (FSP) presents the requirements and procedures for conducting field operations and investigations. This project specific FSP has been prepared to ensure that (1) the data quality objectives specified for this project are met, (2) the field sampling protocols are documented and reviewed in a consistent manner, and (3) the data collected are scientifically valid and defensible. This site specific FSP and the Basewide Quality Assurance Project Plan (QAPP) (HydroGeoLogic Inc. [HydroGeoLogic], 2000), shall constitute, by definition, the Sampling and Analysis Plan.

Guidelines followed in the preparation of this plan are set out in the U.S. Air Force Center for Environmental Excellence's (AFCEE) *Model Field Sampling Plan,* (AFCEE, 1997) and the *Handbook for the Installation Restoration Program (IRP) Remedial Investigations and Feasibility Studies* (AFCEE, 1993).

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

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

2.0 PROJECT BACKGROUND

The following sections briefly describe the project objectives and present site descriptions for this FSP.

2.1 SITE HISTORY

Carswell Air Force Base (AFB) was officially closed on September 30, 1993. A parcel of the former Carswell AFB, Naval Air Station (NAS) Fort Worth Joint Reserve Base (JRB), is undergoing transfer from Air Force to Navy management. Other portions of the former Carswell AFB that are not being transferred to the Navy will remain under Base Realignment and Closure (BRAC) management and funding. Before any BRAC property can be transferred to the local community, all required environmental investigations related to USAF activities at the former Carswell AFB property need to be completed.

2.2 PROJECT OBJECTIVES

The overall objective of this project, and purpose of the field investigations, is to gather sufficient data to fully define the extent of the Southern Lobe Trichloroethene (TCE) Plume and gather additional hydrogeologic data from the area of the Southern Lobe TCE Plume to perform a Focused Feasibility Study (FFS). The FFS will address remedial options and present recommended courses of action for proceeding with possible BRAC turnover of the former Carswell AFB property in the area of the Southern Lobe TCE Plume.

In order to obtain the necessary data to complete the FFS, the data collection efforts will consist of the following five activities:

- Install seven additional monitoring wells and collect groundwater samples to fully define the extent of the Southern Lobe TCE Plume.

- Install six additional monitoring wells within the suspected paleochannel to more fully delineate the location of this potential preferred groundwater flow pathway. Perform flow testing within the paleochannel wells to determine hydraulic conductivity within the paleochannel.

- Perform an aquifer test at the NAS Fort Worth JRB and former Carswell AFB area property line to define the specific hydrogeologic conditions at that location.

- Install groundwater monitoring wells in the Paluxy aquifer to: 1) determine if groundwater quality within the Paluxy Formation has been impacted by operations at Air Force Plant 4 (AFP 4) or the former Carswell AFB; and 2) perform a lithologic characterization of the Goodland/Walnut confining units.

- Perform an assessment of the aqueduct associated with Farmers Branch Creek and determine its influence, if any, on the Southern Lobe TCE Plume and on surface-water quality in Farmers Branch Creek.

These tasks are discussed in greater detail in Section 3.2 of the Work Plan. The information obtained from these investigations will be included in the FFS.

Field studies that will be used to obtain the data gap information include the following:

- Continuous soil borings from the ground surface to the top of the water table. Samples will be collected at 5-foot intervals for lithologic description.

- Monitoring well installation and sampling. The soil borings will be advanced to the top of the water table and sampled every five feet for hydrogeologic characterization until bedrock is encountered. The plume delineation borings and paleochannel borings will be completed as monitoring wells for groundwater sampling within the Terrace Alluvium. The deep bedrock monitoring wells will be screened in the Paluxy Aquifer and isolated from the Terrace Alluvium.

- Bedrock core samples will be collected from three locations beneath the Southern Lobe TCE Plume. Continuous core sections will be collected through the entire thickness of the Goodland/Walnut units and approximately 15 feet into the saturated portion of the Paluxy Formation. A lithologic evaluation of the cores will focus on determining whether contaminant pathways potentially exist within the Goodland/Walnut confining units. In addition, all Paluxy wells at NAS Fort Worth JRB and AFP 4 will be gauged.

- A site walk through the aqueduct will be performed during the data gap investigation. The general vicinity of the aqueduct will be evaluated for surface water infiltration sources from the flightline areas and from AFP 4 properties. The walk through will be videotaped for later evaluation and for recordkeeping.

- An aquifer test will be performed in the Terrace Alluvium to determine the hydraulic properties of the paleochannel near the NAS Fort Worth JRB property boundary. A variable-rate pumping test will be conducted to determine the optimal pumping rate for a subsequent constant-rate pumping test. The constant rate pumping test will be conducted for a total of 72 hours.

- Borehole flowmeter tests will be conducted in 6 wells installed near the current NAS Fort Worth JRB taxi way. The flowmeter tests will be conducted to characterize hydraulic conductivity at different depths within the Terrace Alluvium.

2.3 PROJECT SITE DESCRIPTION

NAS Fort Worth JRB is located on 2,555 acres of land in Tarrant County, Texas, 8 miles west of downtown Fort Worth. The portion of the site covered by this FSP is located in the southeastern corner of the former Carswell AFB. The site consists primarily of the former Carswell AFB golf course and base housing area. The area under investigation corresponds to the location of the Southern Lobe TCE Plume that originates primarily from AFP 4.

The location of the TCE plume and investigation areas in relation to the Base is presented on Figure 1.4 of the Work Plan.

2.4 PROJECT SITE CONTAMINATION HISTORY

Section 1.2 of the Work Plan provides the history of past work conducted at the site and documents contamination discovered. Please refer to this section for this information.

3.0 PROJECT SCOPE AND DATA QUALITY OBJECTIVES

The following sections describe the objectives of the data gap investigations and the specific field activities that will be conducted during the investigations.

3.1 DATA QUALITY OBJECTIVES

The data generated by this project must be of sufficient quality and quantity to support the overall project objective: full delineation of the Southern Lobe TCE Plume; hydrogeologic characterization of the plume area; and assessment of the aqueduct. The objectives and focus of this work will be to provide sufficient contaminant and subsurface data to perform a FFS in support of decision making related to the groundwater TCE plume under the property to be potentially transferred.

Data from the following categories are required for the FFS:

- Site Characterization - Data will be used to evaluate physical and chemical properties of soil, bedrock, and groundwater. The data will also be used to characterize the extent of known contaminants at the site. The aqueduct will be evaluated for its influence on the TCE plume or on the local hydrogeology of the area.

- Health and Safety - Data will be used to establish the level of protection needed for the field sampling team and other site-related personnel. This data will be obtained from organic vapor monitor (OVM) and Dräger tube readings recorded during intrusive activities.

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

- Screening Data with Definitive Confirmation - Screening data are generated by rapid, less precise methods of analysis with less rigorous sample preparation. Sample preparation steps may be restricted to simple procedures such as dilution with a solvent, instead of elaborate extraction/digestion and cleanup. Screening data provides analyte identification and quantification. Although the quantification may be determined using analytical methods with QA/quality control (QC) procedures and criteria associated with definitive data, screening data without associated confirmation data are not considered to be data of known quality.

- Definitive Data - Definitive data will be generated using rigorous analytical methods, such as approved EPA reference methods. Data will be analyte-specific, with confirmation of analyte identity and concentration. These methods produce tangible raw data (e.g., chromatograms, spectra, digital values) in the form of paper printouts or computer-generated electronic files. Data may be generated at the site or at an off-site location, as long as the QA/QC requirements are satisfied. For the data to be definitive, either analytical or total measurement error must be determined.

- The data generated by the laboratory analysis of samples must be sufficiently sensitive to allow comparison of the results. The Basewide QAPP (HydroGeoLogic, 2000) describes each method that will be performed as part of the investigation and outlines the QA measures the contract laboratory must follow. The methods of analysis selected for samples collected from NAS Fort Worth JRB will produce screening as well as definitive data. Table 3.1 is a summary of the data quality levels and intended use for data collected during the data gap investigations.

3.2 SAMPLE ANALYSIS SUMMARY

All samples collected as a part of the investigation will be analyzed for volatile organic compounds (VOCs) by EPA Method 8260B. In addition, groundwater from the paleochannel wells will be analyzed for a set of natural attenuation parameters listed in Section 3.3.2.

3.3 FIELD ACTIVITIES

The following sections describe the proposed field investigation activities planned during this study. More detailed descriptions of the rationale and justification for each of the proposed activities are presented in Section 3.0 of the Work Plan.

The proposed field tasks described in this FSP will be conducted to achieve the project objectives as presented in Section 2.2. Field investigative activities will be conducted in and near the former Carswell AFB property outside of the present NAS Fort Worth JRB. The site consists primarily of a golf course and former base housing area. The paleochannel wells will be installed upgradient of this area close to the flightlines for NAS Fort Worth JRB. Table 3.2 provides a summary of the field activities and Table 3.3 presents the number of soil and groundwater samples to be collected and the analytical methods to be performed during the field investigation.

3.3.1 Southern Lobe Plume Delineation

Seven monitoring wells will be installed within the Southern Lobe TCE Plume to provide a comprehensive delineation of the plume extent and concentration boundaries. Six of the wells will be installed within the boundaries of the former Carswell AFB. The remaining monitoring well will be installed outside the NAS Fort Worth JRB property at the junction of Route 183, White Settlement Road, and Roaring Springs Road. The proposed well locations are illustrated on Figure 3.1 of the Work Plan and Attachment A. The final well locations may deviate slightly from the proposed locations due to cultural influences such as buildings, overhead lines, or buried

Table 3.1
Data Quality Levels and Intended Use for Field and Laboratory Data

Sampling Matrix	Parameters[a]	Analytical Method	Field/Lab Analysis	Data Quality Level	Intended Use
Surface Soil Subsurface Soil	VOCs VOCs	PID PID	Field Field	Screening	Field screening for selecting samples for lab analysis To differentiate the stratigraphy, to identify buried waste
Soil	VOCs	8260B	Lab	Definitive	Nature/extent of contaminants, risk assessment, corrective measures study
Groundwater	VOCs Alkalinity Anions Ethane, Ethene, Methane	8260B SW310.1 SW9060 RSK-175	Lab Lab Lab Lab	Definitive Definitive Definitive Definitive	Nature/extent of contaminants, risk assessment, corrective measures study

[a] VOCs - Volatile Organic Compounds

Table 3.2
Field Activities Summary
NAS Fort Worth JRB, Texas

Mud-Rotary Paluxy Borings	Mud-Rotary Paleochannel Borings	HSA Southern Plume Delineation Borings	DPT/HSA Aquifer Test Borings	Monitoring Wells (Total)	Borings (Total)
3	6	7	3	**19**	**19**

Notes:
HSA - hollow stem auger
DPT - direct push technology

Table 3.3
Soil and Groundwater Sample Analysis Summary
NAS Fort Worth JRB, Texas

Data Gap	Method	Matrix	No. of Samples[1]	No. of Equipment Blanks[2]	No. of Ambient Blanks[3]	No. of Trip Blanks[4]	No. of Field Duplicates[5]	No. of MS/MSD[6]	Total No. of Samples
Plume Delineation	SW8260B	Soil	7	1	1	2	1	1/1	14
Paleochannel Delineation	SW8260B	Soil	6	1	1	2	1	1/1	13
Paluxy Wells	SW8260B	Soil	3	1	1	1	1	1/1	9
Plume Delineation	SW8260B	Groundwater	7	1	1	1	1	1/1	13
Paleochannel Delineation	SW8260B, SW310.1, SW9060, RSK-175	Groundwater	6	1	1	1	1	0	10
Paluxy Aquifer	SW8260B	Groundwater	3	1	1	1	1	0	8

Notes:

1 Soil samples must be collected every 5 feet from the surface to the groundwater for lithologic evaluation. The actual number of soil samples submitted for analysis will vary based on the observations made in the field. Monitoring wells to be sampled for three consecutive rounds 2 months apart.

2 Sites where only one boring will be sampled will be paired with a QC sample from another boring. One equipment blank will be taken per day, per analysis.

3 Ambient blanks for VOCs will only be sampled if VOCs are detected by the photoionization detector (PID) during a sampling effort. One ambient blank will be collected at the beginning of the field investigation for soil.

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

5 Field duplicates collected on a 10% basis of investigation samples.

6 MS/MSDs collected on a 5% basis of investigation samples.

utilities. The monitoring wells will be installed using hollow stem auger (HSA) drilling techniques described in Section 5.4. All monitoring wells will be installed to bedrock (approximately 15 to 35 feet below ground surface [bgs]) and screened within the Terrace Alluvium. Six of the wells will be installed near areas of bedrock lows (as depicted by the arrows in Figure 2.7 of the Work Plan) and at points north of Farmers Branch Creek. The bedrock lows, which appear to correspond with the location of a paleochannel, provides a potential preferred pathway for dissolved contaminant transport. The monitoring well installed outside of the former Carswell AFB perimeter will be used to monitor any potential off-site migration from the AFP 4 source area of the TCE plume. During well installation, soil samples may be collected for VOCs analysis if any staining or high photoionization detector (PID) readings are observed in soil above the water table.

The monitoring wells will be installed as two-inch polyvinyl chloride (PVC) wells with 10 feet of screen set at bedrock. The wells will be developed after installation, then purged and sampled (low flow) for VOCs in groundwater by Method 8260B. The wells will be sampled a second time approximately 1 month after the initial sampling. All drilling, soil screening, and sample collection activities will be performed in accordance with Sections 5.0, 6.0, and 7.0 of this FSP.

3.3.2 Paleochannel Delineation and Flowmeter Testing

Six paleochannel monitoring wells will be installed along the suspected trace of the buried paleochannel. The locations of the paleochannel wells are illustrated on Figure 3.1 of the Work Plan. The wells will be set to a depth of approximately 45 feet bgs and will penetrate two to three feet into the underlying bedrock. The wells, which will be installed using 2-inch PVC, will be screened throughout the entire thickness of the saturated portion of the Terrace Alluvium and extend two to three feet into the bedrock. A HSA drill rig will be used to install the wells per procedures identified in Section 5.4 of this FSP. Unless evidence of VOCs is observed during the drilling (i.e., detected in vapors, staining, etc.), soil samples will not be collected for laboratory analyses. Wells will be developed after installation until the approved stabilization parameters are met (Section 5.5). Following well development, the wells will be purged and groundwater sampled (low flow) for VOCs by Method 8260B and for the following natural attenuation parameters: common anions (EPA Method SW 9060), methane, ethane, ethene (Method RSK-175), and alkalinity (EPA Method 310.1), as well as several standard field parameters.

The six paleochannel wells will be used for flowmeter testing following the groundwater sampling event. Flowmeter testing will be conducted to determine vertical hydraulic conductivity profiles for each well. An electromagnetic borehole flowmeter will be used to determine the ambient flow profiles in the wells. The ambient flow profiles will be collected in each well at one-foot intervals over the saturated thickness of the aquifer. After the ambient profiles are obtained, a sustained rate pump test will be performed on the wells to determine their vertical conductivity profiles. A submersible Grundfos® positive displacement pump with adjustable flow control will be used to perform the groundwater pumping. A portable generator will be used to provide power to the pump. Pumped groundwater will be discharged to the sanitary sewer. The flow profiles recorded for each well, as well as the hydraulic conductivity profiles, will be computed and used in developing a remedial strategy for FFS development. It will take approximately one week to perform flow tests for the six wells.

3.3.3 Aquifer Testing

An aquifer test will be performed at recovery well CAR-RW10 or a nearby monitoring well (Figure 3.2 of the Work Plan) for purposes of evaluating the aquifer characteristics at this location. Well CAR-RW10 is situated at the boundary of the NAS Fort Worth JRB, adjacent to the former Carswell AFB golf course. Well CAR-RW10 is located in an area of the Southern Lobe TCE Plume which has historically contained some of the highest concentrations of dissolved chlorinated hydrocarbons. The results of the aquifer test will be used to support the development and evaluation of remedial alternatives during the FFS.

The existing recovery well infrastructure will be used to perform the aquifer test. The in-well recovery pump installed in CAR-RW10 will be used to extract groundwater from the well. Flow from the well will be controlled by opening or closing the discharge gate valve located downstream of the well and upstream of the flow totalizer. The recovery well's totalizer will be used to monitor flow rate and total gallons of water pumped. No special discharge arrangements or permitting is need. The recovery well's discharge will be sent directly to the on-site treatment system. Arrangement will be made with ASC and IT Corporation (the long term operator) to use the recovery well and treatment system for the duration of the test (approximately one week). Other recovery wells within a 500-foot radius of CAR-RW10 will be shut down for the duration of the test to avoid interference.

Three monitoring points will be installed at 25, 50, and 75 feet from the pumping well (CAR-RW10) to measure drawdown at these distances. The monitoring points will be installed to approximately 35 feet bgs and will be screened across the entire saturated thickness of the aquifer. The only existing monitoring well within the expected radius of influence is well WP07-10B, WP07-10C, and LF04-4F will also be monitored, although no drawdown is anticipated in these wells. WP07-10B is approximately 40 feet from CAR-RW10 and will be used in conjunction with the dedicated monitoring points for drawdown observations. Using multiple observation wells provides greater opportunity for evaluating aquifer heterogeneity and/or anisotropy. The monitoring points will be installed with a HSA rig. Alternatively, monitoring points may be installed using direct push technology (DPT) pending scheduling of field events and availability of a HSA drill rig. The monitoring points will consist of 1-inch schedule 40 PVC casing with 0.010-inch slotted PVC well screen. The casings will extend to the ground surface and will not be completed with permanent protective covers or well pads. A 6-inch square metal plate with a 2-inch diameter sleeve will be used to cover each completed monitoring point. The plates will afford adequate protection of the monitoring points following their installation and their use during aquifer testing. The monitoring points are temporary and will be abandoned (Section 5.3.3) following the conclusion of the aquifer testing. No soil samples will be collected during monitoring point installation activities.

Normal drilling procedures as described in Section 5.4 will be observed during monitoring point installation.

The aquifer test will consist of performing a 72-hour constant-rate pumping test using well CAR-RW10 as the pumping well. Prior to performing the constant rate test, a one-day variable-rate pumping test (i.e., step test) will be performed to determine the optimal pumping rate for the subsequent constant-rate test. During the step test, water will be withdrawn from well CAR-RW10 at three different rates. During each discrete step, the pumping rate will be maintained at a constant rate for 4 hours. At the end of the first two 4-hour time periods, the rate will be increased. The initial pumping rate that will be maintained during the first step will be approximately 5 gallons per minute. The pumping rates for the following two time periods will be determined in the field. The pumping rate for the final step should be close to the maximum pumping rate that can be sustained in the pumping well. After the completion of the last 4-hour pumping period, the pump will be shut off and water levels will be allowed to recover. Groundwater drawdown in the pumping well and the observation wells will be measured during the test and during the subsequent recovery period. The step test will be analyzed using the aquifer testing software, AqteSolve, which allows the evaluation of variable-rate pumping test data. In addition, the specific capacity of the well will be calculated. Based on these analyses, a target pumping rate will be selected for the constant-rate test.

Once a target pumping rate has been determined and water levels in the vicinity of well CAR-RW10 have recovered to ambient conditions, the constant-rate pumping test will be initiated. The pumping rate at CAR-RW10 will be set to the target pumping rate and allowed to continue uninterrupted at this rate for a period of 72 hours. The recovery well, well WP07-10B, the three temporary observation wells, and wells LF04-4F, WP07-10A, WP07-10B, and WP07-10C will be measured for changes in water levels. Pressure transducers capable of recording changes in groundwater levels will be used to monitor water levels in the pumping well and five observation wells. The pressure transducers will provide uninterrupted monitoring data throughout the duration of the variable-rate and constant-rate tests.

In-Situ® pressure transducers capable of recording changes in groundwater elevations will be used to monitor water levels in WP07-10B and the three dedicated monitoring points. The pressure transducers will provide uninterrupted monitoring data throughout the duration of the step and constant rate tests. An In-Situ® HERMIT 3000™ Data Logger will be used to record the pressure transducer data. The HERMIT 3000™ data logger is capable of recording barometric pressure conditions throughout the test so separate instrumentation is not required. The NAS Fort Worth JRB base operations weather station will be contacted prior to initiating the pilot test to obtain the barometric pressure for calibration of the data logger.

Prior to initiating the aquifer tests (i.e., variable-rate and constant-rate tests), at least 24-hours of background water levels will be collected in the pumping and observation wells. During this 24-hour period and during the aquifer tests, barometric pressure data will also be collected. If needed, the background water-level and the barometric pressure data may be used to correct the aquifer test data for climatic changes that may occur during the test.

3.3.4 Lithologic Evaluation of Bedrock and Evaluation of Paluxy Aquifer Groundwater

The lithologic evaluation will consist of obtaining rock cores from the entire thickness of the Goodland/Walnut confining units located beneath the Terrace Alluvium. The borings/core will continue 15 feet into the underlying Paluxy Formation. The Goodland/Walnut and Paluxy cores will be collected from three borings located within the confines of the Former Carswell AFB and the NAS Fort Worth JRB boundary. The proposed core locations are illustrated on Figure 3.1 of the Work Plan. A description of the cores will be provided per Sections 5.1, 5.3.2 and 5.4.2 of this FSP. Special emphasis will be placed on evaluating the Goodland/Walnut confining units for potential contamination infiltration pathways (joints, fractures, and dissolution zones).

Due to the nature of mud rotary drilling, no soil samples will be collected for lithological description or laboratory analyses. No chemical analyses will be performed on the rock cores. Field screening of the soil and rock cores will be performed per Section 7.1.1 of this FSP. The three borings will be completed as groundwater monitoring wells. The monitoring wells will only be screened within the Paluxy Formation. A metal outer casing will be advanced through the Terrace Alluvium and into the weathered upper portion of the Goodland/Walnut unit to seal the Paluxy wells from the Terrace Alluvium groundwater. The monitoring wells will be installed as two-inch PVC wells with approximately 15 feet of 0.020-inch slotted well screen. After development, the wells will be purged (low-flow) and groundwater sampled for VOCs by Method 8260B. The wells will be sampled a second time approximately 2 months after the initial sampling. In addition, the Paluxy wells at NAS Fort Worth JRB and AFP 4 will be gauged.

3.3.5 Aqueduct Assessment

An assessment will be performed on the subterranean aqueduct located beneath the runway and main flightline area of NAS Fort Worth JRB (Figure 3.3 of the Work Plan). The aqueduct consists of two large drainage culverts buried beneath the flightline area. The aqueduct is located south of AFP 4 and bisects the NAS Fort Worth JRB runway in a generally east-west direction. The aqueduct allows surface water to flow east from the White Settlement community, across the Base and through Landfill 8, where it eventually discharges into Farmers Branch Creek on the golf course property. The majority of flow within Farmers Branch Creek is generated from surface runoff. The remaining flow within Farmers Branch is generated from recharge derived from the local Terrace Alluvium groundwater.

The aqueduct will be assessed to evaluate its potential contribution to the Southern Lobe TCE Plume and its effect on local groundwater flow, if any. The assessment will include a characterization of its construction, subsurface setting, and potential contaminant entry points. A site walk will be performed inside the aqueduct to examine surface drainage patterns leading to the aqueduct. Examining the surface drainage patterns will help to characterize the general surface flow patterns in the area and help determine the direction from which surface contaminants can enter the aqueduct. Two properly trained and equipped personnel will perform an aqueduct walk-through, with one individual outside the confined space for health and safety purposes. The walk-through will include a video and photographic log of the interior of the aqueduct. Special emphasis will be placed on evaluating the aqueduct for structural weaknesses such as cracks, broken seams or joints, and deteriorated sections of the walls or floor. The personnel performing the walk-through will be trained in confined space procedures. The walk-through will not be performed if there is a chance of rain during the walk-through or the preceding 24 hours. No intrusive investigations are planned as part of this assessment.

