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FINAL WORK PLANS FOR SITE INVESTIGATION OF 12 UNDERGROUND STORAGE TANKS NAS FORT WORTH TX

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NAVAL AIR STATION
FORT WORTH JRB
CARSWELL FIELD
TEXAS

ADMINISTRATIVE RECORD COVER SHEET

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HydroGeoLogic Inc.

Final Work Plans
Site Investigation of
12 Underground Storage Tanks
NAS Fort Worth JRB, Texas

AF Center for Environmental Excellence

Prepared for

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

Contract Number F41624-95-D-8005

May 1999

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13. ABSTRACT (Maximum 200 words)

This document represents the Work Plan for the Site Investigation of 12 Underground Storage Tanks at NAS Fort Worth JRB. The Work Plan presents detailed procedures for the investigation required to evaluate the potential threat to human health and the environment posed by wastes handled at the subject sites.

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FINAL WORK PLAN
SITE INVESTIGATION OF
12 UNDERGROUND STORAGE TANKS
NAS FORT WORTH JRB, TEXAS

Contract Number F41624-95-D-8005
Delivery Order No. 0016

Prepared for

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

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May 1999

PREFACE

This document constitutes the Final Work Plan for the Site Investigation of 12 Underground Storage Tanks (USTs) at the Naval Air Station (NAS) Fort Worth Joint Reserve Base (JRB), Carswell Field, Texas. The report contains the following sections: Introduction; Summary of Existing Information; Data Gaps Identification and Proposed Sampling Activities; and References.

HydroGeoLogic, Inc. (HydroGeoLogic) prepared this document under contract to the Air Force Center for Environmental Excellence (AFCEE), Contract No. F41624-95-D-8005, Delivery Order No. 0016, in support of the Air Force Installation Restoration Program.

This document was prepared in HydroGeoLogic's main office in Herndon, Virginia, under the direction of Mr. James Costello, the HydroGeoLogic Project Manager. The document was prepared with the assistance of Mr. Joseph Dunkle, the HQ/AFCEE Contracting Officer's Representative, located at Brooks Air Force Base (AFB), Texas.

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LIST OF ACRONYMS AND ABBREVIATIONS

1,2-DCE	1,2-dichloroethene
1,1,1-TCA	1,1,1-trichloroethane
ACC	Air Combat Command
AFB	Air Force base
AFCEE	Air Force Center for Environmental Excellence
AFP-4	Air Force Plant 4
AGE	aerospace ground equipment
ARARs	Applicable or Relevant and Appropriate Requirement
ASTM	American Society for Testing and Materials
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylenes
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cis-1,2-DCE	*cis*-1,2-dichloroethene
cm/sec	centimeters per second
COPC	chemical of potential concern
COR	Contracting Officer's Representative
DCE	dichloroethene
DEQPPM	Defense Environmental Quality Program Policy Memorandum
DERP	Defense Environmental Restoration Program
DoD	Department of Defense
DPT	direct push technology
DRMO	Defense Reutilization and Marketing Office
DRO	diesel-range organics
Eagle	Eagle Construction and Environmental Services, Inc.
EM	electromagnetic
EPA	U.S. Environmental Protection Agency
ESE	Environmental Science and Engineering Inc.
°F	degrees Fahrenheit
FHS	fuel hydrant system
FSP	Field Sampling Plan
ft/d	feet per day
GCA	ground control approach
GC/MS	gas chromatograph/mass spectrometry
gpd/ft	gallons per day per foot
gpd/ft^2	gallons per day per square foot