4.0 PROJECT ORGANIZATION AND RESPONSIBILITY

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

4.1 MANAGEMENT RESPONSIBILITIES

4.1.1 Program Manager

The Program Manager's responsibilities will include the following:

- Reviewing and approving the Work Plan, QAPP, FSP, and Health and Safety Plan (HSP)
- Providing sufficient resources to the project team so that it can respond fully to the requirements of the investigation
- Providing direction and guidance to the PM
- Reviewing the final project report
- Providing other responsibilities as requested by the PM

4.1.2 Project Manager

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

- Reviewing and approving project plans and reports
- Assigning duties to the project staff and orienting the staff to the needs and requirements of the project
- Obtaining the approval of the QA Manager for proposed variances to the Work Plan and FSP
- Supervising the performance of project team members
- Providing budget and schedule control
- Reviewing subcontractor work and approving subcontract invoices

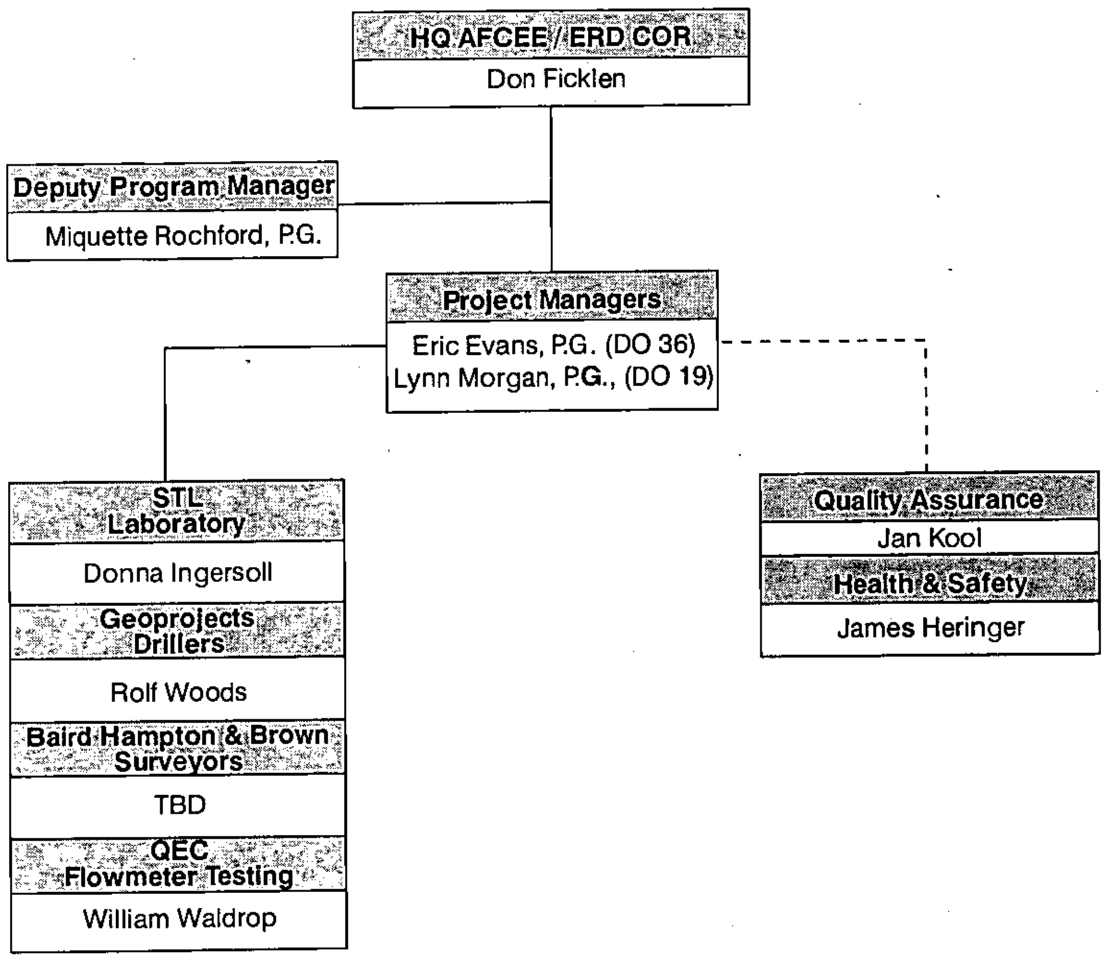

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Figure 4.1

HydroGeoLogic, Inc., Project Organization Chart
NAS Fort Worth JRB, Texas

Table 4.1
Key Project Personnel

Name	Title	Organization	Telephone
Don Ficklen	Team Chief	AFCEE/ERD	(210) 536-5290
Michael Dodyk	NAS Fort Worth JRB POC	AFCEE/ERD	(817) 732-9734
Jim Costello	Program Manager	HydroGeoLogic	(703) 478-5186
Miquette Rochford	Deputy Program Manager	HydroGeoLogic	(703) 736-4511
Eric Evans	Project Manager (DO 36)	HydroGeoLogic	(518) 782-3435
Lynn Morgan	Project Manager (DO 19)	HydroGeoLogic	(703) 736-4518
Jan Kool	QA Manager	HydroGeoLogic	(703) 478-5186
Ken Rapuano	Health & Safety Officer	HydroGeoLogic	(703) 478-5186
Donna Ingersoll	Lab Project Manager	STL- Chicago	(708) 534-5200
TBD	Lab Operations Manager	TBD	TBD
TBD	Lab QA Officer	TBD	TBD
TBD	Lab Sample Custodian	TBD	TBD
Pete Dacyk	Project Geologist	HydroGeoLogic	(518) 782-3435
Brad Nielsen	Project Geologist	HydroGeoLogic	(512) 336-1170
Robert Wallace	Project Geologist	HydroGeoLogic	(703) 478-5186
Omar Abdi	Data Mgmt. Supervisor	HydroGeoLogic	(703) 478-5186
Todd Harrah	Senior Reviewer	HydroGeoLogic	(512) 336-1170

TBD - To Be Determined

- Ensuring that major project deliverables are reviewed for technical accuracy and completeness before their release, including data validity
- Ensuring that all resources of the laboratory are available on an as-required basis
- Overseeing final analytical reports

4.2 QA AND HEALTH AND SAFETY RESPONSIBILITIES

4.2.1 QA Manager

Responsibilities of the QA Manager will include:

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

4.2.2 Health and Safety Officer

Responsibilities of the Health and Safety Officer (HSO) will include:

- Developing the HSP
- Ensuring that the requirements of the QAPP are satisfied

- Providing other responsibilities as identified in the HSP

4.3 LABORATORY RESPONSIBILITIES

4.3.1 Laboratory Project Manager

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

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

4.3.2 Laboratory Operations Manager

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

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

4.3.3 Laboratory QA Officer

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

- Conduct audits of laboratory analyses
- Provide oversight of laboratory QA
- Provide oversight of QA/QC documentation
- Conduct detailed reviews of data

- Determine whether to implement laboratory corrective actions, if required
- Define appropriate laboratory QA procedures
- Prepare laboratory Standard Operation Procedures

4.3.4 Laboratory Sample Custodian

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

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

4.4 FIELD RESPONSIBILITIES

4.4.1 Project Geologist

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

- Providing orientation and any necessary training to field personnel (including subcontractors) on the requirements of the FSP, HSP, and QAPP before the start of work
- Providing direction and supervision to the sampling crews

- Monitoring sampling operations to ensure that the sampling team members adhere to the QAPP and FSP
- Ensuring the use of calibrated measurement and test equipment
- Maintaining a field records management system
- Coordinating activities with the PM
- Supervising geological data interpretation activities
- Overseeing field data documentation and conducting quality checks on interpretive geologic work products
- Reviewing reports for compliance with State of Texas and EPA requirements
- Assuming the duties of the HSO if directed by the HSO

4.5 SUBCONTRACTORS

Subcontractors will be used for the laboratory analyses, the drilling of soil borings, and monitoring well installations during the field investigation.

Qualified subcontractors will be selected in accordance with AFCEE requirements and HydroGeoLogic procurement and QA procedures. Subcontractors will meet predetermined qualifications developed by the PM and defined in the procurement bid packages. Each bid submitted will be reviewed for technical, QA, and purchasing requirements. All subcontractors will be required to follow the procedures of the Work Plan, FSP, QAPP, and HSP. Periodic QC inspections of each subcontractor may be performed as specified in the FSP (Section 7.4), QAPP (Section 9.1), and HSP (Section 1.3.2). These inspections will be performed by the QA Manager, or his designee, as unannounced audits to confirm adherence to the procedures and guidance outlined in the aforementioned documents. Such inspections may relate to health and safety, QAPP requirements, or field standard operating procedures.

5.0 FIELD OPERATIONS

The overall project field logistics and activities necessary to complete the project sampling objectives described in the Work Plan are presented in this section. All field work will be conducted in accordance with the site HSP. HydroGeoLogic is the prime contractor for the field investigation. The point-of-contact (POC) at the Base will be Mr. Michael Dodyk.

5.1 GEOLOGIC STANDARDS

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

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

Columnar sections, well and boring logs, well construction diagrams, cross sections, and three-dimensional (3-D) diagrams shall use standard patterns for the geologic units.

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

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

5.2 SITE RECONNAISSANCE, PREPARATION, AND RESTORATION PROCEDURES

Areas designated for intrusive sampling shall be surveyed for the presence of underground utilities. Utility locations are determined using existing utility maps and are verified in the field using a hand-held magnetometer or utility probe. Prior to commencement of drilling activities, digging permits will be obtained from NAS Fort Worth JRB. The base civil engineer will be contacted to verify that selected locations are free of underground utilities. Those locations not clear of underground utilities will be repositioned within the marked area to a location a safe distance from the utilities, but suitable for the purpose of the investigation. Vehicle access routes to sampling locations shall be determined prior to any field activity.

A centralized decontamination area shall be provided for drilling rigs and equipment. The decontamination area shall be large enough to allow storage of cleaned equipment and materials prior to use, as well as to stage drums of decontamination waste. The decontamination area shall be lined with a heavy gauge plastic sheeting, and designed with a collection system to capture decontamination waters. Solid wastes shall be accumulated in 55-gallon drums and subsequently transported to a waste storage area designated by the USAF. Smaller decontamination areas for personnel and portable equipment shall be provided as necessary. These locations shall include basins or tubs to capture decontamination fluids, which shall be transferred to a large accumulation tank as necessary. These designated areas of decontamination shall be determined during the pre-construction meeting. The field office and the primary staging area for field equipment and supplies will be located at 6560 White Settlement Road.

Each work site or sampling location shall be returned to its original condition when possible. Efforts shall be made to minimize impacts to work sites and sampling locations, particularly those in or near sensitive environments such as wetlands. Following the completion of work at a site, all drums, trash, and other waste shall be removed. Decontamination and/or rinse water and soil cuttings shall be transported to the designated locations as described in Section 5.9. At the completion of field activities, all capital equipment and consumable materials will be removed or turned over to base personnel in accordance with AFCEE procedures. A final site walk will be conducted with the base representative, at his/her discretion, to ensure that all sampling locations have been restored satisfactorily before final demobilization from the site.

5.3 BOREHOLE DRILLING, LITHOLOGIC SAMPLING, LOGGING, AND ABANDONMENT

5.3.1 General Drilling Procedures

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

The location of all borings will be coordinated, in writing, with the base civil engineer, or equivalent, before drilling commences. Soil borings through the Terrace Alluvium will be advanced using HSA drilling techniques. Mud-rotary techniques will be used during coring activities into the Goodland/Walnut units and Paluxy Formation. When installing boreholes through more than one water bearing zone, HydroGeoLogic and its subcontractors will take measures to prevent cross-connection or cross-contamination of the zones or aquifers. A metal casing will be installed through the unconsolidated alluvial sediments prior to commencing boring activities.

Drilling fluids, during mud-rotary operations, will consist of 100% sodium bentonite. Mud rotary techniques will be used during core extraction and bedrock boring. A log of drilling activities will be kept in a bound field notebook. Information in the log book will include location, time on site, personnel and equipment present, down time, materials used, samples collected, measurements taken, and any observations or information that would be necessary to reconstruct field activities at a later date. At the end of each day of drilling, the drilling supervisor will complete a Log of Daily Time and Materials Form. An example of this form is provided in Attachment B.

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

5.3.2 Sampling and Logging

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

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

Plasticity of fines description include the following: (1) color using Munsell Color System, (2) moisture (dry, wet, or moist), (3) consistency of fine grained soils, (4) structure of consolidated materials, and (5) cementation (weak, moderate, or strong).

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

Lithologic descriptions of consolidated materials encountered in the boreholes shall generally be described in accordance with Section 5.1. Consolidated samples for lithologic description shall be obtained as a continuous section comprising the total drilled depth of the boring. Rock cores shall be stored in standard core boxes, and missing sections of core shall be replaced with spacers. The core sections will be marked to indicate their position in the core relative to depth and orientation (top/bottom).

All samples will be monitored with an OVM (e.g., PID). The samples shall be handled in such a way as to minimize the loss of volatiles; these procedures are described in Section 6.2. Cuttings will be examined for their hazardous characteristics. Materials suspected to be hazardous because of abnormal color, odor, or OVM readings will be containerized in conformance with Resource Conservation and Recovery Act (RCRA), state, and local requirements.

5.3.3 Abandonment

Boreholes that are not completed as monitoring wells shall be abandoned in accordance with 30 Texas Administrative Code (TAC) Chapter 238, *Water Well Driller Rules* [Texas Natural Resource Conservation Commission (TNRCC), 1997]. Since the borings will not exceed 100 feet, the boring will be plugged to the ground surface with a solid column of 3/8 inch or larger granular sodium bentonite. The granular bentonite shall be hydrated at frequent intervals while strictly adhering to the manufacturer's specifications (TNRCC, 1997).

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

5.4 MONITORING WELL CONSTRUCTION

The on-site Project Geologist will supervise the drilling, soil boring, geophysical surveys, lithologic sampling, and monitoring well construction. Light non-aqueous phase liquids are not anticipated. Monitoring wells will be screened at the bottom of the aquifer to capture any dense petroleum products (i.e., dense non-aqueous phase liquids) if encountered.

5.4.1 Drilling Requirements

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

The mud-rotary and HSA rigs to be used will be cleaned and decontaminated according to the guidelines described in Section 5.9. The rig will not leak any fluids that may enter the borehole or contaminate equipment that is placed in the hole. Rags or absorbent materials will not be used to absorb leaking fluids.

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

5.4.2 Monitoring Well Borehole Requirements

HSA drilling is to be used to install the Southern Lobe TCE Plume delineation monitoring wells and the paleochannel delineation wells during this project. Mud-rotary will be used to drill the Paluxy wells. The inside diameter of the borings will be at least 4 inches larger than the outside diameter of the casing and well screen. The total outside diameter of the boring will not exceed 6 inches. For the paleochannel delineation wells, the wells will be installed three feet into bedrock and screened across the entire saturated thickness to 3 feet above the water table. For the Paluxy wells, an outer casing extending to the bedrock will be installed.

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

The documentation record and forms (Attachment B) will document the following information for each boring: (1) boring or well identification (this identification shall be unique, and HydroGeoLogic will ensure it has not been used previously at the installation.), (2) purpose of the boring (e.g., soil sampling, monitoring well), (3) location in relation to an easily identifiable landmark, (4) names of drilling contractor and logger, (5) start and finish dates and times, (6) drilling method, (7) types of drilling fluids and depths at which they were used, (8) diameters of surface casing, casing type, and methods of installation, (9) depth at which saturated conditions were first encountered, (10) lithologic descriptions and depths of lithologic boundaries, (11) sampling-interval depths, (12) zones of caving or heaving, (13) drilling rate, and (14) drilling rig reactions, such as chatter, rod drops, and bouncing.

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

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

5.4.3 Casing Requirements

The casing requirements that will be followed are the following: (1) all casing will be new, unused, and decontaminated according to the specifications of Section 5.8, (2) glue will not be used to join casing, and casings will be joined only with compatible welds or couplings that shall not interfere with the planned use of the well, (3) all PVC will conform to the ASTM Standard F-480-88A or the National Sanitation Foundation Standard 14 (Plastic Pipe System), (4) the casing will be straight and plumb within the tolerance stated for the borehole, and (5) the driller shall cut a notch in the top of the casing to be used as a measuring point for water levels.

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

5.4.4 Well Screen Requirements

AFCEE well screen requirements are the following: (1) all requirements that apply to casing will also apply to well screen, except for strength requirements, (2) monitoring wells will not be screened across more than one water-bearing unit, (3) screens will be factory slotted or wrapped, (4) screen slots will be sized to prevent 90 percent of the filter pack from entering the well, and (5) the bottom of the screen is to be capped, and the cap will be joined to the screen by threads.

The monitoring wells will be constructed using flush-threaded two-inch diameter Schedule 40 PVC casing and screen. It is anticipated that the Alluvial Terrace aquifer well screens will be placed from the lowest portion of the alluvial terrace groundwater zone through the surface of the water table. The screen size in the alluvium will be 10-slot (0.010-inch) PVC. The Paluxy aquifer wells will consist of a 10 to 15-foot section of 10-slot (0.010-inch). The bottom of the screens will be capped using flush threaded PVC caps.

5.4.5 Annular Space Requirements

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

5.4.6 Filter Pack Requirements

The filter pack will consist of silica sand or gravel and will extend from the bottom of the hole to at least 2 feet above the top of the well screen. After the filter pack settles, the top of the sand pack will be sounded to verify its depth during placement. Additional filter pack will be emplaced as required to return the level of the pack to 2 feet above the screen.

The filter pack material will be clean, inert, and well-rounded and will contain less than 2 percent flat particles. The sand will be certified free of contaminants by vendor or contractor. If decontamination is necessary, the methods shall be approved in writing by AFCEE. The grain size of the filter pack material will be determined based on existing grain size analysis prior to mobilization to the field. The filter pack will have a grain size distribution and uniformity coefficient compatible with the formation materials and the screen. This will be calculated as described in Chapter 12, *Ground Water and Wells*, 2nd Edition (Driscoll, 1986). Filter packs for the paleochannel wells will use silica sand or pea-gravel that has a hydraulic conductivity that is at least twice as high as hydraulic conductivity values measured during previous aquifer tests conducted in the Terrace Alluvium. To ensure that this condition is met, the grain size distribution of the filter pack material will be used to calculate an effective hydraulic conductivity using the Hazen (1893) and/or Masch and Denny (1966) approximations. The estimated hydraulic conductivities associated with the filter pack material will be compared to hydraulic conductivities measured in the alluvial sediments.

The filter pack will not extend across more than one water-bearing unit. In all wells (deep or shallow), the filter pack will be emplaced with a bottom discharge tremie pipe of at least 1[illegible] inches in diameter to prevent bridging. The tremie pipe will be lifted from the bottom of the hole at the same rate the filter pack is set. HydroGeoLogic will record the volume of the filter pack emplaced in the well. If potable water is necessary to place the filter pack, HydroGeoLogic will obtain prior approval from the regulatory agency providing oversight, and will ensure that no contaminants are introduced into the well.

5.4.7 Bentonite Seal Requirements

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

5.4.8 Casing Grout Requirements

The casing grout requirements are the following: (1) the casing grout will extend from the top of the bentonite seal to ground surface, (2) the grout will be mixed in the following proportions: 94 pounds of neat Type I Portland or American Petroleum Institute Class A cement, not more than 4 pounds of 100 percent sodium bentonite powder, and not more than 8 gallons of potable water, (3) all grout will be pump tremied using a side-discharge tremie pipe, and pumping will continue until 20 percent of the grout has been returned to the surface, and (4) in wells where the bentonite seal is visible and within 30 feet of the land surface, the 20 percent return is not necessary so long as the tremie pipe is pulled back as the grout is emplaced.

5.4.9 Surface Completion Requirements

For flush-mounted completions (the paleochannel wells and other wells designated by the base POC), the casing will be cut about three inches below the land surface and provide a water-tight casing cap to prevent surface water from entering the well. To allow for escape of gas, a small diameter (e.g., ¼-inch) vent hole will be placed in the upper portion of the casing, or a ventilated well cap will be used. A freely draining valve box with a locking cover will be placed over the casing. The top of the casing will be at least one foot above the bottom of the box. The valve box lid will be centered in a three-foot diameter, four-inch thick concrete pad that slopes at a 1-3% grade away from the box at ¼ inch per foot. The identity of the well will be permanently marked on the valve box lid and the casing cap. Where heavy traffic may pass over the well or for other reasons, the concrete pad and valve box/lid assembly will be constructed to meet the strength requirements of surrounding surfaces.

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

All wells will be secured as soon as possible after drilling with COC seals for both flush and above-ground surface completions. The seal number for each well will be recorded in the field notebook. A Monitoring Well Construction Form will be completed for each well. Examples of field forms are presented in Attachment B.

5.5 MONITORING WELL DEVELOPMENT

The monitoring well development requirements are the following: (1) all newly installed monitoring wells will be developed no sooner than 24 hours after installation to allow for grout curing, (2) all drilling fluids used during well construction will be removed during development, (3) wells will be developed using surge blocks and bailers or pumps (prior approval for any alternate method will be obtained, in writing, from AFCEE before well construction begins), and wells will be developed until the turbidity of the well is less than or equal to 10 nephelometric turbidity units (NTU) and remains within a 5 NTU range for at least 30 minutes and the stabilization criteria in Section 6.1 are met, (4) discharge water color and volume will be documented, (5) no sediment will remain in the bottom of the well, (6) no detergents, soaps, acids, bleaches, or other additives will be used to develop a well, and (7) all development equipment will be decontaminated according to the specifications of Section 5.9.

5.6 ABANDONING MONITORING WELLS

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

5.7 SURVEYING

A State of Texas certified land surveyor will measure all field surveying locations. The surveys will be third order and references will be tied to the Texas State Plane Coordinate System (cf. Urquhart, L.C., *1962 Civil Engineering Handbook*, 4th Edition, p. 96 and 97). All surveyed locations will be reported using the Texas State Plane Coordinate System, North Central Zone. The horizontal datum will be the North American Datum of 1983 and the units will be in U.S. Survey feet. The vertical datum will be the National Geodetic Vertical Datum of 1988 and the units will be in U.S. Survey feet. The surveyed control information for all data collection points will be recorded and displayed in a table. The table will give the northing (Y) and easting (X) coordinates, the ground elevation and the measuring point elevation if the location is a groundwater monitoring well. The reference location is the origin. The elevation of all newly installed wells will be surveyed at the water level measuring point (notch) on the riser pipe. The elevation of the ground surface at each water level measuring point will be included in the survey. The accuracy of the X-Y coordinates for each sample location will be accurate to within 0.1 feet.

5.8 EQUIPMENT DECONTAMINATION

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

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

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

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

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

5.9 AQUIFER TESTS

Section 3.3.3 of this FSP described the location, equipment, and procedures that will be used in performing the data gap investigation aquifer test at recovery well CAR-RW10. The following are general AFCEE aquifer testing guidelines which will be followed during performance of the aquifer test.

5.9.1 Aquifer Testing For Hydraulic Properties

5.9.1.1 General

Equipment shall be decontaminated and water levels measured according to the specifications of Sections 5.12. The contractor shall demonstrate that the assumptions of the selected analytical methods for deriving the hydraulic properties match the hydrogeological conceptual site model, and meet the data quality objectives in Section 3.0.

5.9.1.2 Pumping Tests

The contractor will use existing monitoring wells as observation wells whenever possible. The pumping rate will be determined by conducting step-tests prior to the pumping test. The well will be pumped at predetermined rates in order to determine the optimum pumping rate. If a lower pumping rate is preferable because of factors such as nearby supply wells, areas with floating product, disposal costs, or limited storage facilities, the lower rate will be approved by AFCEE. At a minimum, barometric pressures should be monitored at the beginning and end of the test in order to evaluate the impact barometric pressure may have had on the test. The test will not begin until water levels in all wells have completely recovered. The contractor will monitor and regulate the discharge valve for either a constant-discharge or constant-head test. The discharge rate will be measured at least ten times during the first 100 minutes of the test and at least every time water levels are measured thereafter. Water levels will be measured at least ten times per log cycle for the first 100 minutes of the test and at least once every hour thereafter. Time-drawdown or distance-drawdown data will be analyzed during the test. The test will be terminated when collection of additional data will not affect results (e.g., when water levels are essentially at equilibrium, or when a well in low hydraulic conductivity rocks does not yield sufficient water to continue). The pumped water will be discharged to the groundwater treatment system so as not to recharge the portion of the aquifer being tested or otherwise affect the validity of the test.

5.9.1.3 Other Test Methods

The aquifer hydraulic parameters can be estimated from well specific capacity and from step drawdown tests. For low hydraulic conductivity rocks, ASTM D-4630 or D-4631 is applicable. For clay, ASTM D-1587 and D-2434 are applicable.

5.10 WASTE HANDLING

Waste handling will be dealt with on a site-by-site basis. Waste will be classified as either non-investigative derived waste or investigative derived waste (IDW) per the requirements of 30 TAC §335 Subchapter R and 40 Code of Federal Regulations (CFR) Part 261, Subpart C. Non-investigative derived waste, such as litter and household garbage, will be collected on an as-needed basis to maintain each site in a clean and orderly manner. This waste will be containerized and transported to the designated sanitary landfill or collection bin. Acceptable containers will be sealed boxes or plastic garbage bags. Waste containers will be labeled with the following information: type of matrix being contained, depth from which matrix was obtained, date matrix was contained, company name and phone number, and whether matrix is considered hazardous or not.

Characterization of IDW will be based on sample analysis obtained during the field investigation following EPA approved methods. Hazardous waste classification will first be determined as per 40 CFR §261.2, §261.3, or §261.4. Waste that is nonhazardous, is then classified as Class 1, Class 2, or Class 3 according to 30 TAC §335.505 - 335.507. Once the IDW has been characterized, an eight-digit waste code number will be provided as required in §335.501. The disposal of IDW will be conducted in a timely and cost effective manner, and in accordance with all state and federal regulations.

IDW will be properly containerized and temporarily stored at each site, prior to transportation. Depending on the constituents of concern, fencing or other special markings may be required. The number of containers will be estimated on an as-needed basis. Acceptable containers will be sealed in either 55-gallon drums or small dumping bins with lids. The containers will be transported in such a manner to prevent spillage or particulate loss to the atmosphere.

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

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

5.11 CORRECTIVE ACTION

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

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

Situation	Calibration	Frequency	Field Objective Affected	Corrective Action Procedure
Equipment malfunction			Equipment is calibrated and operating properly	- Notification of site supervisory personnel
PID/OVA	- Calibrated to ±20% of known calibration gas	- Daily		- Correct problem, recalibrate
pH	- Calibrated with two buffer solutions that bracket expected sample pH	- Daily		- Repair or replace malfunctioning parts
SC	- Calibrated with two standards in expected range of sample SC	- Daily		- Recalibrate and/or replace standards
Temperature	- Calibrate within expected temperature range of samples	- Monthly		- Repair or replace malfunctioning parts
Turbidity	- Calibrate within expected range of sample turbidity	- Daily		- Submission of document to Project Geologist, Project Manager, and Quality Assurance Manager
Incorrect sample collection procedures	NA	NA	Samples are taken according to standard operating procedures	- Notification of site supervisory personnel - Review of situation and correct procedures - Submission of document to Project Geologist, Project Manager, and Quality Assurance Manager

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

Situation	Calibration	Frequency	Field Objective Affected	Corrective Action Procedure
Insufficient sample volume collection	NA	NA	Sufficient sample volume is provided to maintain sample integrity so that all required analyses can be conducted	- Notification of site supervisory personnel by laboratory manager - Review site affected and impact of samples on site characterization - correct procedures - Submission of document to Project Geologist, Project Manager, and Quality Assurance Manager
Incorrect measurement data collection	NA	NA	Measurements are conducted according to standard operating procedures	- Notification of site supervisory personnel - Review of situation and correct procedures - Submission of document to Project Geologist, Project Manager, and Quality Assurance Management

NA - Not Applicable
PID - Photoionization detect or/organic vapor analyzer
SC - Specific conductivity

6.0 ENVIRONMENTAL SAMPLING

6.1 SAMPLING PROCEDURES

All purging and sampling equipment will be decontaminated according to the specifications in Sections 5.8 and 7.3 prior to any sampling activities and will be protected from contamination until ready for use. The construction material of the sampling devices (e.g., plastic, PVC, metal, etc.) discussed below will be appropriate for the contaminant of concern and will not interfere with the chemical analyses being performed.

6.1.1 Groundwater Sampling

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

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

Before the start of sampling activities, plastic sheeting will be placed on the ground adjacent to the well. The plastic sheeting will be used to provide a clean working area for clean equipment to be placed during sampling. Water will be removed from the protective casing or from vaults around the well casing prior to venting and purging. Every time a casing cap is removed to measure water level or collect a sample, the air in the breathing zone will be checked with an OVM. Procedures in the HSP will be followed when high concentrations of organic vapors are detected. Air monitoring data will be recorded on the well sampling form.

Purge pump intakes will be equipped with a positive check valve to prevent purged water from flowing back into the well. Purging and sampling will be performed in a manner that minimizes aeration in the well bore and the agitation of sediments in the well and formation. Equipment will not be allowed to free-fall into a well.

In addition to the information required in Section 8.0, the following information will be recorded each time a well is purged and sampled: (1) depth to water before and after purging; (2) sounded total depth of the monitoring well; (3) the condition of each well, including visual (mirror) survey; (4) the thickness of any nonaqueous layer and; (5) field parameters, such as pH, temperature, electrical conductivity (EC), oxidation-reduction potential (ORP), dissolved oxygen (DO), and turbidity. This information will be encoded in the Environmental Restoration Program Information Management System (ERPIMS) files when required.

6.1.1.1 Water Level Measurement

An interface probe will be used to determine the presence of floating product, if any, prior to measurement of the groundwater level. The groundwater level will then be measured to the nearest 0.01 foot using the interface probe or an electric water level indicator. Water levels will be measured from the notch located at the top of the well casing and recorded on the well sampling form. If well casings are not notched, measurements will be taken from the north edge of the top of the well casing, and a notch will be made using a decontaminated metal file. The groundwater elevation (mean sea level) is calculated by subtracting the depth to the water from the top of the well casing elevation.

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

6.1.1.2 Purging Prior to Sampling

Purging of monitoring wells is performed to evacuate water that has been stagnant in the well and may not be representative of the aquifer. Purging will be accomplished using the micropurge technique. Micropurge is a low flow-rate monitoring well purging and sampling method that induces laminar (non turbulent) flow in the immediate vicinity of the sampling pump intake, thus drawing groundwater directly from the sampled aquifer, horizontally through the well screen, and into the sampling device.

Pumps capable of achieving low-flow rates in the range of 0.1-0.5 liters per minute (L/min) will be used for purging and sampling. These low flow rates minimize disturbance in the screened aquifer, resulting in the following: (1) minimal production of artificial turbidity and oxidation; (2) minimal mixing of chemically distinct zones; (3) minimal loss of VOCs; and (4) collection of representative samples while minimizing purge volume.

Pumps will be lowered to the middle of the screened interval or slightly above the interval (ie. a measured depth of 43 percent of the saturated screened interval below the top of the water table). This is to minimize the resuspension of solids which have collected at the bottom of the well and to minimize the potential mixing of stagnant water trapped in the casing above the screen. The goal is to minimize the disturbance of water and solids in the well casing.

As a guide to flow rate adjustment during purging, water levels will be checked and recorded to monitor drawdown in the well. Groundwater will be pumped in a manner which minimizes the stress to the system to the extent practical, taking into account established site sampling objectives. The goal is to purge the well at a rate that does not draw down the static water level more than 0.33 feet.

Temperature, pH, EC, DO, ORP, and turbidity will also be measured during purging and recorded on the well sampling form. Measurements will be taken every three to five minutes when flow rates are in the 0.1-0.5 L/min range. Stabilization is achieved after all parameters have stabilized for three consecutive readings. Successive readings should be approximately within ±1.0 degrees Celsius (° C) for temperature, ±0.1 units for pH, ±3 percent for EC, ±0.1 mg/L or 10 percent (whichever is greater) for DO, ±10 percent for ORP, and ±10 percent for turbidity. In general, the order of stabilization is pH, temperature, and EC, followed by ORP, DO, and turbidity. Turbidity readings below 10 NTUs are desired, especially when metal samples are to be collected. When turbidity is high, the purge time will be extended in order for turbidity to reach 10 NTUs; however, if turbidity stabilizes above 10 NTUs for 15-30 minutes, then turbidity will be considered stable as defined above.

Groundwater samples will be collected using the pump used in the purging procedure. If the parameters do not stabilize after one to two hours when the drawdown indicates a laminar flow, a subset (pH, EC, and turbidity or DO) will be used as the stabilization parameters. If subset parameters do not stabilize, then the sample will be collected when a maximum number of parameters stabilize, and the anomalous parameters will be brought to the Field Coordinator's attention. Water samples will be collected immediately after parameter stabilization using the same pump as was used in purging. Field equipment will be calibrated in accordance with the Basewide QAPP (HydroGeoLogic, 1998), Section 6.0, and in Section 7.2 of this FSP.

If during low-flow purging the drawdown is greater than 0.33 feet, then the micropurge technique is assumed to be invalid and will be discontinued. When drawdown is greater than 0.33 feet groundwater flow to the pump is no longer considered to be laminar across the screen from the aquifer. The flow in the vicinity of the pump would then contain a vertical component from the stagnant water column in the filter pack and casing.

In this situation (ie. drawdown >0.33 feet at low-flow rates), the drawdown will continue to be monitored and the pumping rate will be adjusted to avoid pumping the well dry. Measurements for water quality parameters will be taken every 3 to 5 minutes. After stabilization parameters are met, water samples will be collected when the water level has recovered to 80 percent of its static water level or 16 hours after completion of purging. Water samples will be collected using either a low-flow pump or a Teflon™ bailer.

If a well is purged dry, then the well will be sampled as soon as a sufficient volume of groundwater has entered the well to enable the collection of necessary groundwater samples (EPA, 1992). Water samples will be collected using either a low-flow pump or a Teflon™ bailer.

Water removed from the well during purging will be containerized. Detailed information concerning IDW is presented in Section 5.10.

6.1.1.3 Sample Collection

At newly developed wells, water samples may only be collected after a 24-hour period has elapsed from the conclusion of monitoring well development activities.

Following the micropurge techniques, or 3 well volume techniques outlined above, a bladder pump will be used to collect water samples. Samples to be analyzed for volatile or gaseous constituents will not be withdrawn with pumps or at flows that degas the samples. Water quality indicators will be monitored during micropurge (turbidity, DO, specific conductance, temperature, etc.).

Groundwater samples will be collected after the critical water quality indicators have stabilized for three consecutive readings. Stabilization criteria are presented above in Section 6.1.1.2. Where possible, groundwater samples will be collected using the same pump used in the purging procedure. If the parameters do not stabilize, a subset (pH, EC, and turbidity or DO) will be used as the stabilization parameters. If subset parameters do not stabilize, then the sample shall be collected as described above in Section 6.1.1.2, and the anomalous parameters shall be brought to the Field Coordinator's attention. Field equipment will be calibrated in accordance with the Basewide QAPP (HydroGeoLogic, 1998).

If not supplied by the laboratory in a pre-preserved state, the preservative hydrochloric acid shall be added to the VOC sample bottle before introducing the sample water. The sample shall be collected from the pump discharge line using a slow, controlled pour down the side of a tilted sample vial to minimize volatilization. The sample vial shall be filled until a meniscus is visible and immediately sealed. When the bottle is capped, it shall be inverted and gently tapped to ensure no air bubbles are present in the vial. If bubbles are present after the initial filling, the vials shall be discarded and the VOC sampling effort shall be repeated. Refilling of vials will result in loss of preservatives. After the containers are sealed, degassing may cause bubbles to form in the sample. These bubbles shall be left in the container. These samples shall never be composited, homogenized, or filtered.

Following the collection of VOC samples, the remaining water samples shall be collected in the following order (as needed): ethane, ethane, and methane; alkalinity; and common anions. Field filtering of metals will not occur.

Required sample containers, preservation methods, volumes and holding times are given in Section 6.2 and Table 6.1. Sampling equipment shall be decontaminated in accordance with Section 5.8 upon completion of sampling activities.

Table 6.1
Requirements for Containers, Preservation Techniques, Sample Volumes, and Holding Times

Name	Analytical Methods	Container[a]	Preservation[b,c]	Minimum Sample Volume or Weight	Maximum Holding Time
Methane	SW3810 Mod.	3 40 mL clear glass vials with rubber septa & Teflon™ lined caps	4°C	120mL	14 days
Alkalinity	E310.1	One 500-mL polyethylene	4°C	250mL	14 days
Common Anions	SW9056	one 1-L polyethylene	4°C	100mL	28 days for Br^-, F^-, Cl^- and SO_4^{-2}: 48 hours for NO_3^-, NO_2^-, and PO_4^{-3}
Volatile organics (water)	SW8260B	G, Teflon™-lined septum	4°C, 0.008% $Na_2S_2O_3$ (HCl to pH < 2 for volatile aromatics by SW8260)[b]	2 x 40 mL or 4 ounces	14 days; 7 days if unpreserved by acid
Volatile organics (soil)	SW8260B/ SW5035	EnCore™ Sampler	4°C, frozen at -12 °C within 2 days of collection	3 x 5 gram cores	14 days

[a] Polyethylene (P); glass (G); brass sleeves in the sample barrel, sometimes called California brass (T).
[b] No pH adjustment for soil.
[c] Preservation with 0.008 percent $Na_2S_2O_3$ or by ascorbic acid is only required when residual chlorine is present.

6.1.2 Surface Soil Sampling

Although surface soil sampling is not currently proposed, if field conditions warrant their collection the following procedures will be used.

Surface soil samples shall be collected from the land surface to two feet below the surface. The sample shall be homogenized and quartered before being containerized. Samples collected for VOC analysis shall be containerized in EnCore™ core samplers prior to sample homogenization. Stainless steel scoops or trowels, glass jars with Teflon™ lids or equivalent equipment compatible with the chemical analyses proposed shall be used to collect and store samples. Above ground plant parts and debris will be excluded from the sample.

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

6.1.3 Surface Water Sampling

Surface water sampling is not currently proposed, however, if field conditions warrant their collection the following procedures will be used.

Surface water samples will be collected in a manner that does not cause cross-contamination. If both water and sediment samples are being collected at a specific location, the water will be obtained first. Temperature, pH, specific conductance, and dissolved oxygen (when required) will be recorded at all surface water sampling points. The location where surface water or sediment samples are collected will be permanently marked (e.g., flagged stake in stream bank), and the location will be recorded on a site-specific project map.

The sample collection sequence is as follows: (1) if sampling water and sediment or just sediment, sampling will begin at the most downstream point and proceed upstream, (2) if sampling water only and the sample can be taken without disturbing the river or stream bottom, background samples will be collected first, then the farthest downstream sample, and then samples moving upstream toward the source or discharge point, (3) if sampling water only and the stream or river bottom must be disturbed, sampling will begin at the most downstream point and proceed upstream.

Samples shall be taken from the active portion of the stream on the side nearest the source of contamination or suspected plume. Water samples are collected using a Van Dorn Sampler or Kemmerer Sampler when grab samples are required, or using an autosampler (discrete or composite samples) with the inlet line located at the desired sampling depth. If approved by

AFCEE, surface water samples may be collected by direct filling of sample bottles. Samples from multiple locations are combined in a decontaminated bucket (nonvolatile samples only) and aliquots are taken for composite samples.

Surface water samples may also be obtained using a continuous automatic sampler. With a continuous sampler, an intake probe is secured at the sampling point and the sampler is pre-programmed to collect either individual or composite samples at designated times throughout the day.

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

6.1.4 Sediment Sampling

Sediment sampling is not currently proposed, however, if field conditions warrant their collection the following procedures will be used.

Sediment samples are collected from ponds, surface impoundments, and streambeds (both wet and dry). Sediment samples shall be collected using a PVC tube or dredge (Ponar, Peterson, or Ekman) when water is present. Each technique allows for the collection of discrete samples, with the option of compositing samples in either the field or the laboratory. Dry sediment samples may be collected by surface scraping, hand augering, or core sampling using a core sampler. Methods for dry sediment sampling are the same as that for soil. Sediment samples may be collected near discharge points in areas where sediment has accumulated inside an edge of a bend, an area where a stream suddenly widens, etc. The order of sample collection shall be the same as that described for surface water samples.

6.1.5 Subsurface Soil Sampling

Soil samples may be collected based on odors, discoloration and, organic vapor monitor readings. During drilling activities, soil samples will be collected using steel, continuous drive, California modified split-spoon samplers, or equivalent.

As soon as the split-spoon is opened, the soil will be monitored for organic vapors using a PID. Air monitoring results will be recorded on the boring log and in the field logbook. Section 7.1.1 details field screening procedures for soils.

Samples for VOC analysis will be collected as an entire 5 gram core using an En Core™ core sampler. En Core™ is a sampling device which collects, stores, and delivers soil samples. The sealing cap prevents transfer of volatiles, and is therefore ideal when collecting soil samples for VOC analysis. One core will be collected from each VOC sampling location. Each core sampler will be completely filled to eliminate headspace. VOC samples from large gravel or debris will be collected using a 6-inch stainless steel/brass sleeve rather than an En Core™ core sampler. Following sample collection, each sampler will be capped to prevent volatilization. Each core sampler is associated with a dedicated plastic/aluminum foil zip lock bag on which is affixed a sample label. The sample label will be completed, the unique identification number label (matching the number on the bag) will be affixed to the core sampler, and the sampler will be placed into the bag and placed in an iced cooler held at a temperature below 4°C.

Samples collected concurrently with VOC samples to be tested for other analytical parameters will be collected immediately adjacent to (above and below) the VOC sample interval. If VOCs are not collected, acetate liners may be used. Soil chemistry samples collected for analyses other than VOCs will be placed in 4-ounce, laboratory cleaned, EPA-approved glass containers with Teflon™ lined lids. This will be done using clean stainless steel sampling tools. The sample will then be transferred into the appropriate sample container, sealed, labeled, and placed in an iced cooler held at a temperature below 4°C. If initial screening results indicate the presence of organic vapors, a headspace analysis will be conducted on remaining portions of the sample.

6.1.5.1 Hollow Stem Auger Sampling

For split-spoon samples collected using HSA, a standard penetration test will be performed in accordance with ASTM D-1586 "Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils." The sample is obtained by driving the sampler a distance of 1 foot into undisturbed soil with a 140-pound hammer free falling a distance of 30 inches. The sampler is first driven 6 inches to seat it in undisturbed soil; then the test is performed. The number of hammer blows for seating the spoon and making the test are then recorded for each 6 inches of penetration on the drill log (i.e., 5/7/8). The standard penetration test result (N) is obtained by adding the last two figures (i.e., 7+8=15 blows per foot). The sampler is then driven an additional 6 inches to fill the remainder of the split-spoon prior to retrieval.

6.2 SAMPLE HANDLING

6.2.1 Sample Containers

Sample containers will be provided to field personnel, precleaned and treated according to EPA specifications for the methods. No sampling containers will be reused. Containers will be stored in clean areas to prevent exposure to fuels, solvents, and other contaminants.

6.2.2 Sample Volumes, Container Types, and Preservation Requirements

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

6.2.3 Sample Identification

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

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

Each sample will be assigned a unique identification number that describes where and what type of sample was collected. The number that will be used in the field will consist of a maximum 15 digit alphanumeric code. Once data is ready to be entered into the ERPIMS database, the alphanumeric code will be truncated to 15 digits. This system is explained in detail as follows:

abbbccccdd-ee

where:

a represents the medium (e.g., W=monitoring well, B = soil boring, or E = sediment sample).

bbb represents HydroGeoLogic designation (e.g. HGL)

cccc represents the aquifer identification ((e.g., Terrace Alluvium (TA) or Paluxy aquifer (PA))

dd represents the location identification (Locid) (e.g., 01, 02)

ee represents the order that the sample was obtained within the soil boring; i.e., a surface soil sample would be 01, a 5- to 7-foot sample would be 02, etc. These two digits will be dropped once the data is entered into the ERPIMS database.

The numbering system for the soil samples will be based on a continuation of the HGL soil borings previously advanced within the Terrace Alluvium in the data gap investigation area. The first boring of this investigation will begin as number 026. For example, the soil sample collected from the first boring within the Terrace Alluvium will be identified as WHGLTA026-01. The second sample collected from soil boring 36 within the Terrace Alluvium will be identified as WHGLTA036-02. The first soil sample collected from the first Paluxy aquifer boring will be labeled as WHGLPA001-01. Duplicate samples will be submitted to the laboratory blind. A note in the field log book and the Field Sampling Report form will identify the location and sample number that has been duplicated.

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

aabbccdd

where:

aa	represents medium (e.g. ER = equipment rinsate, TB = trip blank, AB = ambient blank, EB = equipment blank)
bb	represents the month, e.g. 06
cc	represents the day, e.g. 15
dd	represents the year, e.g. 00

For example, an equipment blank collected on the 15th day of June in the year 2000 will be "EB061500".

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

6.3 SAMPLE CUSTODY

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

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

The following minimum information concerning the sample will be documented on the COC form:

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

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

6.4 FIELD QUALITY CONTROL SAMPLES

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

6.4.1 Ambient Blank

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

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

6.4.2 Equipment Blank

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

6.4.3 Trip Blank

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

6.4.4 Field Duplicates

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

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

7.0 FIELD MEASUREMENTS

7.1 PARAMETERS

7.1.1 Field Screening of Soils and Rock Borings

Data gap collection field activities will utilize field screening of soil for VOCs to provide data on the chemical characteristics of the soil at the investigation areas. During HSA drilling activities, soil samples will be monitored for organic vapors using an OVM. Headspace analysis will be performed on each lithologic and analytical soil sample collected. A portion of the recovered soil sample will be placed into a quart-size, resealable plastic bag, and the bag will be labeled, sealed, and shaken to mix the sample. The sample will be allowed to volatilize in a shaded area for approximately 15 minutes after which a headspace reading will be taken by punching through the bag with an OVM sampling tip. The OVM shall be calibrated using a standard of known concentration (e.g., isobutylene at 100 parts per million) in accordance with the requirements of the Final Basewide QAPP (HydroGeoLogic, 1998). The sampling tip will not be placed in the soil, but in the headspace of the bag. A background headspace value will be obtained from an empty resealable plastic bag handled in a manner identical to the plastic bag containing the screening sample. The headspace reading and the background reading will be recorded on the Soil Boring Log (located in Attachment B in this FSP). Rock cores will be screened by passing the tip of the screening instrument over the recovered core section. Field screening will be performed immediately after the core is removed from the core barrel. The headspace reading will be recorded on the Soil Boring Log.

7.1.2 Field Parameters for Water Samples

The pH will be measured during groundwater purging using a portable pH meter. The pH meter will be calibrated with three buffer solutions of the appropriate range for the expected values of pH. The meter will be recalibrated daily.

7.2 EQUIPMENT CALIBRATION AND QUALITY CONTROL

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

7.3 EQUIPMENT MAINTENANCE AND DECONTAMINATION

7.3.1 Equipment Maintenance

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

7.3.2 Decontamination of Field Instruments

Decontamination of field instruments will be instrument-specific. The probes of the pH meters will be rinsed with reagent-grade water before and after each use, and at the end of each day. No decontamination is required for the OVA.

7.4 FIELD PERFORMANCE AND SYSTEM AUDITS

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

- Sample labels
- COC records
- Field notebooks
- Sampling operations
- Document control

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

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

The audit will verify whether or not the following items are being accomplished: (1) collection of samples follows the available written procedures, (2) COC procedures are followed for traceability of samples origin, (3) appropriate QC checks are being made in the field and documented in the field log book, (4) specified equipment is available, calibrated, and working properly, (5) sampling crews are adequately trained, (6) record-keeping procedures are being followed and appropriate documentation is maintained, and (7) corrective action procedures are followed. An audit report summarizing the results and corrections will be prepared and filed in the project files.

8.0 RECORD KEEPING

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

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

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

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

8.1 FIELD LOGBOOK

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

Project identification
Field activity subject
General work activity, work dates, and general time of occurrence
Unusual events
Subcontractor progress or problems
Communication with the client or others
Weather conditions
HydroGeoLogic personnel, subcontractors, and visitors on site
Sample number and time of day for each sample collected for analysis

Listing by sample number of samples collected during the day, sorted by COC record number (compiled at the end of the day)
Record of telephone call to laboratory informing it of sample shipment
Accomplishment of decontamination of drilling rig, construction materials, and sampling equipment
Accomplishment of required calibration checks
Disposition of purge water, decontamination fluids, and soil cuttings
Variances from project plans and procedures (details will be recorded in the log book and presented in the FFS)
Accomplishment of tailgate safety meetings
Review of project procedures with site personnel
Head space screening and breathing zone readings
Accomplishment of decontamination of water sampling equipment
Photographs taken and identification numbers
Name and signature of person making log book entries
Inspections and results of inspections.

8.2 FIELD EQUIPMENT LOG BOOK

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

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

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

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

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ATTACHMENT A

PROPOSED WELL LOCATIONS

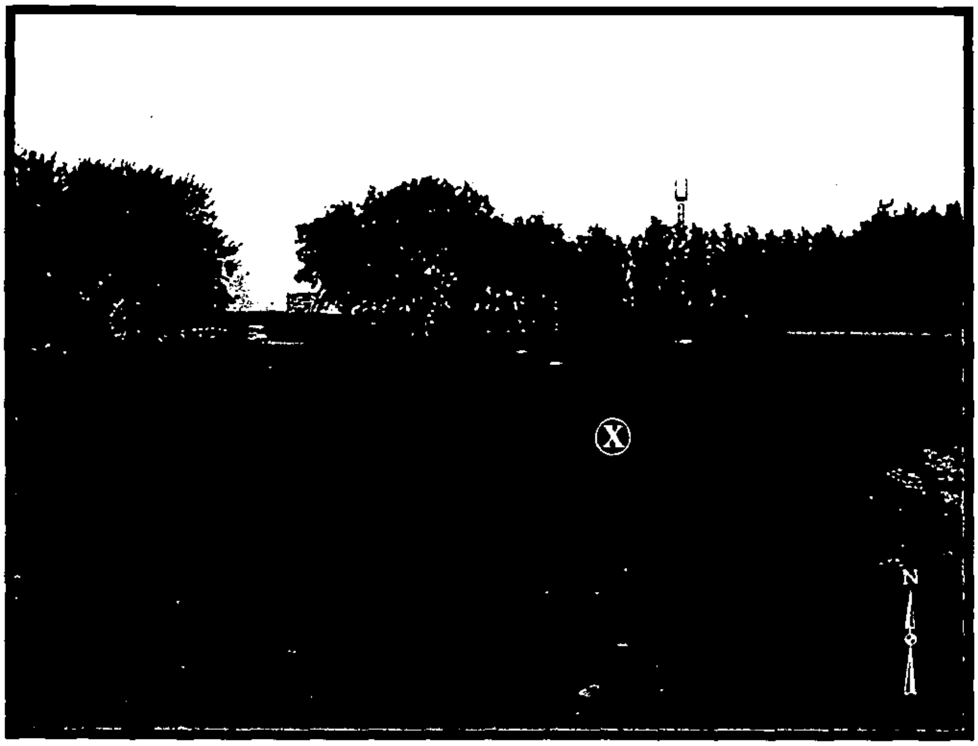
Attachment A
Proposed Well Locations

WHGLPA001

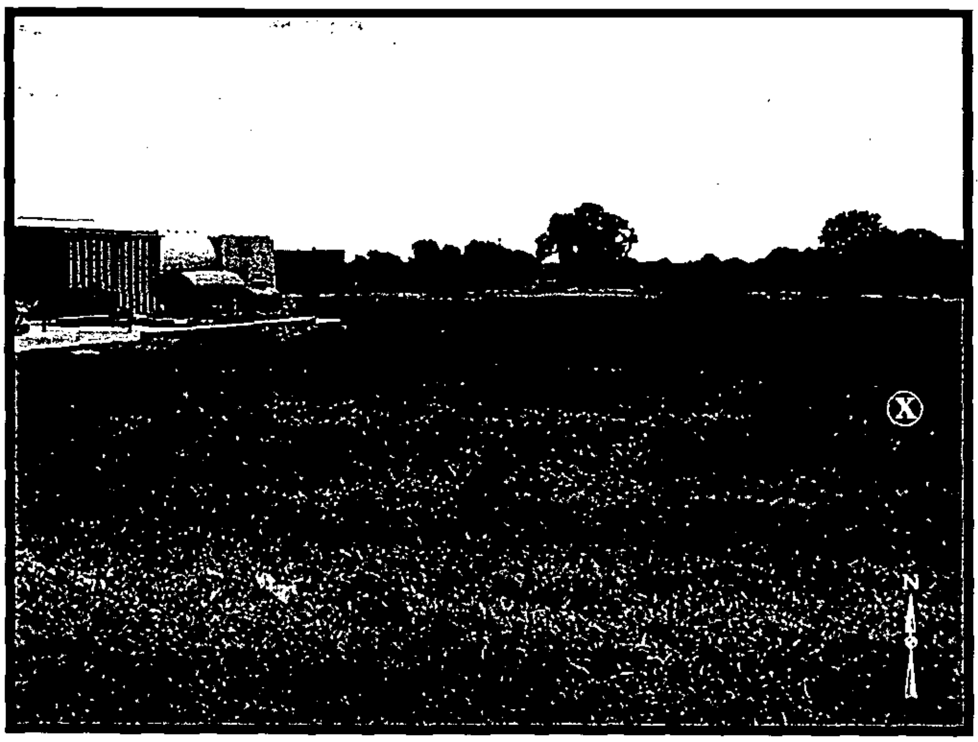
WHGLPA001

X:\AFC001\19BD\photos.cdr
Project No.: AFC001-19BD
Created by: cfarmer 06/29/00
Revised: 07/05/00 cf

Attachment A
Proposed Well Locations



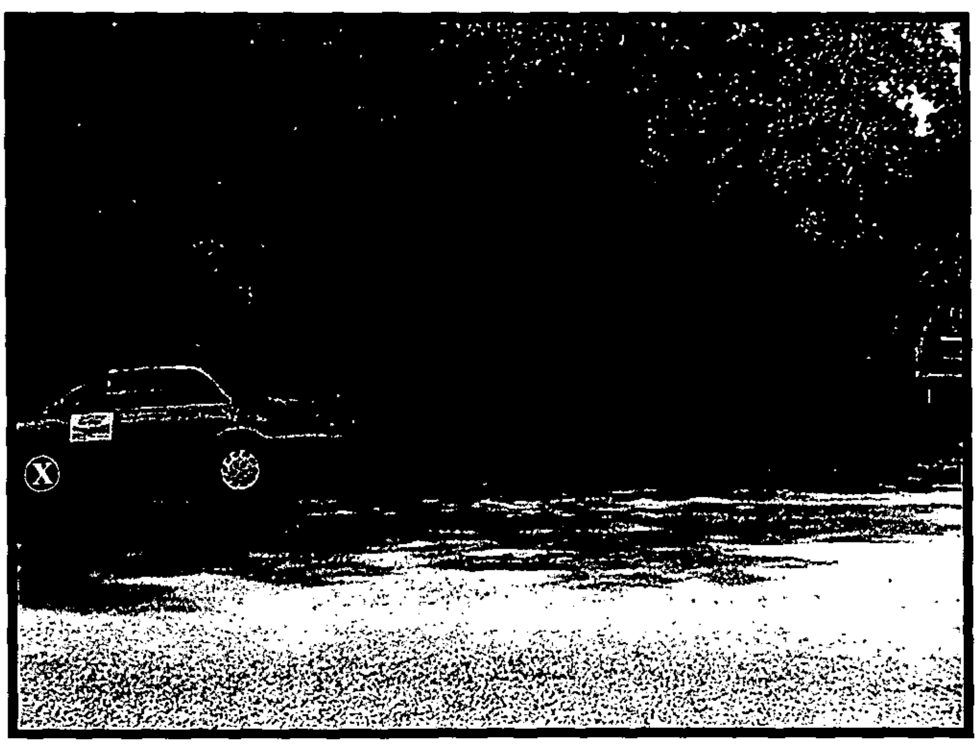
WHGLPA002



WHGLPA003

X:\AFC001\19BD\photos.cdr
Project No.: AFC001-19BD
Created by: clarmer 06/29/00
Revised: 07/05/00 cf

Existing WHGLRW015 shown for perspective.