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

HSP	Health and Safety Plan
HydroGeoLogic	HydroGeoLogic, Inc.
ICP	inductively coupled plasma
ILS	instrument landing system
IRP	Installation Restoration Program
IS	internal standard
IT	International Technology Corporation
Jacobs	Jacobs Engineering Group, Inc.
JP-4	jet propulsion grade 4
JRB	Joint Reserve Base
L	liter
LPST	leaking petroleum storage tank
MCL	maximum contaminant level
MEK	methyl ethyl ketone
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
msl	mean sea level
MTBE	methyl tert-butyl ether
NAS	Naval Air Station
NCP	National Contingency Plan
NGVD	National Geodetic Vertical Datum
NPDES	National Pollutant Discharge Elimination System
OWS	oil/water separator
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PD-680	petroleum naphtha
PID	photoionization detector
PQL	practical quantitation limit
PST	petroleum storage tank
QAPP	Quality Assurance Project Plan
RAPCON	radar approach control
RBCA	risk-based corrective action
RCRA	Resource Conservation and Recovery Act

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

RFA	RCRA facility assessment
RFI	RCRA facility investigation
RI/FS	remedial investigation/feasibility study
RSD	relative standard deviation
SAC	Strategic Air Command
SAP	Sampling and Analysis Plan
SARA	1986 Superfund Amendments and Reauthorization Act
SI	site investigation
SVOC	semivolatile organic compound
SWMU	solid waste management unit
TAC	Texas Administrative Code
TACAN	tactical air navigation
TCE	trichloroethylene
TDS	total dissolved solids
TNRCC	Texas Natural Resource Conservation Commission
TPH	total petroleum hydrocarbons
USACE	U. S. Army Corps of Engineers
USGS	U. S. Geological Survey
U.S.	United States
UST	underground storage tank
VOC	volatile organic compound
WP	Work Plan

TAB

Section 1.0

FINAL
WORK PLAN
SITE INVESTIGATION
12 UNDERGROUND STORAGE TANKS
NAS FORT WORTH JRB, TEXAS

1.0 INTRODUCTION

1.1 THE AIR FORCE INSTALLATION RESTORATION PROGRAM

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

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

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

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

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

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

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

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

The Texas Natural Resource Conservation Commission (TNRCC) leaking petroleum storage tank (LPST) program is the primary regulatory program that governs USTs at NAS Fort Worth JRB. In addition, the Air Force IRP will affect activities at this site. The IRP was implemented in 1996 in conjunction with RCRA. The IRP and RCRA, however, rely heavily on guidance documents prepared under CERCLA.

The Work Plans (WPs) for this delivery order have been prepared using guidance documents from all four of the previously mentioned programs (i.e., TNRCC LPST, RCRA, IRP, CERCLA) in an effort to address as many of the concerned parties as possible. The WPs for this project consists of the following documents:

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

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

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

The Quality Assurance Project Plan describes the field and analytical procedures that will be used to ensure quality control for the project. The QAPP provides the project organization responsibility and defines quality assurance objectives on a project-wide basis. Laboratory operating procedures are presented, including calibration, data management, validation, and reporting. Internal controls and procedures are also defined. This investigation will follow the Final Basewide QAPP generated by HydroGeoLogic (HydroGeoLogic, 1998a).

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

1.2 HISTORY OF PAST IRP WORK AT THE INSTALLATION

This section describes the location, physical setting, and operational history of NAS Fort Worth JRB, Texas. This section also identifies previous environmental investigations relevant to this site investigation (SI).

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 Air Force Plant 4 (AFP-4) to the west. The area surrounding NAS Fort Worth JRB that is not used for DoD 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 currently occupied by the NAS Fort Worth JRB consisted of woods and pasture in an area called White Settlement. 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 NAS Fort Worth JRB. In August 1942, the base was opened as Tarrant Field Airdrome and, under the jurisdiction of the Gulf Coast Army Air Field Training Command, was used to train pilots to fly B-24 bombers. In May 1943, the field was designated the Fort Worth Army Air Field and continued to be used 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 8th Air Force. It was renamed Carswell AFB 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 Navy assumed responsibility for much of the facility, and its name was changed from Carswell AFB to NAS Fort Worth JRB. 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).