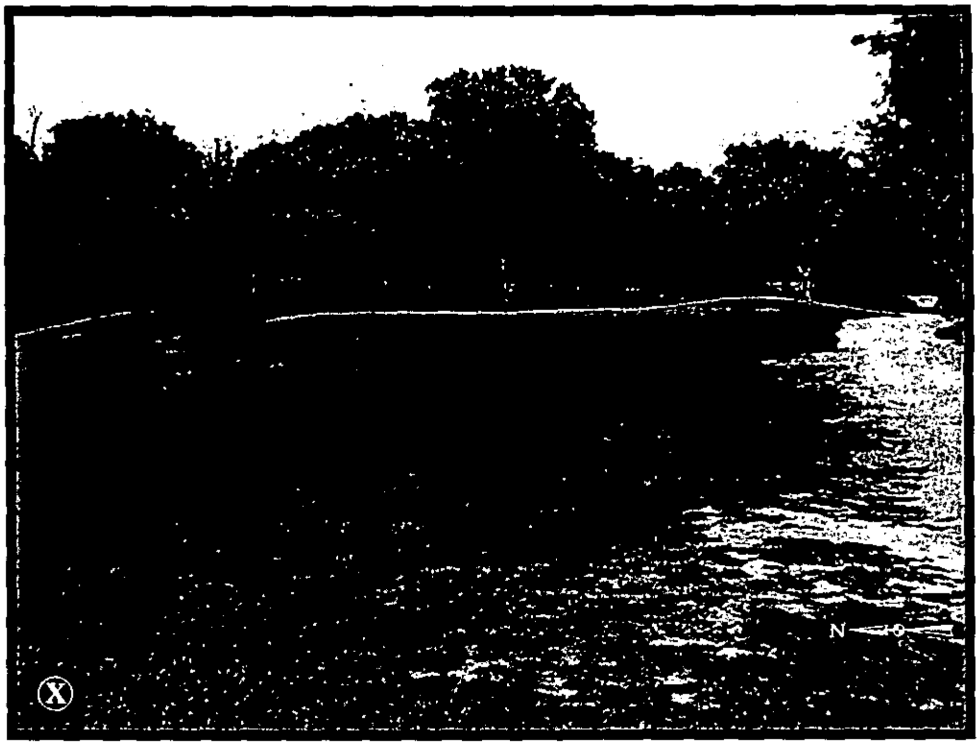
WHGLTA036— Not able to locate directly east of WHGLRW015 due to woods.

X:\AFC001\19BD\photos.cdr
Project No.: AFC001-19BD
Created by: cfarmer 06/29/00
Revised: 07/05/00 cf

WHGLTA037

WHGLTA038

X:\AFC001\19BD\photos.cdr
Project No.: AFC001-19BD
Created by: cfarmer 06/29/00
Revised: 07/05/00 cf



WHGLTA039

WHGLTA040

X:\AFC001\19BD\photos.cdr
Project No.: AFC001-19BD
Created by: cfarmer 06/29/00
Revised: 07/05/00 cf

WHGLTA041

WHGLTA042

X:\AFC001\19BD\photos.cdr
Project No.: AFC001-19BD
Created by: cfarmer 06/29/00
Revised: 07/05/00 cf

ATTACHMENT B

FIELD FORMS

BORING LOG

Borehole ID: ________
Sheet ____ of ____

AFIID				LOCID			
Project Name		Project Number		LTCCODE	Site ID		LPRCODE (IRPIMS)
Drilling Company DRL Code		Driller		Ground Elevation	Total Drilled Depth		EXCODE
Drilling Equipment	Drill/Excav Method	Borehole Diameter		Date/Time Drilling Started	Date/Time Total Depth Reached		
Type of Sampling Device				Water Level (bgs) First/Final	Site Name		
Sample Hammer Type Driving Wt. Drop				Hydrogeologist	Checked by/Date		SITEXREF

Depth	Interval	Recovery	Blow Counts	Description (Include lithology, grain size, sorting, angularity, Munsell color name & notation, minerology, bedding, plasticity, density, consistency, etc., as applicable)	USCS Symbol	Lithology	Water Content	Remarks (Include all sample types & depth, odor, organic vapor measurements, etc.)

HYDRO Geologic

BORING LOG (cont'd)

Borehole ID: ________
Sheet ____ of ___

Project Name	Project Number	Location

Depth	Interval	Recovery	Blow Counts	Description (Include lithology, grain size, sorting, angularity, Munsell color name & notation, minerology, bedding, plasticity, density, consistency, etc., as applicable)	USCS Symbol	Lithology	Water Content	Remarks (Include all sample types & depth, odor, organic vapor measurements, etc.)

HYDRO GeoLogic WELL CONSTRUCTION DETAILS AND ABANDONMENT FORM

FIELD REPRESENTATIVE: ____________________

DRILLING CONTRACTOR: ____________________

DRILLING TECHNIQUE: ____________________
AUGER SIZE AND TYPE: ____________________

BOREHOLE IDENTIFICATION: ____________________
BOREHOLE DIAMETER: ____________________
WELL IDENTIFICATION: ____________________

WELL CONSTRUCTION START DATE: __________
WELL CONSTRUCTION COMPLETE DATE: __________

SCREEN MATERIAL: ____________________
SCREEN DIAMETER: ____________________
STRATUM-SCREENED INTERVAL (FT): __________

CASING MATERIAL: ____________________
CASING DIAMETER: ____________________

TYPE OF FILTER PACK: ____________________
GRADIATION: ____________________
AMOUNT OF FILTER PACK USED: __________

TYPE OF BENTONITE: ____________________
AMOUNT BENTONITE USED: ____________________

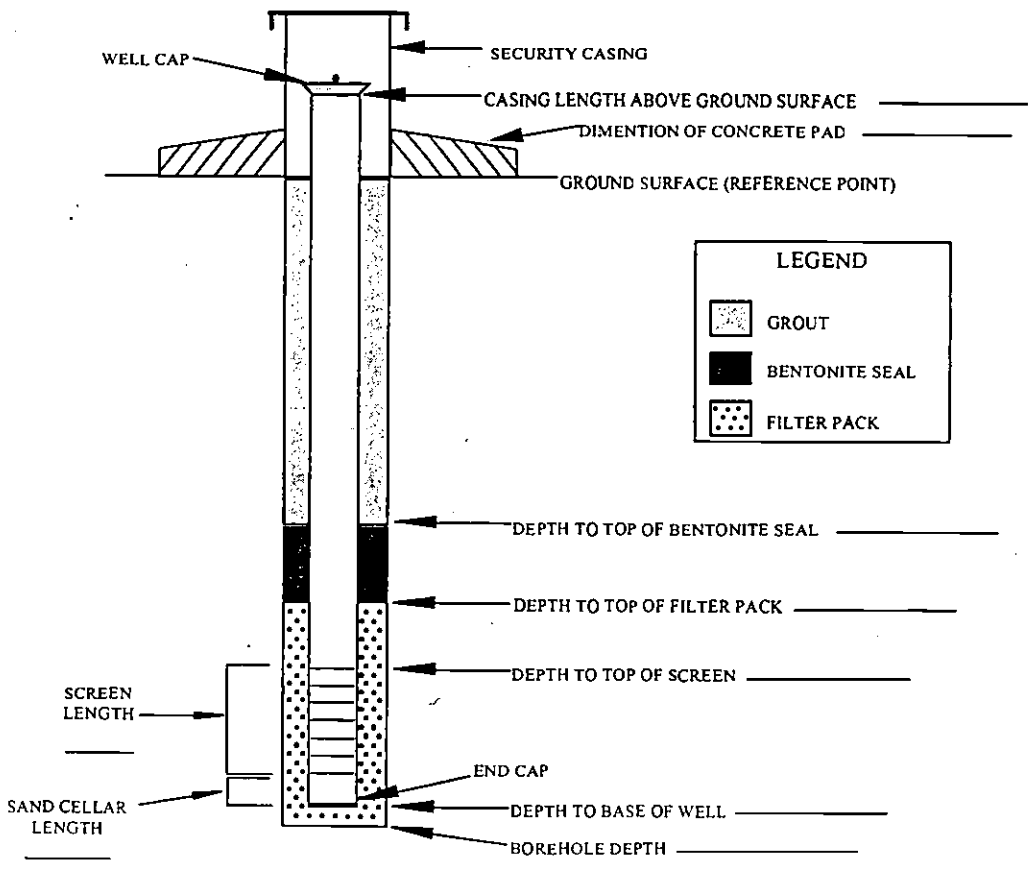
TYPE OF CEMENT: ____________________
AMOUNT CEMENT USED: ____________________
GROUT MATERIALS USED: ____________________

DIMENSIONS OF SECURITY CASING: __________

TYPE OF WELL CAP: ____________________
TYPE OF END CAP: ____________________

COMMENTS:

SPECIAL CONDITIONS
(describe and draw)



NOT TO SCALE

INSTALLED BY: ____________________ INSTALLATION OBSERVED BY: ____________________

DISCREPANCIES: ____

HYDRO GeoLogic

WELL DEVELOPMENT RECORD

WELL/PIEZOMETER ID ______
SHEET ______ of ______

AFID: ______________________ LOCID: ______________________ SITEID: ______________________

PROJECT NAME: ________________ PROJECT NO. : ________________ DATE: ________________

LOCATION: ________________ DATE INSTALLED: ______________________________

TOTAL DEPTH (FTOC) __________ CASING DIAMETER ______________ LOGCODE: HGL-H__________

METHODS OF DEVELOPMENT

☐ Swabbing ☐ Bailing ☐ Pumping ☐ Describe ______________________

Equipment decomtaminated prior to development ☐ Yes ☐ NO

Describe____

EQUIPMENT NUMBERS:

pH Meter ____________ EC Meter ____________ Turbidity Meter ____________ Thermometer ____________

CASING VOLUME INFORMATION:

Casing ID (inch)	1.0	1.5	2.0	2.2	3.0	4.0	4.3	5.0	6.0	7.0	8.0
Unit Casing Volume (A) (gal/ft)	0.04	0.09	0.16	0.2	0.37	0.65	0.75	1.0	1.5	2.0	2.6

PURGING INFORMATION:

Measured Well Depth (B) ____________________ ft.

Static Water Level Depth (C) ________________ ft.

Length of Static Water Column (D) _______ (B) - _______ (C) = _________ ft.

Casing Water Volume (E) + _______ (A) x _______ (D) = _________ gal

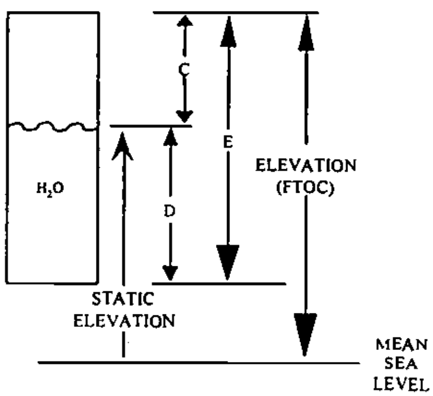
Total Purge Volume = _________ (gal)

Pumping/Purge Rate (PRODRATE) = ___________ (gal/min)

Pumping Depth (PUMPDEP) = _______________ (ft)

Water Level Recovery Depth (DEPWAT) = ____________ (ft)

Recovery Time (LECTIME) = ______________ (min)



Date	Time	Water Level (FTOC)	Volume Removed (gal)	pH	EC	Temperature F or C	Turbidity (NTU)	Comments

HYDRO GeoLogic

MONITOR WELL PURGING FORM

PROJECT : ______________________________ DATE: ________________

LOCATION: ______________________________ EXPLOSIMETER BOREHOLE READING ________

WELL ID: ______________________________ PURGE VOLUME (3 WELLBORE VOLUMES): ______________(L)

WELL DEPTH: ______________________________

Time	Depth to Water (ft)	Flow Meter Reading	Volume Purged (L)	Temp. (°C)	pH	Electrical Conductivity (mmho)	Turbidity N.T.U	Comments

Note: Condition of the well: ______________________________________

pH - Calibrate at start and before last reading.

Sampler ______________________________ Observer ______________________________

HYDRO GeoLogic

GROUNDWATER FIELD SAMPLING DATA SHEET

Well Name.:	Project Name:	LOCID:
Sampler(s):	Project No.:	
Well Depth:	Date:	Time:
DTW (ft TOC):	Screen Interval:	
Well Diameter (in):	Placement of Pump (ft TOC):	
Type of Pump:		

Field Parameters

Time	Depth to Water (ft)	Flow Rate (gpm)	Total Volume (gal)	pH	Temp. (C)	Cond. (umhos/cm)	ORP	D.O. (mg/L)	Turb. (N.T.U.)	Description

Observations

Notes:
Signed/Sampler(s):

HYDRO GeoLogic

MONITOR WELL STATIC WATER LEVEL FORM

PROJECT NAME: ____________________ DATE: ____________

PROJECT NO.: ____________________

WATER LEVEL INDICATOR ID NO.: ____________ FIELD BOOK NO.: ________

LOCATION: ____________________ PAGE NO.: ________

Monitor Well Name	LOCID	Time	Depth to Static Water Level (from T.O.C.)	Total Well Depth (ft)	Explosimeter Reading (above background)	PID Reading (above background)

Note: Total well depth to be measured at time of gauging.

Comments: ____

Sampler ____________________ Observer ____________________

HYDRO GeoLogic

AQUIFER TEST DATA FORM

AQUIFER TEST DATA

LOCATION ____________ SLUG VOLUME (FT^3) ____________

LOCATION I.D. ____________ LOGGER CODE ____________

LOGDATE ____________ ACCEPTANCE CODE ____________

TEST METHOD: ____________

COMMENTS: ____________

ELAPSED TIME (MIN)	DEPTH-TO-WATER (FT)
0.00	

ELAPSED TIME (MIN)	DEPTH-TO-WATER (FT)

ACCEPTANCE CODES: A - ACCEPTABLE R - RECONNAISSANCE U - UNACCEPTABLE N - NOT DETERMINED

FORM COMPLETED BY / DATE

TECHNICAL REVIEWER / DATE

HYDRO GeoLogic

SLUG TEST DATA FORM

SLUG TEST DATA

LOCATION ____________________ SLUG VOLUME (FT^3) ____________________

LOCATION I.D. ____________________ LOGGER CODE ____________________

LOGDATE ____________________ ACCEPTANCE CODE ____________________

TEST METHOD: [ ] SLUG INJECTION OR [ ] SLUG WITHDRAWAL

COMMENTS: ____________________

ELAPSED TIME (MIN)	DEPTH-TO-WATER (FT)	ELAPSED TIME (MIN)	DEPTH-TO-WATER (FT)
0.00			

ACCEPTANCE CODES: A - ACCEPTABLE R - RECONNAISSANCE U - UNACCEPTABLE N - NOT DETERMINED

FORM COMPLETED BY / DATE

TECHNICAL REVIEWER / DATE

HYDRO Geologic

FIELD SAMPLING REPORT

LOCATION: ____________________ PROJECT : ____________________

SITE: ____________________

SAMPLE INFORMATION

MATRIX ____________________ SAMPLE ID: ____________________

SAMPLING METHOD ____________ DUP./REP. OF : ____________________

BEGINNING DEPTH ____________ MATRIX SPIKE/MATRIX SPIKE DUPLICATE YES ( ) NO ( )

END DEPTH ____________________

GRAB ( ) COMPOSITE ( ) DATE: __________ TIME: __________

CONTAINER SIZE/TYPE	#	PRESERVATIVE/ PREPARATION	EXTRACTION METHOD	ANALYTICAL METHOD	ANALYSIS

NOTABLE OBSERVATIONS

PID READINGS	SAMPLE CHARACTERISTICS	MISCELLANEOUS
1st	COLOR:	
2nd	ODOR:	
	OTHER:	

pH ______ Temperature ______ Dissolved oxygen ______ Specific Conductivity______

GENERAL INFORMATION

WEATHER: SUN/CLEAR ____ OVERCAST/RAIN ____ WIND DRIECTION ______ AMBIENT TEMP _____

SHIPMENT VIA: FED-X ____ HAND DELIVER _____ COURIER ______ OTHER ______

SHIPPED TO: ____

COMMENTS: ____

SAMPLER: ____________________ OBSERVER: ____________________

MATRIX TYPE CODES

DC=DRILL CUTTINGS
WG=GROUND WATER
LH=HAZARDOUS LIQUID WASTE
SH=HAZARDOUS SOLID WASTE
SE=SEDIMENT
SL=SLUDGE
SO=SOIL
GS=SOIL GAS
WS=SURFACE WATER
SW=SWAP\WIPE

SAMPLING METHOD CODES

B=BAILER
BR=BRASS RING
CS=COMPOSITE SAMPLE
C=CONTINUOUS FLIGHT AUGER
DT=DRIVEN TUBE
W=SWAB\WIPE
G=GRAB
HA=HAND AUGER
H=HOLLOW STEM AUGER
HP=HYDRO PUNCH
SS=SPLIT SPOON
SP=SUBMERSIBLE PUMP

HYDRO GeoLogic INC.

Daily Equipment Calibration Log

Project Name: ____________________

Project No.: ____________________

Date/Time	Calibrated by	Instrument Make/ Model/Serial	Standard/ Manufacturer/Lots	Calibration Solution or Gas Concentration	Instrument Readings	Comments

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HYDRO GeoLogic INC.

WASTE INVENTORY TRACKING FORM

LOCATION : ______________________________

PROJECT NAME: ______________________________

ACTIVITIES: ______________________________

Date Waste Generated	Activity Generating Waste (borehole # / well #)	Description of Waste	Field Evidence of Contamination	Estimated Volume	Type of Container (storage ID#)	Location of Container	Waste Characterization	Comments

Note: Describe whether soil or water samples have been collected for waste characterization, include date, if known.

Signature: ______________________________

Chain of Custody Record

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

Client:____________

Project Name/No.:____________

Project Manager:____________

Sampler:____________

Phone: (703) 478-5186 Fax: (703) 471-4180

SAMPLE IDENTIFICATION	DATE COLL.	TIME COLL.	GRAB	COMPOSITE	MATRIX: SOIL	MATRIX: WATER	MATRIX: OTHER	TOTAL NO. OF CONTAINERS	ANALYSIS REQUIRED								REMARKS OR SAMPLE LOCATION

APPLICABLE REGULATION
- RCRA
- ECRA
- CERCLA
- NPDES
- CWA
- SDWA
- OTHER

Special Instructions

Possible Hazard Identification • Non-Hazard • Flammable • Skin Irritant • Poison B • Unknown			Sample Disposal • Return to Client • Disposal by Lab • Archive for ______ Months		
Turn Around Time Required • Normal • Rush	QC Level • I. • II. • III.		Project Specific (specify)		
1. Relinquished by	Date	Time	1. Received by	Date	Time
2. Relinquished by	Date	Time	2. Received by	Date	Time
3. Relinquished by	Date	Time	3. Received by	Date	Time

Comments

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LOG OF DAILY TIME AND MATERIALS

Project Name: ____________________
Project Number: ____________________
Subcontractor: ____________________
Date: ____________________

Boring or Well No.: ____________________

ITEM	NO. UNITS
Drilling /ft	
_____-inch augerhole	/ft
_____-inch mud rotary hole	/ft
_____-inch air rotary	/ft
Split spoon samples	
Shelby tube samples	
_____-rock coring	/ft
Driven casing _____-inch	/ft
Well Materials	
_____-inch stainless steel riser pipe	/ft
_____-inch stainless steel screen	/ft
_____-inch PVC riser pipe	/ft
_____-inch PVC screen	/ft
Couplings	
Bottom caps	
Top caps	
Protective casings w/ locking caps	
Well installation	/ft
Revert (bags)	
Bentonite powder (bags)	
Bentonite pellets (buckets)	
Sand (bags)	
Cement (bags)	
Other Charges	
Standby	/hr
Decontamination	/hr
Well development	/hr
Spoil disposal (barrels)	

Other: ____

____

HydroGeoLogic Site Representative: ____________________

Subcontractor Site Representative: ____________________

TAB

Health and Safety Plan

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FINAL
HEALTH AND SAFETY PLAN
DATA GAP INVESTIGATION
OF THE SOUTHERN LOBE TCE PLUME
NAS FORT WORTH JRB, TEXAS

Prepared for

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

Contract Number F41624-95-D-8005

Prepared by

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

August 2000

FINAL
HEALTH AND SAFETY PLAN
DATA GAP INVESTIGATION
OF THE SOUTHERN LOBE TCE PLUME
NAS FORT WORTH JRB, TEXAS

PROJECT:	U.S. Air Force Center for Environmental Excellence
PROJECT NUMBER:	Contract No. F41624-95-D-8005 HydroGeoLogic Project No. AFC001-0019 and 0036
PROJECT SITE LOCATION:	NAS Fort Worth JRB, Texas
PROJECT MANAGER:	Lynn A. Morgan, P.G.
HEALTH AND SAFETY OFFICER:	Kenneth F. Rapuano
SITE SAFETY OFFICER:	TBA
PLAN PREPARER:	Jorie Wilson
PREPARATION DATE:	July 2000

APPROVED BY:

8.22.00

Kenneth F. Rapuano — Date
HydroGeoLogic, Inc.
Health and Safety Officer

8/22/00

Lynn A. Morgan, P.G. — Date
HydroGeoLogic, Inc.
Project Manager

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LIST OF FIGURES

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LIST OF ACRONYMS AND ABBREVIATIONS

AFCEE	U.S. Air Force Center for Environmental Excellence
AFP-4	Air Force Plant 4
ANSI	American National Standards Institute
AOC	area of concern
AOI	area of interest
BRAC	Base Realignment and Closure
°C	degrees Celsius
CAFB	Carswell Air Force Base
CFR	Code of Federal Regulations
COR	contracting officer's representative
CPC	chemical protective clothing
CPR	cardiopulmonary resuscitation
dB(A)	decibel A-weighted scale
EBF	Electronic Borehole Flowmeter
EPA	U.S. Environmental Protection Agency
°F	degrees Fahrenheit
FAR	Federal Acquisition Regulation
FSP	Field Sampling Plan
FTA-2	Fire Training Area No. 2
HAZWOPER	Hazardous Waste Site Operations
HCS	hazard communication standard
HEPA	high efficiency particulate air
HPS	Hantarirus Pulmoney Syndrome
HSO	Health and Safety Officer
HSP	Health and Safety Plan
HydroGeoLogic	HydroGeoLogic, Inc.
IDLH	Immediately dangerous to life and health
JRB	Joint Reserve Base
LEL	lower explosive limit
MEK	methyl ethyl ketone
mg/m^3	milligrams per cubic meter

LIST OF ACRONYMS AND ABBREVIATIONS

MSDS	Material Safety Data Sheet
NAS Fort Worth JRB	Naval Air Station Fort Worth Joint Reserve Base
NIOSH	National Institute for Occupational Safety and Health
O_2	oxygen
OSHA	Occupational Safety and Health Administration
P.G.	Professional Geologist
PEL	permissible exposure limit
PID	photoionization detector
PM	Project Manager
POC	point of contact
PPE	personal protective equipment
ppm	parts per million
PVC	polyvinyl chloride
RCO	Responsible Corporate Officer
RFI	RCRA Facility Investigation
SSO	Site Safety Officer
SWMU	solid waste management unit
T	air temperature
T_{aj}	adjusted air temperature
TLV	threshold limit value
UEL	upper explosive limit
USCG	U.S. Coast Guard

FINAL
HEALTH AND SAFETY PLAN
DATA GAP INVESTIGATION
OF THE SOUTHERN LOBE TCE PLUME AT
NAS FORT WORTH JRB, TEXAS

1.0 INTRODUCTION

1.1 PURPOSE

This Health and Safety Plan (HSP) is designed to assign responsibilities, establish personnel protection standards, specify mandatory operating procedures, and provide for emergency contingencies with respect to health and safety issues that may arise while HydroGeoLogic, Inc. (HydroGeoLogic) personnel and subcontractor personnel are engaged in the following field investigations at the following sites (pictured in Figure 1.1 of the Work Plan):

- Paleochannel Delineation Wells - NAS Fort Worth JRB
- Paluxy/ Bedrock Continuity Wells - NAS Fort Worth JRB and Former Carswell Air Force Base (AFB)
- Southern TCE Plume Delineation Wells - Former Carswell AFB
- Aquifer Testing - Former Carswell AFB
- Aqueduct Assessment - NAS Fort Worth JRB and Former Carswell AFB

All of the sites are located within the former Carswell Air Force Base or the Naval Air Station Fort Worth Joint Reserve Base (NAS Fort Worth JRB), located in Fort Worth, Texas. The activities under this HSP and corresponding Work Plans were requested under the authorization of U.S. Air Force Center for Environmental Excellence (AFCEE) Contract Number F41624-95-D-8005, Delivery Order Numbers 0019 and 0036.

This HSP conforms to the requirements of Occupational Safety and Health Administration (OSHA) Standard 29 Code of Federal Regulations (CFR) 1910 and 1926. Detailed OSHA requirements for hazardous waste operations are contained in OSHA Standard 29 CFR 1910.120 and OSHA Standard 29 CFR 1926.65, "Hazardous Waste Operations and Emergency Response." Additional guidance for hazardous waste operations may be found in the U. S. Environmental Protection Agency (EPA) publication "Standard Operating Safety Guides" (June 1992), the National Institute of Occupational Safety and Health (NIOSH)/OSHA/U.S. Coast Guard (USCG)/EPA publication "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities" (October 1985), and Federal Acquisition Regulation (FAR) clause 52.236-13, Accident Prevention.

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

1.2 APPLICABILITY

The provisions of the HSP are mandatory for all official visitors, HydroGeoLogic employees, and subcontractors while investigations are being conducted at NAS Fort Worth JRB. These investigations will include the completion and sampling of 19 soil borings and monitoring wells. Inadequate health and safety precautions on the part of visitors or subcontractors, or the belief that personnel on the site are or may be exposed to an immediate health hazard, can be cause for HydroGeoLogic to suspend on-site activities and require all personnel to evacuate the area.

1.3 PROJECT ORGANIZATION, PERSONNEL, AND RESPONSIBILITIES

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

1.3.1 Responsible Corporate Officer

The Responsible Corporate Officer (RCO) for this project will be Jim Costello, P.G. The RCO has authority to direct changes to the Corporate Health and Safety Program and determines and implements personnel disciplinary actions, as required. The RCO's responsibilities for this project include the following:

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

1.3.2 Health and Safety Officer

The HSO for this project will be Ken Rapuano. The HSO has the authority to:

- Suspend work or otherwise limit exposure to personnel if health and safety plans appear to be unsuitable or inadequate
- Direct personnel to change work practices if existing practices are deemed to be hazardous to their health and safety

- Remove personnel from projects if their actions or conditions endanger their health and safety or the health and safety of coworkers

- Approve the qualifications of employees to work at hazardous waste sites

- Approve health and safety plans

The HSO responsibilities for this project will include the following:

- Interfacing with the Project Manager (PM) in matters of health and safety

- Keeping the RCO and PM informed on the status of the site health and safety plan

- Developing or reviewing and approving project health and safety plans prior to submittal

- Conducting staff training and orientation on health and safety-related activities

- Appointing or approving the Site Safety Officer (SSO)

- Monitoring compliance with health and safety plans and conducting site audits

- Assisting in obtaining required health and safety equipment

- Approving personnel to work on hazardous waste management projects with regard to medical examinations and health and safety training

- Maintaining records pertaining to medical surveillance, training, fit testing, chemical exposure, and accidents/incidents

- Providing industrial hygiene/chemical safety guidance

1.3.3 Project Manager

The PM for work under Delivery Order 19 will be Lynn A. Morgan, P.G. The PM for work under Delivery Order 36 will be Eric E. Evans, P.G. The PM has the authority to

- Coordinate with the HSO on health and safety matters

- Assign an HSO-approved SSO to the project and, if necessary, assign a suitably qualified replacement

- Temporarily suspend field activities if health and safety of personnel are endangered, pending an evaluation by the HSO

- Temporarily suspend an individual from field activities for infractions of the health and safety plan, pending an evaluation by the HSO

The PM responsibilities for this project will include the following:

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

1.3.4 Site Safety Officer

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

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

- Directing health and safety activities on the site
- Ensuring that appropriate personal protective equipment (PPE) is available and properly utilized by HydroGeoLogic personnel, visitors, and subcontractor personnel
- Ensuring that personnel are aware of the provisions of this plan, are instructed in the work practices necessary to ensure safety, and are aware of planned procedures for dealing with emergencies
- Ensuring that personnel are aware of the potential hazards associated with investigation activities
- Monitoring the safety performance of all personnel to ensure that required work practices are followed

- Monitoring the physical condition of site workers for heat and cold stress

- Correcting any work practices or conditions that may result in injury or exposure to hazardous substances

- Ensuring the completion of the site-specific HSP forms presented in Section 14.1 (e.g., Compliance Agreement, Accident/Incident Reports, Site Safety Briefing Form, etc.)

- Ensuring that a copy of the HSP is maintained on the site during all investigation activities

- Ensuring that all air monitoring and equipment calibrations required by the HSP are performed and recorded, and that logs/forms that include these activities are maintained (Section 14.1)

- Ensuring that the subcontractor's medical monitoring program is adequate per OSHA Standard 29 CFR 1910.120 and this HSP

- Verifying OSHA 40-hour health and safety training before admitting official site visitors (e.g., Air Force and regulatory representatives) in an exclusion zone and verifying medical certification and fit-testing for respirator use for visitors requesting admittance into a Level C PPE exclusion zone (per OSHA Standard 29 CFR 1910.120).

1.3.5 Project Field Personnel

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

- Taking all reasonable precautions to prevent injury to themselves and to their fellow employees

- Implementing the HSP and reporting any deviations from the anticipated conditions described in the plans to the SSO

- Performing only those tasks that they believe they can do safely, and immediately reporting any accidents and/or unsafe conditions to the SSO

1.3.6 Subcontractor Responsibilities

It is the responsibility of each HydroGeoLogic subcontractor to ensure compliance with all applicable Federal and state regulations, including OSHA Standard 29 CFR, Parts 1900 through 1910, and Part 1926, and the contents of this HSP. Specifically contained within these

OSHA regulations is OSHA Standard 29 CFR 1910.120, which includes requirements for training and medical surveillance for employees engaged in certain hazardous waste operations.

2.0 SITE DESCRIPTION INFORMATION

The primary area of interest (AOI) for this Data Gap Investigation consists of the area comprising the boundary of the NAS Fort Worth JRB and extending into the remaining extent of former Carswell AFB in the vicinity Southern Lobe TCE Plume. This area is located in the southeastern corner of former Carswell AFB and consists primarily of the former Carswell AFB golf course and base housing area. This area is under consideration for transfer to the Westworth Redevelopment under the BRAC program.

This investigation will also examine the aqueduct that acts as a subterranean conduit for Farmers Branch Creek. The aqueduct is located beneath the runway and flightline area, south of AFP 4, and transects the property in a generally east-west direction.

The locations of these areas are presented on Figure 1.1 of the Work Plan.

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

3.0 SITE INVESTIGATION ACTIVITIES

The following sections present the proposed field investigation tasks.

3.1 FIELD INVESTIGATION TASKS

The proposed field tasks described in the following sections will be conducted to achieve the investigation objectives. The field tasks described in the following sections were selected based on the type of data needed to complete the data collection process.

The following sections provide the investigative activities proposed by HydroGeoLogic, Inc. Suggested monitoring well locations may shift due to localized site-specific conditions such as utilities, fences, and structures encountered during the field implementation.

3.1.1 Mobilization

Mobilization to the field is expected to begin as soon as relevant portions of the Work Plan are approved. Several basic requirements for conducting field activities have already been established. Contractor photographic identification badges have been obtained for lead personnel who will escort subcontractors to and from restricted areas. The field office and primary staging area for field equipment and supplies will be located at 6560 White Settlement Road, NAS Fort Worth JRB, Texas.

3.1.2 Southern TCE Plume Delineation

Seven additional monitoring wells will be installed within the Southern Lobe TCE Plume to provide a comprehensive delineation of the plume extent and concentration boundaries. The proposed boring locations are illustrated on Figure 3.1 on the Work Plan. Six of the wells will be installed within the boundaries of the Former Carswell AFB. All monitoring wells will be installed to bedrock (approximately 35 feet bgs) and screened within the Terrace Alluvium. Six of the wells will be installed near areas of bedrock lows and generally north of Farmers Branch Creek. The remaining monitoring well will be installed outside the Former Carswell AFB property at the junction of Route 183, White Settlement Road, and Roaring Springs Road. One soil sample from each boring, with the highest field-screened volatile organic compound (VOC) concentration above the water table, will be submitted for VOC analysis by Method 8260B.

The monitoring wells will be installed as two-inch polyvinyl chloride (PVC) wells with 10 feet of screen set at bedrock. The wells will be developed after installation then purged (low flow) and sampled for VOCs in groundwater by Method 8260B. The wells will be sampled a second time approximately 2 months after the initial sampling.

3.1.3 Paleochannel Delineation and Aquifer Flow Testing

Six paleochannel monitoring wells will be installed along the suspected trace of the buried paleochannel. The locations of the paleochannel wells are illustrated on Figure 3.1 of the Work Plan. The wells will be set to a depth of approximately 45 feet bgs and will penetrate two to three feet into the underlying bedrock. The wells will be installed as 2-inch PVC wells screened throughout the entire thickness of the saturated portion of the Terrace Alluvium and extending 3 feet into the vadose zone. Soil samples will be collected and analyzed for VOCs at each well at the interval with the highest photoionization detector reading above the water table. Following well installation and development, the wells will be purged and sampled (low flow) for VOCs in groundwater by Method 8260B. The wells will be sampled a second time approximately 2 months after the initial sampling.

The six paleochannel wells will be used for flowmeter testing following the first groundwater sampling event. Flowmeter testing will be conducted in the six newly installed wells to determine vertical hydraulic conductivity profiles for each well. An Electromagnetic Borehole Flowmeter (EBF) will be used to determine the ambient flow profiles in the wells.

3.1.4 Aquifer Testing

An aquifer test will be performed at recovery well CAR-RW10 for purposes of evaluating the aquifer characteristics at this location. The location of the aquifer test area is shown on Figure 3.2 in the Work Plan. Well CAR-RW10 is situated at the boundary of the NAS Fort Worth JRB, adjacent to the former Carswell AFB golf course. Well CAR-RW10 is located in an area of the southern lobe TCE plume which has historically contained some of the greatest concentrations of dissolved chlorinated hydrocarbons. The aquifer test will consist of performing a 72-hour constant-rate pumping test from well CAR-RW10. Prior to performing the constant rate test, a one-day pumping rate step-test will be performed on CAR-RW10 to determine the optimal pumping rate from the well. The step test will begin at 5 gallons per minute (gpm) for 3 hours followed by 10 gpm for 3 hours and concluded by pumping 20 gpm for an additional 3 hours. A rest period between pumping events is required to allow the test well to return to baseline conditions prior to proceeding with the next pumping event.

3.1.5 Lithologic Evaluation of Bedrock and Paluxy Aquifer Wells

The lithologic evaluation will consist of obtaining rock core from the entire thickness of the Goodland/Walnut confining units located beneath the Terrace Alluvium. The borings/core will continue 15 feet into the saturated portion of the underlying Paluxy Formation. The Goodland/Walnut and Paluxy cores will be collected from three borings located within the NAS Fort Worth JRB and Former Carswell AFB boundaries. The proposed core locations are illustrated on Figure 3.1 of the Work Plan. One soil sample from each boring, with the highest field-screened VOC concentration above the water table, will be submitted for VOC analysis by Method 8260A. The three borings will be completed as groundwater monitoring wells. The monitoring wells will be screened only within the Paluxy Formation. The monitoring wells will be installed as two-inch PVC wells with approximately 15 feet of well screen. The wells will be developed after installation then purged (low flow) and sampled for VOCs in groundwater by Method 8260B. The wells will be sampled a second time approximately 2 months after the initial sampling.

3.1.6 Aqueduct Assessment

An assessment will be performed on the subterranean aqueduct located beneath the runway and main flightline area of NAS Fort Worth JRB (Figure 3.3 in the Work Plan). The aqueduct consists of two large drainage culverts buried beneath the flightline area. The aqueduct is located south of AFP 4 and bisects the NAS Fort Worth JRB runway in a generally east-west direction. The aqueduct allows Farmers Branch Creek to flow east from the White Settlement community, across the base and through the golf course area, and discharge into the West Fork of the Trinity River. The majority of flow within Farmers Branch Creek is generated from surface runoff. The remaining flow within Farmers Branch is generated from recharge derived from the local Terrace Alluvium groundwater. Farmers Branch creek is also fed by intermittent, unnamed tributaries prior to its entrance into the aqueduct and after its emergence within the golf course area. The assessment will include a characterization of its construction, subsurface setting, and potential contaminant entry points obtained by conducting a site walk through. The walk through will be videotaped for later evaluation and for record keeping. No other intrusive investigations are planned as part of this assessment.

4.0 HAZARD ASSESSMENT

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

- Section 6.0, Air Monitoring
- Section 7.0, Personal Protective Equipment
- Section 11.0, Standard Work Practices
- Section 11.5 , Confined Space Entry

4.1 CHEMICAL HAZARDS

The primary concerns from a chemical exposure standpoint are inhalation, ingestion, and absorption by direct skin contact with contaminants in locations expected to be source areas. Based upon the information obtained from previous site investigations (groundwater and soil), the primary chemicals of concern at NAS Fort Worth JRB have been identified and are listed in Table 4.1, along with their exposure limits and recognition properties. The acute and chronic symptoms of overexposure to these chemical contaminants and first aid procedures are presented in Table 4.2. If additional contaminants are identified during project activities, this HSP will be amended accordingly.

4.2 DECONTAMINATION SOLUTIONS AND PRESERVATIVES

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

- Nitric Acid
- Hydrochloric Acid
- Sulfuric Acid
- Methanol
- Hexane
- Liquid Tide ™
- Alconox ™

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

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

4.3 PHYSICAL HAZARDS

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

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

Control measures to help protect site personnel from these potential hazards are incorporated in the following subsections and throughout this HSP.

4.3.1 Heat Stress

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

- Heat rash may result from continuous exposure to heat or humid air.

- Heat cramps are caused by heavy sweating with inadequate electrolyte replacement. Signs and symptoms include muscle spasms and pain in the hands, feet, and abdomen.

- Heat exhaustion occurs from increased stress on various body organs, including inadequate blood circulation due to cardiovascular insufficiency or dehydration. Signs and symptoms include pale, cool, and moist skin; heavy sweating; dizziness, fainting, and nausea.

- Heat stroke is the most serious form of heat stress. Temperature regulation fails and body temperature rises to critical levels. Immediate action must be taken to cool the body before serious injury or death occurs. When heat stroke is suspected, professional medical help must be obtained immediately. Signs and symptoms include red, hot, and unusually dry skin; lack of or reduced perspiration; dizziness and confusion; strong, rapid pulse; and coma.

Proper training and preventive measures will help avert serious illness and loss of work productivity. Preventing heat stress is particularly important, because once someone suffers from heat stroke or heat exhaustion, that person may be predisposed to additional injuries. To avoid heat stress, the following steps should be taken:

- Work schedules should be adjusted. The following guidelines of rest and cooling of the body will be followed to minimize the effects of heat stress:

  - If oral temperature exceeds 99.6 degrees Fahrenheit (°F) (37.6 degrees Celsius [°C]), shorten the next work cycle by one-third without changing the rest period.
  - If oral temperature still exceeds 99.6 °F (37.6 °C) at the beginning of the next rest period, shorten the following work cycle by one-third.
  - Do not permit a worker to wear a semipermeable or impermeable garment when his/her oral temperature exceeds 100.6 °F (38.1 °C).

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

- Shelter (equipped with air conditioners and other cooling devices, if possible) or shaded areas should be provided to protect personnel during rest periods.

- Workers' body fluids should be maintained at normal levels to ensure that the cardiovascular system functions adequately. Daily fluid intake must approximately equal the amount of water perspired, which will vary from day to day. The normal thirst mechanism is not sensitive enough to ensure that water intake is sufficient to replace water lost through perspiration. When heavy sweating occurs, workers should be encouraged to drink more. Have workers drink fluid (preferably water or diluted drinks) before beginning work. Urge workers to drink a cup or two at each scheduled break. A total of 1 to 1.6 gallons (4 to 6 liters) of fluid per day are recommended, but will depend on actual fluid replacement needs, which will vary depending on the sweat rate.

- The drinking water temperature should be maintained at 50 °F to 60 °F (10 °C to 15.6 °C).

- Disposable cups that hold about 16 ounces should be provided.

- Workers should be encouraged to maintain an optimal level of physical fitness. Where indicated, acclimatize workers to site work conditions.

- Workers should be trained to recognize, identify, and treat heat stress.

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

- Move the victim out of the heat.

- Loosen tight clothing.

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

4.3.2 Cold Stress

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

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

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

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

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

4.3.3 Noise Hazards

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

4.3.4 Materials Handling

The most common type of materials handling accident involves fingers or toes of field personnel being caught between two objects. Special precautions must be implemented during the moving, shifting, or rolling of materials; and these activities should never be attempted by a single individual. Workers are required to use proper lifting techniques for handling materials, and oversized or heavy loads require "team lift" procedures.

4.3.5 Utility Hazards

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

4.4 BIOLOGICAL HAZARDS

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

- Poisonous Animals
- Ticks
- Animal-Borne Diseases
- Poisonous Plants (e.g., poison sumac, poison ivy, poison oak)

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

4.4.1 Poisonous Animals

Poisonous animals that pose a potential threat at NAS Fort Worth JRB include snakes, insects (ants, bees, wasps), and spiders. Rattlesnakes are the most common poisonous snake in the area. Reactions from a snakebite are aggravated by acute fear and anxiety. Other factors that affect the severity of local and general reaction from a poisonous snakebite include the amount of venom injected and the speed of absorption of venom into the victim's circulation; the size of the victim; protection provided by clothing, including shoes and gloves; quick anti-venom therapy; and location of the bite. Poisoning can occur from injection or absorption of venom through cuts or scratches. Personnel should avoid walking in grass or underbrush at night and not climb rocky ledges without prior visual inspection. Field personnel should wear high-top boots and heavy pants since more than half of all snakebites are on the lower parts of the legs. Workers should not attempt to kill snakes unnecessarily as many people are bitten in such attempts.

Biting and stinging insects, such as ants, bees, and wasps, are very common. Generally, the bite and stings from these insects, although painful, are not dangerous; however, if bitten or stung by a large number of these insects, an individual may experience serious injury or even death. This is especially true of individuals who are particularly sensitive or allergic to insect toxins. Most of these insects live in easily recognizable nests, but many are encountered far from their nest. Care should be taken when entering little-used structures (sheds, utility buildings) and when opening monitoring well covers.

Spiders in the United States are generally harmless, with two notable exceptions: the black widow spider (*Latrodectus mactans*) and the brown recluse or violin spider (*Lox osceles reclusa*). The symptoms of a black widow spider bite are slight local reaction, severe pain produced by nerve toxin, profuse sweating, nausea, painful cramps in abdominal muscles, and difficulty in breathing and speaking. The symptoms of a brown recluse spider bite can be mild to severe. In the mildest form, the bite can cause pain and swelling like a bee sting or ant bite. If the reaction is severe, the bite area may become swollen, painful, and weep fluid. Swelling and reddening may spread to an entire limb, and if left untreated, the bite may cause necrosis of surrounding tissue and infection. Diarrhea, stomach cramps, and hot/cold flashes may also occur. Victims of poisonous spider bites recover in almost all cases, but an occasional death is reported.

Field personnel should exercise caution when lifting items such as logs, rocks, covers to manholes, and sump covers where poisonous animals could be encountered.

4.4.1.1 First Aid Procedures (Snakebite)

The objective of first aid is to reduce the circulation of blood through the bite area, to delay absorption of venom, to prevent aggravation of the local wound, and to sustain respiration. Several steps are listed to properly care for a snakebite victim. The most important step is to get the snakebite victim to the hospital quickly. In addition, take the following first aid measures:

- Keep the victim from moving around.
- Keep the victim as calm as possible and preferably in a lying position.
- Immobilize the bitten extremity and keep it at or below heart level. If the victim can reach a hospital within 4 to 5 hours, and if no symptoms develop, no further first aid measures need to be applied.
- If mild-to-moderate symptoms develop, apply a constricting band 2 to 4 inches above the bite, but not around a joint (the elbow, knee, wrist, or ankle) and not around the head, neck, or trunk. The band should be ¾ to 1½ inches wide, not thin like a rubber band. The band should be snug but loose enough for a finger to be slipped underneath. Watch for swelling and loosen the band if it becomes too tight, but do not remove it. Periodically check the pulse in the extremity beyond the bite to insure that the blood flow has not completely stopped.

Several other factors must be considered in cases of snakebite:

- Shock. Keep the victim lying down and comfortable, and maintain his or her body temperature.
- Breathing and heartbeat. If breathing stops, give mouth-to-mouth resuscitation. If breathing stops and there is no pulse, perform CPR if you have been trained to do so.
- Identifying the snake. If you can kill the snake without risk or delay, bring it to the hospital for identification, but exercise extreme caution in handling the snake.
- Cleaning the bitten area. You may wash the bitten area with soap and water and blot it dry with sterile gauze. You may apply dressings and bandages, but only for a short period of time.

- Medicine to relieve pain. Do not give the victim alcohol, sedatives, aspirin, or any medicine containing aspirin. Consult a doctor or other medical personnel for specific medications that may be used.

- Snakebite kits. Keep a kit accessible for all outings in primitive areas or areas known or suspected to be snake infested.

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

4.4.1.2 General First Aid for Poisonous Insect Bites/Stings

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

- Apply a constricting band above the injection site on the victim's arm or leg (between the site and the heart). Do not apply tightly. You should be able to slip your index finger under the band when it is in place. Give artificial respiration if necessary.

- Keep the affected part below the level of the victim's heart.

- If medical care is ready available, leave the band in place; otherwise, remove it after 30 minutes.

- Apply ice contained in a towel or plastic bag, or cold cloths, to the site of the sting or bite.

- Give home medicine, such as aspirin, for pain.

- If the victim has a history of allergic reactions to insect bites/stings or is subject to attacks of hay fever or asthma, or if he or she is not promptly relieved of symptoms, call a physician or take the victim immediately to the nearest location where medical treatment is available. **In a highly sensitive person, do not wait for symptoms to appear, since delay can be fatal.**

- In case of a bee sting, use tweezers to remove and discard the stinger and venom sac.

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

4.4.2 Ticks

Field personnel should be aware of the presence of ticks at the site. When in an area suspected of harboring ticks (grassy, bushy, or woodland area) the following precautions can minimize the chances of being bitten by a tick:

- Wear long pants and long-sleeved shirts that fit tightly at the ankles and wrists.
- Wear light colored clothing so ticks can be easily spotted.
- Wear tick repellents.
- Inspect clothing frequently while in tick habitat.
- Inspect your head and body thoroughly when you return from the field.

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

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

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

4.4.3 Animal-Borne Diseases

There are three principal diseases that can be transmitted by contact with rodents and other animals: rabies, bubonic plague, and hantavirus pulmonary syndrome (HPS). For this reason, field personnel will avoid all contact with rodents and other animals (alive or dead), rodent droppings. and rodent nests. All of these should be considered to be potentially contaminated with life-threatening pathogens.

Rabies is a disease that is transmitted through the saliva of rodents, as well as other mammals, such as dogs, cats, raccoons, foxes, bats, and cattle. An animal infected with the disease may act strangely (e.g., not afraid of humans, out at the wrong time of day or night), drool, or appear partially paralyzed. **If left untreated, rabies is a fatal disease.** If someone is bitten by an animal, treat the wound first, especially if the bleeding is serious, then get the person immediate medical attention. Do not attempt to kill or capture the animal, as further injuries could result. Call the local animal control authorities, and provide them with a description of the animal and the location of the incident.

Bubonic plague is the disease that was the cause of the plague known as the Black Death which decimated the populations of Europe in the Middle Ages and Renaissance. The disease is caused by a bacterium carried by the oriental rat flea, *Xenopsylla cheopis*, which is found on rats, mice, and jackrabbits. Epidemics of the disease do not occur in the U.S., but isolated cases have occurred in the southwestern states. The symptoms of the disease are a dark, pimple-like inflammation at the site of the bite, followed by a swelling of the lymph node closest to the bite area. The victim will develop an extremely high fever and dark splotching due to subcutaneous hemorrhaging. Untreated bubonic plague has a mortality rate of approximately 60%; however, the disease responds well when treated promptly with antibiotics (though not penicillin).

HPS is an infectious respiratory disease caused by exposure to the hantavirus. While cases of HPS are rare (generally less than 50 per year), HPS is fatal in approximately half the reported cases. This virus is present throughout the southwestern U.S. and is carried by rodents, especially mice. The virus enters the human body by the inhalation of particles, such as dust, which has become contaminated by the virus by exposure to rodent saliva, urine, or droppings. If personnel are exposed to rodents, droppings, or rodent nests, get immediate medical attention. HPS can be diagnosed using an antibody test. The symptoms of HPS are initially flu-like; after three to five days, the victim will develop coughing and shortness of breath, which will rapidly become more serious. At this point, it is imperative that the victim receive medical attention. If treated in time, there is an excellent chance of surviving the disease; however, untreated HPS is very often fatal.

Armadillos are common in the Fort Worth area. These animals are nocturnal and avoid humans, but are often found dead, especially along roads. It is estimated that 5% of these animals carry the bacillus that causes leprosy, *Mycobacterium leprae*. This disease is not very contagious (it is believed that up to 95% of all humans are naturally immune); however, all dead armadillos encountered at the site should be treated as potentially infectious and avoided.

4.4.4 Poisonous Plants

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

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

4.4.4.1 First Aid Procedure

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

5.0 HAZARD COMMUNICATION

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

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

In order to comply with the HCS, HydroGeoLogic has made the following determinations:

- All containers of hazardous chemicals must be appropriately labeled or tagged to identify the hazard and provide information on effects and appropriate protective measures.
- Labels, tags, or signs must be properly affixed and visible at all times while a hazard is present and removed promptly when the hazard no longer exists.
- Written information (i.e., MSDSs) on hazardous chemicals in the workplace must be available to employees working with the substances.
- Appropriate MSDSs will be available to any contractor or subcontractor employee working on projects under HydroGeoLogic's control.

When investigation results indicate potential imminent health risks to contracted or Federal personnel, or the public at large, the contracting officer's representative (COR) and the base point of contact (POC) will be notified as soon as practicable. Written notification and supporting documentation will be provided within 3 days of finding potential imminent health risks during investigation activities.

6.0 AIR MONITORING

This section presents requirements for the use of real-time air monitoring instruments during site activities involving potential for exposure to site contaminants. It establishes the types of instruments to be used, the frequency of their use, the techniques for their use, the action levels for upgrading/downgrading levels of protection, and the methods for instrument maintenance and calibration.

6.1 INSTRUMENTS AND USE

A photoionization detector (PID) equipped with an appropriate lamp will be utilized for detecting the presence of emissions from chemicals of concern. A Dräger pump and colorimetric tubes will be used to confirm any detections observed with the PID in accordance with Table 6.1. Additionally, lower explosive limit/oxygen (LEL/O_2) detectors will be used during all drilling and excavation activities to detect the presence of flammable/explosive atmospheres. Visual observation will be used to detect the presence of airborne particulate.

The PID/Dräger pump will be used throughout the execution of these activities:

- Soil boring installation
- Soil sampling
- Sampling equipment decontamination/heavy equipment decontamination
- Waste characterization and disposal

6.2 AIR MONITORING REQUIREMENTS

6.2.1 Photoionization Detector

Air monitoring with the PID will be initiated at potential sources of vapor emissions (source monitoring) at specified frequencies. The frequencies will be increased where concentrations of constituents are measured. The following potential sources and monitoring frequencies are anticipated:

- The PID will be used to monitor each sample location during environmental sampling.
- The PID will be used to monitor each 5-foot interval during surface and subsurface soil sampling.
- The PID will be used to monitor each container sampled during RFI waste characterization.

If source monitoring indicates the presence of airborne emissions, air monitoring will then be initiated in the breathing zones of those workers who could be affected by the emissions. Air monitoring will also occur upon the request of site workers who notice unusual site odors or an increase in their intensity. If work is to be performed downwind of a site, air monitoring will be conducted to determine what type of PPE, if any, is required to protect workers and to determine the potential for an imminent threat to public health.

The presence of elevated readings in the worker's breathing zone as identified in Table 6.1 requires amendments to the HSP before workers are allowed to enter the exclusion zone. Depending on the air monitoring readings, air-purifying respirators may not be acceptable because some contaminants of concern have poor warning properties and/or cannot be filtered from inspired air with chemical cartridges (Table 6.1). Elevated readings will be based on confirmation sampling using a Dräger pump and colorimetric tubes in accordance with Table 6.1.

6.2.2 Dräger Pump and Tubes

A hand-operated Dräger pump with colorimetric tubes will be used to confirm the results of PID testing. If the results of the PID tests show concentrations greater than 0.5 parts per million (ppm) above background concentrations in the breathing zone, then the colorimetric tubes will be used to identify the contaminants in the breathing zone. Colorimetric tubes to be utilized in the event of elevated PID readings will include vinyl chloride, benzene, tetrachloroethene, or trichloroethene in accordance with Table 6.1. The colorimetric tube utilized will depend on the chemical anticipated to be present at the site.

6.2.3 LEL/O_2 Detectors

Air monitoring with the LEL/O_2 detectors will be conducted during all drilling and excavation activities within boreholes, and immediately over drill cuttings at every 5-foot depth interval, and also during the aqueduct walk through. If elevated (above background) LEL readings are observed, personnel must be advised of the potential explosive nature and must initiate the use of spark proof tools in accordance with Table 6.1. LEL readings in excess of 10 percent requires cessation of drilling and abandonment of the drilling location until readings subside.

6.2.4 Visual Observations

If airborne particulate are observed and air monitoring results (as indicated in Table 6.1) warrant, personnel must don air-purifying respirators equipped with organic vapor cartridges and high efficiency particulate air (HEPA) filters. If airborne particulate are observed due to intrusive activities at these sites, dust control measures will be implemented.

6.3 MODIFICATION OF AIR MONITORING REQUIREMENTS

The action levels and protection measures presented in Table 6.1 are based upon the assumption that the contaminants listed in Table 4.1 are the only contaminants that pose a reasonable health risk to site workers. In the event that this assumption is found to be invalid through analysis of samples collected, or by some other means, the action levels will be modified as necessary.

6.4 INSTRUMENT MAINTENANCE AND CALIBRATION

Air and noise monitoring instruments are maintained and prefield-calibrated at the HydroGeoLogic field office on the golf course. Field maintenance will consist of daily cleaning of the instruments using a damp towel or rag to wipe off the instrument's outer casing, overnight battery recharging, and cleaning or replacing of the lamp whenever calibration cannot be attained. Procedures for accomplishing instrument maintenance is contained in the PID user's manual provided with each instrument. The user's manual provided with each instrument will be followed to field calibrate the instrument prior to each day of use under the environmental conditions (temperature and humidity) that sampling will occur. Field equipment will also be calibrated at the end of each day to account for instrument drift and reliability.

6.5 RECORD KEEPING

Instrument calibrations and readings will be recorded on the Air Monitoring Log Sheet provided in Section 14.1 of this HSP. Copies of these log sheets will be maintained on-site until field activities covered by this HSP have been completed. The log sheets will be transmitted to the HydroGeoLogic HSO and to the project file at the completion of the field work.

LEL/O_2 readings will not be recorded unless flammable/explosive or oxygen deficient/enriched atmospheres are detected, in which case entries will be made in the field log book.

LEL/O_2, detector, and the PID will undergo daily operational checks. These checks will be recorded in the field log book and Equipment Calibration Log (Section 14.1).

7.0 PERSONAL PROTECTIVE EQUIPMENT

This section presents requirements for the use of PPE for each of the activities being conducted. This section includes anticipated levels of protection for each of the activities, the criteria used for selecting various levels of protection, and criteria for modifying levels of protection based on monitoring instrument readings, and personal observations.

7.1 ANTICIPATED LEVELS OF PROTECTION

Most work is anticipated to be performed in Level D protection, as defined in Appendix B of OSHA Standard 29 CFR 1910.120. Many activities may require the use of chemical resistant coveralls, gloves, and boot covers as presented in Table 7.1.

Entry to the aqueduct is to be performed in Level B protection, as defined in Appendix B of OSHA Standard 29 CFR 1910.120 except as follows. Level B protection in this instance is for respiratory protection. Skin protection is not anticipated to be necessary. Long pants and long sleeve shirts are required due to possible spiders, tics, etc. Tyvek is expected to create an unnecessary heat stress hazard.

The items of PPE anticipated to be used for each activity are presented in Table 7.1. Where overlap in activities occurs, the more protective requirement will apply.

7.2 PPE SELECTION CRITERIA

Respiratory protection is not anticipated for use during the initial stages of work until detectability of site contaminants with air monitoring instruments warrants the donning of respirator protection in accordance with Table 6.1. See Section 7.3 for modification criteria of respiratory protection. Basic requirements for field personnel using respiratory protection include the following:

- All field personnel will be medically certified to wear a full-face respirator and have the proper fit test documentation within the past 12 months prior to assignment.
- Only NIOSH-approved respirators are to be used on-site. The respirators are to be properly cleaned, inspected, and maintained prior to and at the conclusion of the work day.
- Cartridges to air-purifying respirators will be disposed of at the end of each work day and when load-up or breakthrough occurs.
- Field personnel will be clean shaven in areas that might prevent the seal of the respirator to the face, and contact lenses will not be permitted while wearing a respirator.

Hard hats, safety glasses, and steel-toe work boots will be used as minimum protection to reduce the potential for injury resulting from exposure to the physical hazards associated with on-site investigations.

Boot covers, disposable nitrile gloves, and Tyvek™ coveralls will be used to minimize contamination of work clothes and to prevent direct skin contact with low level contamination. Nitrile gloves of 11 mil thickness or greater will be worn for activities that may involve direct contact with appreciable concentrations of contaminants thought to be present as site contaminants.

Polyvinyl chloride (PVC) or Saranex™ coveralls, hoods, and/or splash shields will be worn to prevent saturation of work clothes during activities involving large volumes of liquids and/or saturated soils/equipment.

7.3 PPE MODIFICATION CRITERIA

This section presents criteria for upgrading and downgrading chemical protective clothing (CPC) and/or respiratory protection. When uncertainties arise, the more protective requirement will apply.

7.3.1 CPC Modification Criteria

Tyvek™ coveralls and boot covers must be worn anytime there is a reasonable potential for contamination of street clothes.

Disposable nitrile gloves must be worn anytime there is a reasonable potential for contact with unsaturated soils or equipment that may contain trace contamination.

Nitrile gloves (11 mil or greater) must be worn anytime there is a reasonable potential for contact with groundwater, saturated soils, and/or soils producing elevated PID readings.

PVC or Saranex™ coveralls must be worn anytime there is a reasonable potential for saturation of work clothes.

8.0 DECONTAMINATION

This section describes the steps site personnel will follow to prevent the spread of site contaminants into areas that may affect unprotected, unsuspecting site personnel or the public. It includes requirements for decontamination of personnel, sampling equipment, and augering/drilling equipment.

8.1 PERSONNEL DECONTAMINATION

The decontamination of personnel and their protective clothing will be performed within the decontamination zone. Table 8.1 presents the six stages for decontamination for Modified Level D protection.

Wash tubs containing an appropriate decontamination solution and soft-bristle brushes will be used to wash reusable PPE and boots. Clean water will be used for the final rinse. The choice of decontamination solution is dependent upon the type of materials that must be removed from reusable protective equipment. Based on the current understanding of potential site contaminants, a detergent and water solution is recommended for general purpose decontamination. Acceptable detergents include laboratory-grade cleaners (e.g., Alconox™ or equivalent), or a high strength consumer detergent such as Liquid Tide™.

Alternative decontamination solutions may be called for if the contaminants encountered are different or in a more concentrated state than anticipated. Alternative solutions include the following:

- Dilute acids for removal of basic (caustic) compounds, amines, and hydrazines
- Dilute bases (soaps and detergents) for removal of acidic compounds, phenols, thiols and some nitro and sulfonic compounds
- Organic solvents for removal of nonpolar compounds (organic)

Gloves and other PPE should be inspected frequently for integrity, and manufacturers' data for breakthrough times should be considered if concentrated contaminants are encountered.

The decontamination of personnel and their protective clothing will be performed in 18 stages for Level C protection, if necessary. The 18 stages are presented in Table 8.2.

All decontamination fluids generated will be contained and disposed of as specified in the Work Plan. The decontamination area will be physically identified with rope or flagging and will be sufficiently equipped to be conducive for completion of the stages listed above.

8.1.1 Closure of the Personnel Decontamination Station

All disposable clothing and plastic sheeting used during the operation will be double-bagged and contained on-site prior to removal to an approved off-site disposal facility as identified in the Work Plan. Decontamination and rinse solution will be contained on-site prior to disposal. Reusable rubber clothing will be dried and prepared for future use. If contamination of non-disposable clothing has occurred, the item will be discarded. All wash tubs, pail containers, etc., will be thoroughly washed, rinsed, and dried prior to removal from the site.

8.1.2 Disposal of Decontamination and Other Wastes

All PPE, polyethylene sheeting, and sampling support materials (e.g., paper towers, ziplock bags) will be collected at the end of each work day, placed in plastic trash bags, and left at the site overnight. The following day, the air within the plastic trash bag will be tested using a PID. If the air within the bag does not show significant concentrations of organic vapors (greater than 10 ppm above background), the plastic trash bag will be double-bagged and placed in the municipal waste dumpster for disposal.

All other wastes generated during decontamination other than decontamination fluids will be placed into 55-gallon drums; each drum will have a removable top cover fitted with a top cover bung (type 17E/H) as identified in the FSP. The drums will be filled partially or completely, depending upon the difficulty of transporting them from the work site. All containers will be numbered and clearly labeled with the boring/well number and date of filling. The mixing of solid and liquid wastes will be avoided. The containers will be stored at a predesignated site until the analytical results from each boring/well can be reviewed in order to determine the waste classification for handling, transportation, and disposal.

8.2 EQUIPMENT DECONTAMINATION

All sampling equipment will be decontaminated prior to use, between sampling locations, and at the end of sampling activities to avoid cross-contamination, to decrease contact between personnel and contaminated materials, and to reduce the probability of removing contamination from the site. The procedures for decontaminating equipment are presented in Section 5.8 of the FSP.

9.0 MEDICAL SURVEILLANCE

9.1 REQUIREMENTS FOR HYDROGEOLOGIC PERSONNEL

All employees involved in field activities will be active participants in the HydroGeoLogic medical surveillance program. All medical examinations and procedures will be performed by or under the supervision of a licensed occupational physician. The examination will include the tests, procedures, and frequencies that comply with the requirements of OSHA Standard 29 CFR 1910.120 (f) and American National Standards Institute (ANSI) Z-88.2, and will be medically qualified to perform hazardous waste site work under respiratory protection. Medical surveillance documents confirming the worker's fitness to perform hazardous waste operations on this project are on file at HydroGeoLogic's headquarters in Herndon, Virginia, and can be made available upon request.

9.2 REQUIREMENTS FOR SUBCONTRACTORS

Subcontractors are also required to obtain a certificate of their ability to perform hazardous waste operations work and to wear respiratory protection. Subcontractors, that have a company medical surveillance program meeting the requirements of OSHA Standard 29 CFR 1910.120 (f) will be required to submit a letter, on company letterhead, confirming that all on-site workers to be utilized for this project are medically qualified to perform the investigation activities. In addition, medical surveillance documents for personnel assigned to this project must be made available upon request.

10.0 TRAINING REQUIREMENTS

10.1 INITIAL TRAINING

10.1.1 Requirements for HydroGeoLogic Personnel

All investigation personnel to be utilized are currently enrolled in HydroGeoLogic's continuous training program in accordance with OSHA Standard 29 CFR 1910.120. Individuals working on a site have successfully completed an approved 40-hour Hazardous Waste Site Operations (HAZWOPER) course including 24-hours of actual field experience under the direction of a trained supervisor, and any subsequent annual 8-hour refresher courses. In addition, the on-site field leader will have completed an 8-hour supervisory course, and a majority of HydroGeoLogic's field investigation personnel are also current in first aid/CPR training requirements. HydroGeoLogic employee records are on file in the company's home office in Herndon, Virginia.

10.1.2 Requirements for Subcontractors

All HydroGeoLogic subcontractor personnel must also have completed a 40-hour HAZWOPER training course or the equivalent work experience as defined in OSHA Standard 29 CFR 1910.120(e) prior to performing work at the site. In addition, subcontractor personnel must also have successfully completed any subsequent annual 8-hour refresher training.

HydroGeoLogic subcontractors must certify that each subcontractor employee who will perform work at the site has had training meeting the requirements of OSHA Standard 29 CFR 1910.120(e). This certification can be accomplished by submitting a letter to HydroGeoLogic, on company letterhead, containing such information.

HydroGeoLogic subcontractor must certify that each subcontractor employee who will enter the aqueduct must have completed Permit Required Confined Space Training meeting the requirements of OSHA Standard 29 CFR 1910.146(g). This certification can be accomplished by submitting a letter to HydroGeoLogic on company letterhead, containing such information.

10.1.3 Requirements for Site Visitors

No person will be allowed in the work zones (exclusion and decontamination) unless they have completed the necessary health and safety training as required by OSHA Standard 29 CFR 1910.120(e) and are wearing the necessary protective equipment as required by this HSP.

10.2 SITE-SPECIFIC TRAINING

HydroGeoLogic will provide site-specific training to all HydroGeoLogic employees and subcontractor personnel who will perform work at the site. Daily health and safety meetings will be held prior to beginning field activities to discuss each day's activities, potential hazards, and any new health and safety issues not previously discussed. Personnel who do not participate in training will not be permitted to perform work at the site. Site-specific training will include the following:

- Contents of the HSP
- Names of personnel and alternates responsible for site health and safety
- Safety, health, and other hazards present on the site
- Use of PPE including Level B equipment
- Work practices by which the employees can minimize risks from hazards
- Confined space entry training for aqueduct entry
- Safe use of engineering controls and equipment on the site
- Medical surveillance requirements, including recognition of symptoms and signs that might indicate overexposure to hazards
- Decontamination procedures
- Emergency response procedures

HydroGeoLogic and subcontractor personnel will be required to sign a statement indicating receipt of site-specific training and understanding of site hazards and control measures. This form is presented in Section 14.1.

11.0 STANDARD WORK PRACTICES

All site investigation activities will follow these appropriate health and safety standard work practices.

11.1 GENERAL REQUIREMENTS/PROHIBITIONS

- A copy of this HSP will be available on-site for all field personnel, including visitors, to reference during investigation activities.
- No running or horseplay will be permitted.
- Eating, drinking, chewing gum or tobacco, taking medication, applying cosmetics, and/or smoking are prohibited in the exclusion and decontamination zones, or any location where a possibility for contact with site contaminants exists.
- The minimum required level of PPE to be worn by all on-site personnel will include steel-toed safety boots, safety glasses, and hard hat, if necessary.
- Upon leaving the exclusion zone, each worker's hands and face must be thoroughly washed. Any protective outer clothing is to be decontaminated and removed as specified in this HSP and left at a designated area prior to entering the clean area.
- Contact with potentially contaminated substances must be avoided. Contact with the ground or with contaminated equipment must also be avoided. Air monitoring equipment must not be placed on potentially contaminated surfaces.
- Facial hair that interferes with a satisfactory fit of the mask-to-face seal is not permitted on personnel required to wear respiratory protective equipment.
- All personnel must satisfy medical monitoring procedures.
- No flames or open fires will be permitted on-site.
- All personnel must be aware of and follow the action levels presented in this HSP for upgrading respiratory protection.
- Any new analytical data must be promptly conveyed via telephone to the project HSO by the laboratory technician or field leader.
- Personnel must develop hand signals with users of heavy equipment (e.g., drillers, geoprobe operators, etc.). Standard hand signals to be used by personnel for nonverbal communication include:

Stop	With arm extended to the side and palm down, hold position rigidly.
Hoist	With forearm and forefinger pointing up, move hand in small horizontal circle.
Lower	With forearm extended and forefinger pointing down, move hand in a small horizontal circle.
Travel	With palm up, fingers closed, and thumb pointing in the direction of motion, jerk hand horizontally.
Slow Move	Use one hand to give any motion signal, and place the other hand motionless next to the hand giving the motion signal.
Emergency	With arm extended to the side and palm down, move hand rapidly right and left.

- Standard hand signals will be discussed during each daily health and safety meeting when the use of heavy equipment is anticipated.

- A copy of the OSHA "Job Safety and Health Protection" poster must be prominently posted at each site.

- Only equipment that has been approved by the manufacturer may be used in conjunction with site equipment.

- Medicine and alcohol can potentiate the effects from exposure to toxic chemicals. Prescribed drugs should not be taken by personnel on operations where the potential for absorption, inhalation, or ingestion of toxic substances exists unless specifically approved by a qualified physician. Alcoholic beverage intake will not be allowed at any time, including during breaks.

- No person will enter the exclusion zone alone.

- Safety devices on equipment must be left intact and used as designed.

- Equipment and tools will be kept clean and in good repair and used only for their intended purpose.

- Eye protection must be worn when any hammering or pounding is performed that may produce flying particles or slivers.

- Field personnel are not allowed to lift more than 60 pounds. Rules to remember when attempting to lift heavy objects include:

  - Size up the load before trying to lift it, test the weight, and get help if needed.
  - Bend the knees and look up to keep the neck and back straight.
  - Do not twist or turn your body once you have made the lift.
  - Make sure you can carry the load where you need to go before lifting it.

- Set the load down properly, lower slowly by bending the knees.
- Always push, not pull, the object when possible.

- Heavy lifting (more than 60 pounds per worker) must be accomplished using mechanical lifting equipment. Mechanical lifting equipment that will be available on-site will include forklifts, hoists, dollies, backhoe/trackhoe, and other types of equipment that can be easily rented from an off-site location.

- Leather gloves must be worn when handling objects that may produce slivers or create a cutting or pinching hazard (e.g., driving wood stakes, handling drill rods/augers).

- No person shall climb the drill mast without the use of ANSI-approved fall protection (i.e., approved belts, lanyards, and a fall protection slide rail) or a portable ladder that meets the requirements of OSHA standards.

- The SSO must make an entry into the site field logbook at least daily to include the following:

  - Weather conditions
  - Site personnel
  - New arrivals and their clearance for site work
  - Air monitoring data summary
  - Monitoring instrument calibration
  - Indications of inhalation exposure
  - PPE used per task
  - Deviations from HSP
  - Inspection and cleaning of respiratory equipment
  - General health and safety problems/corrective actions

- If personnel note any warning properties of chemicals (irritation, odors, symptoms, etc.) or even remotely suspect the occurrence of exposure, they must immediately notify the SSO for further direction.

11.2 DRILLING ACTIVITIES

Prior to the commencement of drilling activities, all locations will be surveyed and marked for underground utilities. In addition, a hand auger or probe will be used to a depth of 3 feet to ensure the absence of underground utilities at the location of interest. If any uncertainties exist, the location will be moved to an adjacent area.

The following general drilling practices must be adhered to during investigation activities:

- All drilling equipment (i.e., rigging, derrick, hoists, augers, etc.) must be inspected by the drilling crew and SSO prior to starting work. Defective equipment will be removed from service and replaced.

- No drilling within 20 feet in any direction of overhead power lines will be permitted. The locations of all underground utilities must be identified and marked prior to initiating any subsurface activities.

- All drill rigs and other machinery with exposed moving parts must be equipped with an operational emergency stop device. Drillers and geologists must be aware of the location of this device. This device must be tested prior to job initiation and periodically thereafter. The driller and helper shall not simultaneously handle moving augers or flights unless there is a standby person to activate the emergency stop.

- Prior to raising the mast, the drill rig operator shall ensure that the proper stabilization measures have been taken. The drill rig shall not be moved while the mast is in the raised position.

- The driller must never leave the controls while the tools are rotating unless all personnel are clear of the rotating equipment.

- Drillers must wear hearing protection unless the employer can provide documentation that noise exposures are less than a dose of 50 percent as required by OSHA Standard 29 CFR 1910.95.

- Drilling activities shall immediately cease when inclement weather (e.g., heavy rains, lightning) or high winds occur at the site. All site personnel should immediately seek shelter.

- To maintain a clean operation, drill cuttings shall be promptly containerized as they are generated. A long-handled shovel or equivalent must be used to clear drill cuttings away from the hole and from rotating tools. Hands and/or feet are not to be used for this purpose.

- A remote sampling device must be used to sample drill cuttings if the tools are rotating. Samplers must not reach into or near the rotating equipment. If personnel must work near any tools, that could rotate, the driller must shut down the rig prior to initiating such work.

- Drillers, helpers, and samplers must secure all loose clothing when in the vicinity of drilling operations.

- Only equipment that has been approved by the manufacturer may be used in conjunction with site equipment. Pins that protrude from augers will not be allowed.

A variety of additional work practices (i.e., hoisting, cat line, pipe and auger handling, etc.) are to be adhered to by the drilling crew, but will not be addressed in this HSP. If the on-site field team leader or site supervisor observes any operations or actions that are perceived as threatening to the health and safety of site personnel, drilling operations will be temporarily suspended until a mutual understand of the action(s) in question are addressed and/or corrected.

Soil borings have the potential for releases to the environment and exposure to personnel. Gases and vapors that have a vapor density of less than 1.0 are lighter-than-air and tend to migrate upward in the atmosphere and disperse (e.g., methane). Heavier-than-air gases and vapors tend to stay close to the ground and may migrate to low-lying areas (e.g., hydrogen sulfide). In general, the only containment for a release to the air is termination of the release at the source (e.g., plug the boring). Depending on the contaminant encountered, it may be necessary to evacuate persons who are downwind of the area of the release. Emergency response personnel should be notified (Section 13.6) if air concentrations at the perimeter of the exclusion zone exceed threshold limit values (TLVs) or permissible exposure limits (PELs).

11.3 HOUSEKEEPING

Housekeeping is a very important aspect of an investigation program and will be strongly stressed in all aspects of field work. Good housekeeping plays a key role in occupational health protection and is a way of preventing dispersion of dangerous contaminants. All work areas will be kept as clean as possible at all times and spills will be cleaned up immediately. Housekeeping will be the responsibility of all employees.

HydroGeoLogic will implement a housekeeping program for the field activities to minimize the spread of contamination beyond the work site. The program will include the following:

- Daily scheduling to police the area of debris including paper products, cans, and other materials brought on-site
- Changing of wash and rinse water for hands, face, and equipment as needed
- Periodic (daily minimum) removal of all garbage bags and containers used to dispose of food products, plastic inner gloves, and contaminated disposable clothing

11.4 WORK LIMITATIONS

All investigation activities will be performed during normal daylight hours.

11.5 CONFINED SPACE ENTRY

Certain tasks required under this project (such as the inspection of the aqueduct) will require entry into a confined space. A confined space is defined as an enclosure which is large enough for an employee to enter, but which has limited means of access and egress and is not designed for continuous employee occupancy.

A permit-required confined space is a confined space as defined above which also contains one or more health and/or safety hazards. This can include chemical, mechanical, electrical, or other hazards. All confined spaces on this project are to be considered Permit Required Confined Spaces.

Access to the storm water aqueduct and all work within it must be conducted in accordance with 29CFR 1910.146. Key provisions of this policy include:

Combustible gas and oxygen levels shall be measured at the confined space opening and inside the confined space prior to entry and continuously during occupancy. The person conducting the monitoring must have completed Entry Supervisor training.

Oxygen levels must be between 20 and 23½ percent at all times during occupancy.

Combustible gas readings must not exceed 10 percent of the LEL at any time during occupancy.

A confined space entry permit must be completed, reviewed, and approved by the OSO and posted outside the confined space entrance prior to entry.

Two entrants are required for this entry. The entrants must have successfully completed Confined Space Entry training.

For this entry Level B protection must be worn by all confined space entrants. The Self Contained Breathing Apparatus is to be high pressure tank with 1 hour rating. Training in level B work is required for entry.

An attendant trained in Confined Space Entry shall be posted outside the manhole entrance at all times during occupancy and shall remain in contact with the entrant. A second attendant must be nearby.

Communications signals via rope and/or flashlight shall be established prior to entry. Radio communication is preferred if feasible. Flashlights and/or radios must be intrinsically safe.

All confined space entry must be supervised by a Entry Supervisor on site.

All appropriate lockout/tagout procedures must be implemented prior to entry and must remain in effect until operations inside the space have been completed.

Entry during inclement weather is prohibited due to potential of water rising to dangerous levels.

11.6 SPILL CONTAINMENT

The procedures defined in this section comprise the spill containment activities in place at the site.

- All drums and containers used during the cleanup will meet appropriate United Nations, OSHA, and EPA regulations for the waste that they will contain.
- Drums and containers will be inspected and their integrity ensured prior to being moved. Drums or containers that cannot be inspected before being moved because of storage conditions will be positioned in an accessible location and inspected prior to further handling.
- Operations on-site will be organized so as to minimize the amount of drum or container movement.
- Employees involved in the drum or container operations will be warned of the hazards associated with the containers.
- Where spills, leaks, or ruptures may occur, adequate quantities of spill containment equipment (absorbent, pillows, etc.) will be stationed in the immediate area. The spill containment program must be sufficient to contain and isolate the entire volume of hazardous substances being transferred.
- Drums or containers that cannot be moved without failure will be emptied into a sound container.
- Fire extinguishing equipment meeting 29 CFR Part 1910, Subpart L shall be on hand and ready for use to control fires.

12.0 SITE CONTROL

12.1 WORK ZONES

Each investigation location will be physically barricaded with rope flagging or caution tape to control entry to and exit from the area. These barricaded areas will be referred to as the exclusion zones. The exclusion zone will be identified by the site supervisor and consist of a 20-foot radius surrounding the drilling location. Each person leaving an exclusion zone will proceed directly to the decontamination zone, which will be located adjacent to the exclusion zone and identified by physical barriers. The decontamination zone will consist of a low-lying area covered with a plastic sheeting. At the completion of decontamination procedures at each location, the debris will be enclosed in the plastic sheeting and deposited into 55-gallon type 17 E/H drums for later disposal as identified in the Work Plan and FSP. Only personnel who are cleared by the HydroGeoLogic field leader and SSO will be permitted in the exclusion zones and/or decontamination zones. Clearance for accessing these areas will only be given to personnel who meet the training and medical surveillance requirements of OSHA Standard 29 CFR 1910.120 and are wearing the appropriate PPE required for the work activity.

The support zone, where the administrative, communications, and other support services will be based, will be in a controlled area off the site or on the far end upwind of potential site contamination or areas of potential exposure. Only persons and equipment that are free of contamination will be permitted in the support zone.

12.2 ON-SITE/OFF-SITE COMMUNICATIONS

Communications will consist of a centrally located telephone within the designated support zone (i.e., trailer, office) in addition to a mobile phone stationed within the on-site vehicle utilized for transportation. Field personnel may also utilize telephones located at NAS Fort Worth JRB in emergency situations.

13.0 EMERGENCY RESPONSE

This HSP has been developed in an attempt to prevent the occurrence of situations that may jeopardize the health and safety of on-site personnel. However, supplemental emergency procedures must be identified in the event that an unforeseen health and safety accident or incident occurs. In general, HydroGeoLogic will evacuate their employees and subcontractors from the workplace if an emergency involving chemical spills, chemical fires, chemical exposure, and/or chemical emissions occurs. For this reason, emergency response planning will be in accordance with OSHA Standard 29 CFR 1910.38(a).

13.1 PREPLANNING

Upon initial arrival at the site, the HydroGeoLogic field leader and SSO will visit the base's fire department to determine the status of emergency response services. This meeting will include a determination as to the need for further coordination with local rescue and police services.

Another aspect of preplanning for emergencies includes completion of the Medical Data Sheet (Section 14.1). This sheet must be completed by all HydroGeoLogic personnel and subcontractors so that, in the event of personal injury or illness, the examining physician has background information readily available on the injured/ill party.

13.2 EMERGENCY PROCEDURES AND ASSIGNMENTS

Upon notification of a site emergency requiring evacuation, all HydroGeoLogic personnel and subcontractors will proceed directly to the support zone (i.e., trailer, office). If personnel cannot reach the support zone without endangering life or health, an alternate meeting point will be specified by the HydroGeoLogic SSO. Emergency egress routes and meeting points will be discussed at each daily health and safety briefing.

In the event of an emergency, the following procedures will be implemented:

- The site supervisor will evaluate the incident, assess the need for assistance, and call the appropriate contacts, if necessary.
- The site supervisor will act as the point of contact for outside emergency personnel and on-site personnel.
- The site supervisor will advise emergency response and emergency room personnel as to the types of contamination potentially contacted by injured workers receiving emergency care.
- The site supervisor will ensure that the SSO promptly notifies the HydroGeoLogic PM and HSO of the incident.

13.2.1 Chemical Inhalation

It is not anticipated that chemicals of concern will be present at the site in concentrations to cause immediate danger to life and health. However, any field personnel exhibiting or complaining of symptoms of chemical exposure as described in Section 4.1 will be removed from the work zone and transported to the designated medical facility for examination and treatment.

13.2.2 Eye and Skin Contact

Field personnel who have come into contact with contaminants while in the exclusion zone will proceed immediately to the decontamination zone, where an eye wash station will be located. At the eyewash station the following procedures will be followed:

- Do not decontaminate prior to using the eye wash
- Remove necessary PPE to perform the eye wash procedures
- Flush the eye with the clean water for at least 15 minutes
- Arrange for prompt transport to the designated medical facility

Unless skin contact with contaminants is severe, personnel should proceed through the decontamination zone. Field personnel should remove any contaminated PPE and wash the affected area for at least 15 minutes. If the personnel show signs of skin irritation, they will be transported to the designated medical facility.

13.3 PROCEDURES FOR PERSONNEL REMAINING ON-SITE

No HydroGeoLogic or subcontractor personnel will remain on-site to operate critical site emergency operations.

13.4 PROCEDURES TO ACCOUNT FOR SITE PERSONNEL

The HydroGeoLogic and subcontractor work force will be small enough so that accounting for site personnel will not be a problem. The HydroGeoLogic field leader and SSO will ensure that the whereabouts of all personnel are known.

13.5 RESCUE AND MEDICAL DUTIES

Only those persons who have been trained by the American Red Cross, or equivalent, will be permitted to perform rescue, first aid, and/or CPR treatment. Outside emergency services and medical facilities will be the primary providers of such services. At least one person who is currently certified in first aid and CPR will be on-site at all times during field activities. A "physicians-approved" first aid kit, an ANSI-approved eye wash station with 15-minutes of free-flowing freshwater, and a Class ABC fire extinguisher will be readily available on-site.

Any HydroGeoLogic employee who shows signs or symptoms of overexposure must immediately be examined by a licensed physician. Subcontractor personnel who show signs or symptoms of overexposure will be encouraged to visit a licensed physician as well. Figure 13.1 describes the directions to the nearest medical facility.

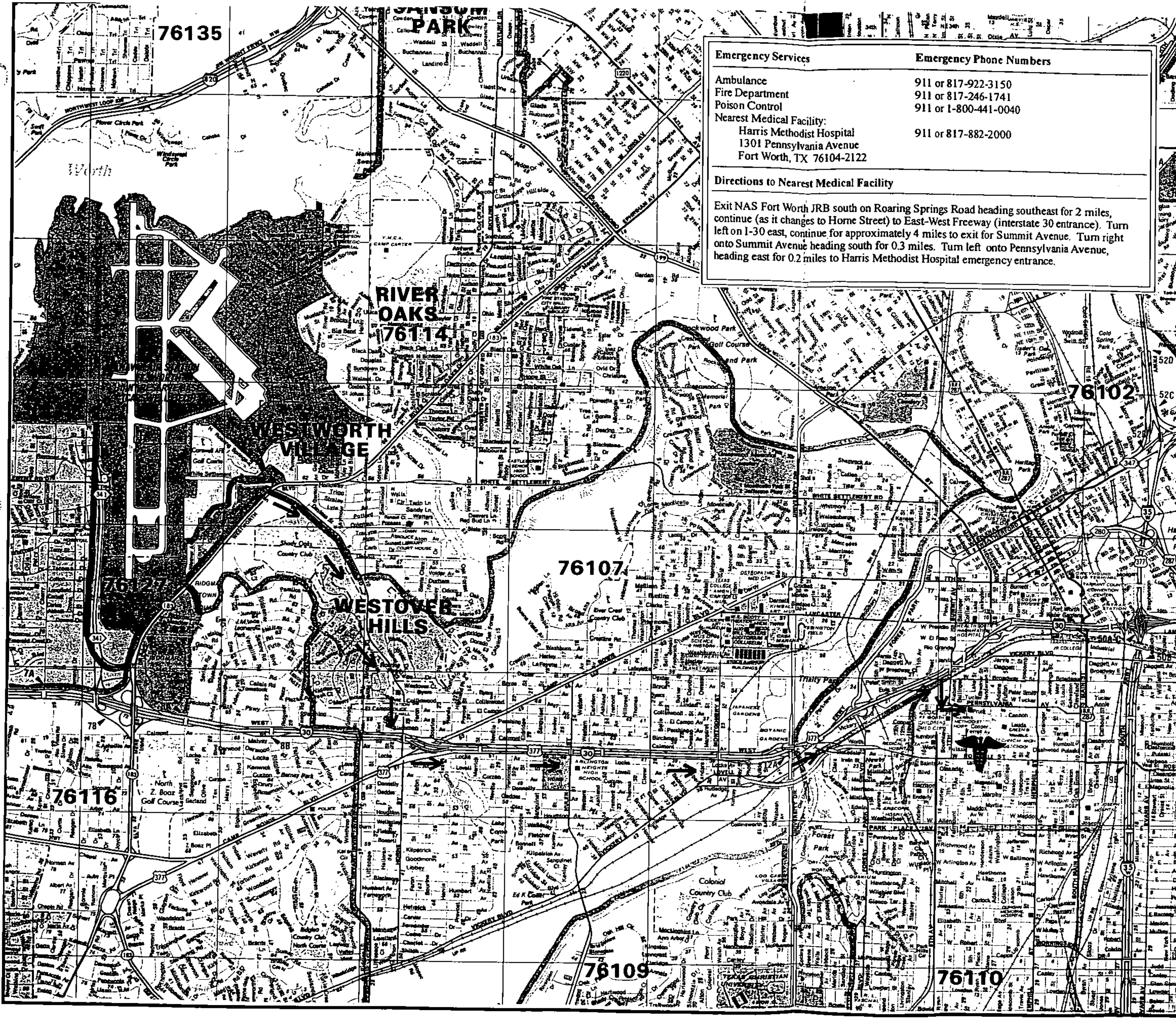
13.6 EMERGENCY COMMUNICATION PROCEDURES, CONTACTS, AND PHONE NUMBERS

Persons who observe an emergency situation must immediately notify the HydroGeoLogic field leader and/or SSO. The field leader or SSO will then immediately assess the emergency and appoint someone to telephone appropriate outside emergency services and will coordinate site evacuation. Emergency telephone numbers and directions to the nearest medical facility are included as Table 13.1, a copy of which will be posted at the nearest telephone. In addition, Figure 13.1 illustrates the directions to the nearest medical facility.

13.7 ACCIDENT/INCIDENT FOLLOW-UP AND REPORTING

Upon receiving a report of an incident (or near-incident), the SSO shall immediately investigate the circumstances and make appropriate recommendations to prevent recurrence. The HSO shall also be immediately notified by telephone on occurrence of a serious accident or incident. The HSO, at their individual discretion, may also participate in the investigation.

Details of the incident shall be documented on the Accident/Incident/Near Miss Investigation form (Section 14.1) within 24 hours of the incident and shall be distributed to the PM, HSO, and COR. A copy of this report shall also be sent to the appropriate administrative contact for inclusion into the OSHA Form 101 and 200 log. Incident report forms will be available at site support facilities.



Emergency Services	Emergency Phone Numbers
Ambulance	911 or 817-922-3150
Fire Department	911 or 817-246-1741
Poison Control	911 or 1-800-441-0040
Nearest Medical Facility:	
Harris Methodist Hospital 1301 Pennsylvania Avenue Fort Worth, TX 76104-2122	911 or 817-882-2000

Directions to Nearest Medical Facility

Exit NAS Fort Worth JRB south on Roaring Springs Road heading southeast for 2 miles, continue (as it changes to Home Street) to East-West Freeway (interstate 30 entrance). Turn left on I-30 east, continue for approximately 4 miles to exit for Summit Avenue. Turn right onto Summit Avenue heading south for 0.3 miles. Turn left onto Pennsylvania Avenue, heading east for 0.2 miles to Harris Methodist Hospital emergency entrance.

Figure 13.1

Nearest Medical Facility to NAS Fort Worth JRB

U.S. Air Force Center For Environmental Excellence

Legend

Hospital

Route to Hospital

N

Filename: X:AFC001\19BD\Report\Fig_13-1.cdr
Project: AFC001-19BD
Revised: 07/05/00 TKH
Source: Rand McNally, 1996

HYDRO GEOLOGIC INC.

14.0 DOCUMENTATION AND EQUIPMENT

This section summarizes the documentation and equipment needs for the project as specified in the HSP. Its purpose is to serve as a partial checklist to help ensure all of the necessary resources are available to carry out the requirements of the HSP.

14.1 DOCUMENTATION AND FORMS

The following documents are presented in the following pages for use during site operations:

- Site Safety Briefing Form
- HSP Compliance Agreement Form
- HSP Amendments Form
- Accident/Incident/Near Miss Investigation Form
- Medical Data Sheet
- Daily Equipment Calibration Log
- Air Monitoring Log

In addition, the following documentation will be present on-site during site operations:

- Approved HSP (signed copy)
- OSHA poster
- MSDSs
- Employee training and medical surveillance certificates
- Subcontractor training and medical surveillance certificates

14.2 EMERGENCY HEALTH AND SAFETY EQUIPMENT

- First aid kit
- Eye wash
- Inner latex or vinyl gloves
- Outer nitrile gloves (disposable and 11 mil thick)
- Boot covers
- Hard hats and safety glasses
- Tyvek™ suits
- PVC and/or Saranex™ suits (with hoods)
- Ear defenders/plugs
- Decontamination kit
- Fire extinguisher
- Fall protection devices (body harness and lanyard)
- Duct tape
- LEL/O_2 meter
- PID

The site supervisor and/or SSO shall be responsible for maintaining first aid kits and fire extinguishers at each site where field activities are taking place. The location of first aid kits and fire extinguishers will be discussed during each daily health and safety meeting.

15.0 REFERENCES

A.T. Kearney, 1989, RCRA Facility Assessment, Preliminary Review/Visual Site Inspection.

CH2M HILL, 1996, Site Characterization Summary-Informal Technical Information Report, NAS Fort Worth JRB, Carswell Field, Texas.

CH2M HILL, 1984, Installation Restoration Program Records Search, Carswell Air Force Base, Texas.

Dames & Moore, February 17, 1995, Final Summary Report-Remediation Projects, SWMUs 19, 20, and 53, Carswell Air Force Base, Texas. Radian Corporation, October 1986 a Installation Restoration Program Phase II. Confirmation/Quantification, Stage 1, Volume 1, Final Report.

Dräger Aktiengesellschaft (Kurt Leichnitz), July 1989, Detector Tube Handbook, 7th Edition.

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International Technology Corporation, 1997, Draft RCRA Facilities Investigation, Sanitary Sewer System, NAS Fort Worth JRB, Texas.

NIOSH/OSHA/USCG/EPA, October 1985, Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities, (DHHS (NIOSH) Publication No. 85-115); EPA, June 1992, Standard Operating Safety Guides, (NTIS Publication No. 9285.1-03).

Occupational Safety and Health Administration (OSHA) General Industry Standards, 29 CFR 1910, and Construction Industry Standards, 29 CFR 1926; especially 29 CFR 1910.120/29 CFR 1926.65, Hazardous Waste Site Operations and Emergency Response.

U.S. Air Force Occupational and Environmental Health Laboratory Human Systems Division, 1989, Hazardous Waste Technical Assistance Survey, Carswell AFB, Texas.

U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health (NIOSH), June 1997, Pocket Guide to Chemical Hazards.

TABLES

Table 4.1
Exposure Limits and Recognition Qualities

Compound	Permissible Exposure Limit (PEL)[a]	IDLH Level[b]	Recognition Qualities			Odor Warning Concentration (ppm)	LEL[c] (%)	UEL[d] (%)	Ionization Potential (eV)
			Color	Odor	State				
Anthracene	See coal tar pitch volatiles								
Arsenic Compounds	0.010 mg/m^3	5 mg/m^3[e]	Silver gray to tin-white	Odorless	Solid	NA	NA	NA	NA
Benzene	1.0 ppm[f]	500 ppm[e]	Colorless to light yellow	Aromatic	Liquid	1.5 - 5.0	1.2	7.8	9.24
Benzo[a]anthracene	See coal tar pitch volatiles								
Benzo[b]fluoranthene	See coal tar pitch volatiles								
Benzo[k]fluoranthene	See coal tar pitch volatiles								
Benzo[g,h,i]perylene	See coal tar pitch volatiles								
Benzo[a]pyrene	See coal tar pitch volatiles								
bis(2-Ethylhexyl)phthalate	5 mg/m^3	5,000 mg/m^3[e]	Colorless	Slight	Liquid	NA	0.3	NA	NA
2-Butanone (MEK)	200 ppm	3,000 ppm	Colorless	Sharp, mint-like	Liquid	ND	1.4	11.4	9.54
Cadmium	0.005 mg/m^3	9 mg/m^3[e]	Bluish-silver	N/A	Metal	NA	NA	N/A	NA
Chloroethane	1,000 ppm	3,800 ppm	Colorless	Ether-like	Liquid or gas	NA	3.8	15.4	10.97
Chrysene	See coal tar pitch volatiles								

Table 4.1 (continued)
Exposure Limits and Recognition Qualities

Compound	Permissible Exposure Limit (PEL)[a]	IDLH Level[b]	Recognition Qualities			Odor Warning Concentration (ppm)	LEL[c] (%)	UEL[d] (%)	Ionization Potential (eV)
			Color	Odor	State				
Coal tar pitch volatiles	0.2 mg/m³	80 mg/m³[e]	Black or brown	None	Solid	NA	NA	NA	NA
1,1-Dichloroethane	100 ppm	3,000 ppm	Colorless	Chloroform-like	Liquid	NA	5.4	11.4	11.06
1,1-Dichloroethene	ND	ND[e]	Colorless	Chloroform-like	Liquid or gas	50	6.5	15.5	10.00
1,2-Dichloroethene	200 ppm	1000 ppm	Colorless	Slightly acrid, chloroform-like	Liquid	17.0	5.6	12.8	9.65
Ethylbenzene	100 ppm	800 ppm	Colorless	aromatic	Liquid	4.7 - 5.0	0.8	6.7	8.76
Ethylene dibromide	20 ppm	100 ppm	Colorless	Sweet	Liquid	ND	NA	NA	9.45
Fluoranthene	See coal tar pitch volatiles								
Freon 113	1,000 ppm	2,000 ppm	Colorless to water-white	Ether-like	Liquid or gas	ND	NA	NA	11.99
Gasoline	ND	ND[e]	Clear	Gasoline	Liquid	ND	1.4	7.6	ND
Hexane	500 ppm	1,100 ppm	Colorless	Gasoline-like	Liquid	NA	1.1	7.5	10.18
Hydrochloric Acid	C 5 ppm	50 ppm	Colorless to light yellow	Irritating	Gas	NA	NA	NA	12.74
Indeno[1,2,3-cd]pyrene	See coal tar pitch volatiles								
Jet Fuel (JP-4)	ND	ND	Tea-brown	Gasoline	Liquid	ND	ND (flammable)	ND (flammable)	ND

Table 4.1 (continued)
Exposure Limits and Recognition Qualities

Compound	Permissible Exposure Limit (PEL)[a]	IDLH Level[b]	Recognition Qualities			Odor Warning Concentration (ppm)	LEL[c] (%)	UEL[d] (%)	Ionization Potential (eV)
			Color	Odor	State				
Lead	0.050 mg/m³	100 mg/m³	Gray	Odorless	Solid	NA	NA	NA	NA
Mercury	0.100 mg/m³	10 mg/m³	Silver-white	Odorless	Liquid	NA	NA	NA	NA
Methanol	200 ppm	6,000 ppm	Colorless	Pungent	Liquid	100	6.0	36.0	10.84
Naphthalene	10 ppm	250 ppm	Colorless to brown	Mothballs	Solid	ND	0.9	5.9	8.12
Nitric Acid	2 ppm	25 ppm	Colorlessred or yellow	Acrid, suffocating	Liquid	NA	NA	NA	11.95
Phenanthrene	See coal tar pitch volatiles								
Pyrene	See coal tar pitch volatiles								
Sulfuric Acid	1 mg/m³	15 mg/m³	Colorless, yellow, or brown	Odorless	Solution	NA	NA	NA	ND
1,1,1,2-Tetrachloroethane	ND	ND	Yellowish-red	None	Liquid	NA	NA	NA	NA
1,1,2,2-Tetrachloroethane	1ppm [skin]	100 ppm[e]	Colorless to pale yellow	Pungent, chloroform-like	Liquid	ND	NA	NA	11.10
Tetrachloroethene	100 ppm[f]	150 ppm[e]	Colorless	Chloroform-like	Liquid	27.0	NA	NA	9.32
Toluene	200 ppm	500 ppm	Colorless	Aromatic	Liquid	0.17 - 40	1.1	7.1	8.82
1,1,1-Trichloroethane	350 ppm	700 ppm	Colorless	Mild, chloroform-like	Liquid	ND	7.5%	12.5%	11.00
1,1,2-Trichloroethane	10 ppm	100 ppm[e]	Colorless	Sweet, chloroform-like	Liquid	ND	6	15.5	11.00

Table 4.1 (continued)
Exposure Limits and Recognition Qualities

Compound	Permissible Exposure Limit (PEL)[a]	IDLH Level[b]	Recognition Qualities			Odor Warning Concentration (ppm)	LEL[c] (%)	UEL[d] (%)	Ionization Potential (eV)
			Color	Odor	State				
Trichloroethene	100 ppm[f]	1,000 ppm[e]	Colorless	Chloroform-like	Liquid	28.0	8.0	10.5	9.45
Vinyl Chloride	1 ppm	ND[e]	Colorless	Pleasant	Liquid or gas	3,000	3.6	33	9.99
Xylenes (total)	100 ppm	900 ppm	Colorless	Aromatic	Liquid	1.0 - 1.5	1.1	7.0	8.56

a OSHA permissible exposure limit or the American Conference of Governmental Industrial Hygienists' threshold limit value (both 8-hour time weighted averages).
b Immediately dangerous to life or health.
c Lower explosive limit.
d Upper explosive limit.
e To be treated as a carcinogen.
f The value presented is the OSHA PEL, which is not necessarily the most conservative of the available exposure limits. The air monitoring screening levels in Table 6.1 are based upon the most conservative values.

C Ceiling value, a 15-minute Time Weighted Average that shall not be exceeded at any time during the work day.
eV Electron volts.
mg/m³ Milligrams per cubic meter.
NA Not applicable.
ND Not determined
ppm Parts per million.

Sources: NIOSH, 1997
Dräger, 1989

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

Compound	Symptoms Of Overexposure	First Aid Treatment
Anthracene	See coal tar pitch volatiles	
Arsenic	Ulceration of nasal septum; dermatitis; gastrointestinal disturbances; peripheral neuropathy; respiratory irritation; hyperpigmentation of skin; carcinogen	Eye: Irrigate immediately (15 min) Skin: Soap wash immediately Inhalation: Not an inhalation hazard Ingestion: Medial attention immediately
Benzene	Irritation to eyes, nose, respiratory systems; giddiness; headache, nausea, staggered gait; fatigue, anorexia, lassitude; dermatitis; bone marrow depressant/depression; carcinogenic	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Artificial respiration Ingestion: Medical attention immediately: DO NOT INDUCE VOMITING
Benzo[a]anthracene	See coal tar pitch volatiles	
Benzo[b]fluoranthene	See coal tar pitch volatiles	
Benzo[k]fluoranthene	See coal tar pitch volatiles	
Benzo[g,h,i]perylene	See coal tar pitch volatiles	
Benzo[a]pyrene	See coal tar pitch volatiles	
bis(2-Ethylhexyl)phthalate	Irritation of eyes, mucous membranes; carcinogen	Eye: Irrigate immediately Skin: Not a dermal hazard Inhalation: Respiratory support Ingestion: Medical attention immediately
2-Butanone (MEK)	Irritating to eyes and nose; headache; dizziness; vomiting	Eye: Irrigate immediately Skin: Water wash immediately Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Cadmium	Pulmonary edema, dyspnea, coughing, chest tightness, substernal pain; headache; chills, muscle pain; nausea, vomiting , diarrhea, anosmia, emphysema, proteinuria, mild anemia; carcinogenic	Eye: Irrigate immediately Skin: Soap wash immediately Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately

Table 4.2 (continued)
Acute and Chronic Effects
Symptoms of Overexposure and First Aid Treatment

Compound	Symptoms Of Overexposure	First Aid Treatment
Chloroethane	Incoordination, inebriate; abdominal cramps; cardiac arrhythmias, cardiac arrest; liver and kidney damage	Eye: Irrigate immediately Skin: Water flush promptly Inhalation: Respiratory support Ingestion: Medical attention immediately
Chrysene	See coal tar pitch volatiles	
Coal tar pitch volatiles	Dermatitis, bronchitis, carcinogenic	Eye: Irrigate immediately Skin: Soap wash immediately Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
1,1-Dichloroethane	Central nervous system depressant; skin irritant; liver and kidney damage	Eye: Irrigate immediately Skin: Soap flush promptly Inhalation: Respiratory support Ingestion: Medical attention immediately
1,1-Dichloroethene	Irritation to eyes, skin, and throat; dizziness, headache, and nausea; breathing difficulty; liver and kidney dysfunction; pneumonitis; carcinogen	Eye: Irrigate immediately Skin: Water flush immediately Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
1,2-Dichloroethene	Irritation of eyes and respiratory system; central nervous system depressant/depression	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Respiratory support Ingestion: Medical attention immediately
Ethylbenzene	Irritation to eyes, mucous membranes; headache; dermatitis; narcosis; coma	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Artificial respiration Ingestion: Medical attention immediately
Ethylene dibromide	Irritation to eyes, skin, respiratory system; dermatitis with vesiculation; liver, heart, spleen, kidney damage; reproductive effects; carcinogen	Eye: Irrigate immediately Skin: Soap wash immediately Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Fluoranthene	See coal tar pitch volatiles	

Table 4.2 (continued)
Acute and Chronic Effects
Symptoms of Overexposure and First Aid Treatment

Compound	Symptoms Of Overexposure	First Aid Treatment
Freon 113	Irritation of skin, throat; drowsiness, dermatitis; central nervous system depression	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Respiratory support Ingestion: Medical attention immediately
Gasoline	Irritation to eyes, skin, mucous membranes; dermatitis; headaches, fatigue, blurred vision, dizziness, slurred speech, confusion, convulsions, chemical pneumonia (aspiration); possible liver, kidney damage; carcinogen	Eye: Irrigate immediately Skin: Soap flush immediately Inhalation: Respiratory support Ingestion: Medical attention immediately
Hexane	Light-headedness, nausea, headaches, numbness in extremities, weak muscles, eye irritation, nose irritation, dermatitis, chemical pneumonia, giddiness	Eye: Irrigate immediately Skin: Soap, wash immediately Inhalation: Respiratory support Ingestion: Medical attention immediately
Hydrochloric Acid	Inflammation of the nose, throat, laryngeal; cough, burns throat, choking; burns eyes, skin; dermatitis	Eye: Irrigate immediately Skin: Water flush immediately Inhalation: Respiratory support Ingestion: Medical attention immediately
Indeno(1,2,3-cd)pyrene	See coal tar pitch volatiles	
Jet fuel (JP-4)	Irritation to eyes, skin, and mucous membranes; dermatitis; headaches, narcosis, coma	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Lead	Weak, lassitude, insomnia; facial pallor; pal eye, anorexia, weight loss, malnutrition; constipation, abdominal pain, colic; anemia; gingival lead line; tremors; paralysis of wrist and ankles; encephalaopathy; nephropathy; irritation to eyes; hypotension	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Respiratory support Ingestion: Medical attention immediately
Mercury	Cough, chest pain, dyspnea, bronchitis pneumonitis; tremors, insomnia; irritability, indecision; headache, fatigue, weak; stomatitis, salivation; gastrointestinal disturbance, anorexia, weight loss; proteinuria; irritation of the eyes, skin	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Respiratory support Ingestion: Medical attention immediately

Table 4.2 (continued)
Acute and Chronic Effects
Symptoms of Overexposure and First Aid Treatment

Compound	Symptoms Of Overexposure	First Aid Treatment
Methanol	Eye irritant, headache, drowsiness; lightheadedness, nausea, vomiting; visual disturbances, blindness	Eye: Irrigate immediately Skin: Water flush immediately Inhalation: Respiratory support Ingestion: Medical attention immediately
Napthalene	Eye irritation; headache, confusion, excitement, malaise; nausea, vomiting, abdominal pain; irritated bladder; profuse sweating; jaundice; blood in urine; hemoglobinuria; renal shutdown; dermatitis; optical neuritis; cornea damage	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Nitric Acid	Irritation of eyes, mucous membranes, and skin; delayed pulmonary edema, pneuitis, bronchitis; dental erosion	Eye: Irrigate immediately Skin: Water flush immediately Inhalation: Respiratory support Ingestion: Medical attention immediately
Phenanthrene	See coal tar pitch volatiles	
Pyrene	See coal tar pitch volatiles	
Sulfuric Acid	Irritation to eyes, nose, and throat; pulmonary edema; bronchitis; emphysema, conjunctivitis; stomitis; dental erosion; thracheobronchitis; eye and skin burns; dermatitis	Eye: Irrigate immediately Skin: Water flush immediately Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
1,1,1,2-Tetrachloroethane	Irritated eyes, skin; weakness, restlessness, irregular respiration, muscle incoordination	Eye: Irrigate immediately Skin: Soap wash immediately Inhalation: Respiratory support Ingestion: Medical attention immediately
1,1,2,2-Tetrachloroethane	Nausea, vomiting, abdominal pain; tremor fingers; jaundice, hepatitis, liver tenderness; dermatitis; monocytosis; kidney damage; carcinogen	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Respiratory support Ingestion: Medical attention immediately
Tetrachloroethene	Irritation of the eyes, nose, throat; nausea; flush face, neck; vertigo, dizziness, in coordination; headache, somnolence; skin erythema; liver damage; carcinogen	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Respiratory support Ingestion: Medical attention immediately

Table 4.2 (continued)
Acute and Chronic Effects
Symptoms of Overexposure and First Aid Treatment

Compound	Symptoms Of Overexposure	First Aid Treatment	
Toluene	Fatigue, weakness; confusion, euphoria, dizziness, headache; dilated pupils, lacrimation; nervousness, muscle fatigue, insomnia; paresis; dermatitis	Eye: Skin: Inhalation: Ingestion:	Irrigate immediately Soap wash promptly Move to fresh air Medical attention immediately; DO NOT INDUCE VOMITING
1,1,1-Trichloroethane	Irritation to eyes, skin; head, weakness, exhaustion, central nervous system depression, poor equilibrium; dermatitis; cardiac arrhythmia, liver damage	Eye: Skin: Inhalation: Ingestion:	Irrigate immediately Soap wash promptly Respiratory support Medical attention immediately
1,1,2-Trichloroethane	Irritation to eyes and nose; central nervous system depression; liver and kidney damage; dermatitis; carcinogenic	Eye: Skin: Inhalation: Ingestion:	Irrigate immediately Soap wash promptly Move to fresh air; respiratory support Medical attention immediately
Trichloroethene	Headache, vertigo; visual disturbance, tremors, somnolence, nausea, vomiting; irritation of the eyes; dermatitis; cardia arrhythmias, paresthesia; carcinogen	Eye: Skin: Inhalation: Ingestion:	Irrigate immediately Soap wash promptly Respiratory support Medical attention immediately
Vinyl Chloride	Weakness; abdominal pain, gastrointestinal bleeding; hepatomegaly; pallor or cyan of extremities; carcinogen	Inhalation:	Respiratory support
Xylenes (total)	Dizziness, excitement, drowsiness, in coordination, staggering gait; irritation of eyes, nose, throat; corneal vacuolization; anorexia, nausea, vomiting, abdominal pain; dermatitis	Eye: Skin: Inhalation: Ingestion:	Irrigate immediately Soap wash promptly Move to fresh air Medical attention immediately; DO NOT INDUCE VOMITING

Source: NIOSH, 1997

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

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

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

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

Source: NIOSH/OSHA/USCG/EPA, 1985.

Table 6.1
Hazard Monitoring Methods, Action Levels, and Protection Measures

Hazard	Monitoring Method	Action Level	Protective Measures	Monitoring Schedule
Toxic Vapors (as identified in Table 4.1)	PID	0.0 to <0.5 ppm above background based on judgment of SSO	Level D (see Table 7.1)	-continue with regular monitoring of breathing zone
		0.5 ppm above background based on judgment of SSO	Level D (see Table 7.1)	-confirm/deny reading with vinyl chloride and benzene colorimetric tubes -if confirmed as vinyl chloride and/or benzene, then see vinyl chloride/benzene hazard identified below -if denied as vinyl chloride and benzene, then continue with regular monitoring of breathing zone
		≥0.5 ppm to <25 ppm above background based on judgment of SSO (if denied as vinyl chloride and benzene)	Level D (see Table 7.1)	-confirm/deny reading with vinyl chloride and benzene colorimetric tubes -if confirmed as vinyl chloride and/or benzene, then see vinyl chloride/benzene hazard identified below -if denied as vinyl chloride and benzene, then continue with regular monitoring of breathing zone -confirm/deny reading with tetrachloroethene and TCE colorimetric tubes -if confirmed , then see hazard identified below -if denied as tetrachloroethene or TCE, then continue with regular monitoring of breathing zone
		≥25 to <250 ppm above background based on judgment of SSO (if denied as vinyl chloride, benzene, and tetrachloroethene)	Level C (see Table 7.1)	-continue with regular monitoring of breathing zone - contact HSO and Project Manager - continue use of tubes, attempt to identify unknown air contaminants

Table 6.1 (continued)
Hazard Monitoring Methods, Action Levels, and Protection Measures

Hazard	Monitoring Method	Action Level	Protective Measures	Monitoring Schedule
Vinyl Chloride	Colorimetric Tubes	confirmed 1.0 ppm to 10 ppm above background based on judgment of SSO	Level C (See Table 7.1)	-continue regular monitoring of breathing zone
Benzene	Colorimetric Tubes	confirmed 0.5 ppm to 5 ppm above background based on judgment of SSO	Level C (See Table 7.1)	-continue regular monitoring of breathing zone
Tetrachloroethene	Colorimetric Tubes	confirmed 25 ppm to 250 ppm above background based on judgment of SSO	Level C (See Table 7.1)	-continue regular monitoring of breathing zone
Trichloroethene	Colorimetric Tubes	confirmed 50 ppm to 500 ppm above background based on judgment of SSO	Level C (See Table 7.1)	-continue regular monitoring of breathing zone
Flammable/Explosive Gases and/or Vapors	LEL/O_2 Detector	0.0 to 5.0 percent LEL	-notify sampling team of readings	-prior to and during sampling activities, monitor all areas suspected of containing flammable/explosive gases and/or vapors -continue with regular monitoring of breathing zone
		5.0 to <10.0 percent LEL	-use spark proof equipment/tools	-continue with regular monitoring of breathing zone - notify HSO and Project Manager
		>10.0 percent LEL	STOP WORK, EVACUATE AREA, NOTIFY PROJECT MANAGER	-requires HSP amendments unless readings subside
Toxic Vapors (as identified in Table 4.1)	PID	≥250 above background based on judgment of SSO (if denied as all chemicals listed above)	STOP WORK, EVACUATE AREA, NOTIFY PROJECT MANAGER	-requires identification of new chemical hazard and HSP amendments
Vinyl Chloride	Colorimetric Tubes	confirmed 10 ppm or greater above background based on judgment of SSO	STOP WORK, EVACUATE AREA, NOTIFY PROJECT MANAGER	- requires HSP amendments

Table 6.1 (continued)
Hazard Monitoring Methods, Action Levels, and Protection Measures

Hazard	Monitoring Method	Action Level	Protective Measures	Monitoring Schedule
Benzene	Colorimetric Tubes	confirmed 5 ppm or greater above background based on judgment of SSO	STOP WORK, EVACUATE AREA, NOTIFY PROJECT MANAGER	-requires HSP amendments
Tetrachloroethene	Colorimetric Tubes	confirmed 250 ppm or greater above background based on judgment of SSO	STOP WORK, EVACUATE AREA, NOTIFY PROJECT MANAGER	-requires HSP amendments
Trichloroethene	Colorimetric Tubes	confirmed 500 ppm or greater above background based on judgment of SSO	STOP WORK, EVACUATE AREA, NOTIFY PROJECT MANAGER	- requires HSP amendments

Table 7.1
Protective Equipment for On-site Activities

Activity	Level	Protective Equipment
Surface Soil Sampling Subsurface Soil Sampling Groundwater Sampling	D	• Street clothes or overalls (long sleeves) • Impermeable safety boots/shoes (steel-toed) • Safety glasses/goggles (if hazard to eyes exists) • Hard hat (if hazard to head exists) • Gloves (nitrile, neoprene) • Ear plugs/defenders (if hazard exists)
	D (modified)	• Rubber boots; chemically-resistant with steel toe • Gloves (nitrile, neoprene) • Tape for sealing ankle and wrist openings • Hard hat (if hazard to head exists) • Safety glasses/goggles (if hazard to eyes exists) • Unbolted Tyvek™ or equivalent • Ear plugs/defenders (if hazard exists)
	C	• Coated Tyvek™ or equivalent • Rubber boots; chemically resistant with steel toe • Rubber boot covers • Latex inner gloves • Tape for sealing ankle and wrist openings • Chemical resistant outer gloves (nitrile, neoprene) • Full-face respirator (organic vapor cartridges) • Additional items may be required (site-specific) • Ear plugs/defenders (if hazard exists)

Table 8.1
Six Stages for Decontamination in Modified Level D Protection

Stage	Procedure
Stage 1: Segregated Equipment Drop	Deposit equipment used on-site on plastic drop cloths or in assigned containers with plastic liners.
Stage 2: Boot Cover and Glove Wash	Scrub outer boot covers and gloves with decontamination solution, and rinse with water.
Stage 3: Tape Removal	Remove tape around boots and gloves and deposit in container with plastic liner.
Stage 4: Remove boots, gloves, and disposable clothing	Deposit in appropriate plastic-lined container. Discard disposable clothing.
Stage 5: Field wash	Wash hands and face with soap and water.
Stage 6: Redress	Put on clean clothes.

Table 8.2
Eighteen Stages for Decontamination in Level C Protection

Stage	Procedure
Stage 1: Segregated Equipment Drop	Deposit equipment used on-site on plastic drop cloths or in different containers with plastic liners. Segregation at the drop reduces the probability of cross-contamination. During hot weather operations, a cool-down station may be set up within this area.
Stage 2: Boot Cover and Glove Wash	Scrub outer boot covers and gloves with decon solution of detergent and water.
Stage 3: Boot Cover and Glove Rinse	Rinse off decon solution from Stage 2 using copious amounts of water.
Stage 4: Tape Removal	Remove tape around boots and gloves and deposit in container with plastic liner.
Stage 5: Boot Cover Removal	Remove boot covers and deposit in container with plastic liner.
Stage 6: Outer Glove Removal	Remove outer gloves and deposit in container with plastic liner.
Stage 7: Suit, Glove, and Boot Wash	Wash splash suit, gloves, and safety boots. Scrub with long-handle scrub brush and decon solution.
Stage 8: Suit, Glove and Boot Rinse	Rinse off decon solution using water. Repeat as many times as necessary.
Stage 9: Canister or Mask Change	Perform last step in the decontamination procedure (if worker is leaving exclusion zone to change canister or mask). Worker's canister is exchanged, new outer gloves and boot covers donned, and joints taped; worker returns to duty.
Stage 10: Safety Boot Removal	Remove safety boots and deposit in container with plastic liner.
Stage 11: Splash Suit Removal	Remove splash suit with assistance of helper. Deposit in container with plastic liner.
Stage 12: Inner Glove Wash	Wash inner gloves with decon solution.
Stage 13: Inner Glove Rinse	Rinse inner gloves with water.
Stage 14: Face Piece Removal	Remove face piece. Deposit in container with plastic liner. Avoid touching face with fingers. Note: Certain parts of contaminated respirators, such as the harness assembly and leather or cloth components are difficult to decontaminate. If grossly contaminated, they may need to be discarded. Rubber components can be soaked in soap and water and scrubbed with a brush. Use a final rinse of water and allow to air dry before using again. Inspect the respirator for damage and signs of wear before and after each use.
Stage 15: Inner Glove Removal	Remove inner gloves and deposit in lined container.
Stage 16: Inner Clothing Removal	Remove clothing soaked with perspiration and place in lined container. Do not wear inner clothing off the site since there is a possibility that small amounts of contaminants might have been transferred when removing the disposal coveralls.

Table 8.2 (continued)
Eighteen Stages for Decontamination in Level C Protection

Stage	Procedure
Stage 17: Field Wash	Shower if highly toxic, skin-corrosive, or skin-absorbable materials are known or suspected to be present. Wash hands and face if shower is not available.
Stage 18: Redress	Put on clean clothes.

Table 13.1
Emergency Telephone Numbers, Contacts, and Directions to Nearest Medical Facility

Key Personnel	Number
Lynn Morgan - Project Manager	(703) 736-4518
Eric Evans - Project Manager	(518) 782-3435
Ken Rapuano - Health and Safety Officer	(703) 736-4546
Jim Costello - Program Manager	(703) 736-4507
Michael Dodyk - Base Point of Contact (AFCEE/ERD)	(817) 782-7167
Don Ficklen - AFCEE/ERD Contracting Officer's Representative	(210) 536-5290
Emergency Phones Numbers	
Ambulance	911 or (817) 782-6330
Fire Department	911 or (817) 782-6330
Poison Control	911 or (800) 764-7661
Hospital - Harris Methodist - Fort Worth 1301 Pennsylvania Avenue	911 or (817) 882-2000
Directions to Nearest Medical Facility (Figure 13.1)	
Exit NAS Fort Worth JRB on Pumphrey Rd. heading south. Turn left on Roaring Springs Rd. heading southeast for 2.0 miles. Roaring Springs Rd. turns into Horne St. prior to I-30. Turn left on I-30 heading east for 4.0 miles. Turn right on Summit Ave. heading south for 0.3 miles. Turn left on Pennsylvania Ave. heading east for 0.2 miles. Turn right on South Lake St. heading south to 1301 Pennsylvania Ave. Emergency entrance is located on the right.	

FIELD FORMS

SITE SAFETY BRIEFING FORM

Project ____

Date ______________ Time ______________ Job No. ______________

Location ____

Type of Work ____

____

____

SAFETY TOPICS PRESENTED

Protective Clothing/Equipment ____

____

Chemical Hazards ____

____

Physical Hazards ____

____

Emergency Procedures ____

____

Hospital/Clinic ______________________________ Phone ______________

Hospital Address ____

Special Equipment ____

____

Other ____

____

____

____

ATTENDEES

Name (Printed)	Signature

Meeting Conducted by: ______________________________

Site Safety Officer: ______________________________

HEALTH AND SAFETY PLAN

COMPLIANCE AGREEMENT FORM

PROJECT: Data Gap Investigations

CLIENT: U.S. Air Force Center for Environmental Excellence

LOCATION: NAS Fort Worth JRB, Texas

PROJECT NO: AFC001-0036

I, ______________________________, have received a copy of the Health and Safety Plan for the above-referenced project. I have read the plan, understand it, and agree to comply with all its provisions. I understand that I can be prohibited from working on the project for violating any of the safety requirements specified in the plan.

Signed:

______________________________ ______________________________

Signature Date

____

Company

HEALTH AND SAFETY PLAN AMENDMENTS FORM

Change in field activities or hazards: ______________________________

____

____

____

____

____

____

Proposed Amendments: ______________________________

____

____

____

____

____

____

Proposed by: ______________________ Date: __________

Approved by: ______________________________

Accented: __________ Declined: __________ Date: __________

Amendment Number: __________

Amendment Effective Date: __________

HYDROGEOLOGIC, INC.
Accident/Incident/Near Miss Investigation Form

Employee's Name:________________________
Address:________________________
________________ SS#____________
Job Title:____________ Supervisor's Name:____________
Office Location:________________________
Location at Time of Incident:________________________
Date/Time of Incident:________________________

Describe clearly how the accident occurred:________________________

Was incident: Physical____________ Chemical____________
Parts of body affected ____________ Exposure: Dermal____________
right left Inhalation____________
Ingestion____________

Witnesses: 1)____________ 2)____________

Conditions/acts contributing to this incident________________________

Managers must complete this section:
Explain specifically the corrective action you have taken to prevent a recurrence:____________

Did injured go to doctor:____________ Where:____________
When:____________
Did injured go to hospital:____________ Where:____________
When:____________

Signatures:

Employee	Reporting Manager	Health & Safety Officer
Date	Date	Date

Accidents must be reported immediately; this form must be completed and returned to the Health and Safety Officer within **24 hours.**

MEDICAL DATA SHEET

This brief Medical Data Sheet will be completed by all onsite personnel and will be kept in the command post during the conduct of site operations. This data sheet will accompany any personnel when medical assistance is needed or if transport to hospital facilities is required.

Project ______________________________

Name ______________________ Home Telephone ______________

Address ______________________________

Age ____________ Height ____________ Weight ____________

Name of Next of Kin ______________________________

Drug or other Allergies ______________________________

Particular Sensitivities ______________________________

Do You Wear Contacts? ______________________________

Provide a Checklist of Previous Illnesses or Exposure to Hazardous Chemicals.

____

____

What medications are you presently using? ______________________________

____

____

Do you have any medical restrictions? ______________________________

____

____

Name, Address, and Phone Number of personal physician: ______________

____

____

____

____

____

I am the individual described above. I have read and understand this HSP:

____

______________________ ______________

Signature Date

DAILY EQUIPMENT CALIBRATION LOG

Project Name:

Project No:

DATE/TIME	INITIALS	INSTRUMENT	CALIBRATION SOLUTION OR GAS CONCENTRATION	ADJUSTMENTS REQUIRED/ COMMENTS

Project________________

HEALTH AND SAFETY/AIR MONITORING LOG

Date: ______________________________ Logged by:________________________

Weather: ____
Field Tasks: ____

HydroGeoLogic Personnel (or subs) working on the site (name and affiliation):

HydroGeoLogic Personnel (or subs) working in restricted zone:

HydroGeoLogic Site Visitors:

Air Quality Monitoring Measurements:

Time	Instrument	Parameter	Concentration	Locations

Background:

Exclusion zone:

Level of PPE: ____

Comments on other safety-related matters:

(including infractions, accidents, injuries, unusual occurrences, physical complaints)

FINAL PAGE

ADMINISTRATIVE RECORD

FINAL PAGE