1.2.3 Site Operational History

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

1.2.3.1 Industrial Activities

Major industrial operations that have been performed at 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, 1996a).

Waste oils generally refer to lubricating fluids/oils and, to a lesser extent, hydraulic fluids. Recoverable fuels refer to fuels drained from aircraft tanks and other base vehicles, such as jet propulsion grade 4 (JP-4) and unleaded gasoline. Spent solvents and cleaners refer to stripping liquids used for degreasing and cleaning the following: aircraft, aircraft systems and parts, electronic components, and vehicles. Spent solvents and cleaners include petroleum naphtha (PD-680) and various chlorinated organic compounds. Specific types of degreasing solvents used by the Air Force have changed over the years. Carbon tetrachloride was commonly used in the 1950s, until it was replaced by trichloroethylene (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, 1996a).

1.2.3.2 Waste Disposal Operations

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

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 area 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 by service contract either directly or through the Defense Reutilization and Marketing Office (DRMO). Recovered JP-4 was stored at the fire department training area and burned during practice exercises. Recovered JP-4 was also used in 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 flight line area of the base. The wastes are subsequently disposed of by contractor removal through the DRMO.

Recovered JP-4 and other fuels (mogas - unleaded gasoline) are stored at the fire department training area for subsequent burning in practice exercises or 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 the DRMO.

1.2.4 Site Investigation History

This SI is being conducted at each of the 12 UST locations as part of the ongoing IRP. The IRP is designed to identify, characterize, and remediate any contamination discovered on-site. The IRP effort at NAS Fort Worth JRB was initiated in 1984 and has continued to the present.

The following IRP reports have been consulted in the preparation of this WP:

- CH2M HILL, Site Characterization Summary-Informal Technical Information Report, November 1996.
- HydroGeoLogic, Inc., 1998, Final Basewide Groundwater Sampling and Analysis Program, 1997 Annual Report.
- HydroGeoLogic, Inc., 1999, Final Technical Memorandum, Recommended Actions, Underground Storage Tanks, NAS Fort Worth JRB, Texas.
- International Technology Corporation, Draft RCRA Facility Investigation, Sanitary Sewer System, September 1997.
- Jacobs Engineering Group, Inc., Removal/Upgrade of Underground Storage Tanks, Technical Report, March 1997.

1.3 SITE IDENTIFICATION AND DESCRIPTION

A total of 132 USTs have been identified at NAS Fort Worth JRB; however only 12 USTs are being investigated under this WP. The details regarding the 132 USTs at NAS Fort Worth JRB are presented in the "Final Technical Memorandum, Recommended Actions, Underground Storage Tanks, NAS Fort Worth JRB, Texas", prepared by HydroGeoLogic and dated January 1999. According to this Memorandum, a total of 112 USTs were removed from further consideration under the Air Force DERA program; consequently, the Navy will assume regulatory responsibility for these USTs. The remaining eight USTs only require submittal of a request for closure.

The areas of interest for this WP are 12 USTs located throughout the NAS Fort Worth JRB installation. Table 1.1 provides a summary description of each UST site and lists the current status of each tank. The locations of the 12 USTs being investigated are presented on Figure 1.3. These USTs are identified and described as follows:

- **UST 1040-1:** UST 1040-1 was installed in 1955 and was removed in June 1994. According to as-built drawings, the former UST was located on the northwest side of Building 1040, the water-fire pump station, and was described as a 400-gallon steel UST used for the storage of diesel fuel. A site visit by HydroGeoLogic and Navy personnel identified hardware on Building 1040 generally associated with a UST vent pipe and a nearby monitoring well. Photographs depicting the area surrounding former UST 1040-1 are shown in Figure 1.4.

- **UST 1191-1:** UST 1191-1 was a 500-gallon steel waste oil tank located along the south side of Building 1191, the vehicle maintenance shop. The UST was installed in 1983 and removed in October 1993. As-built drawings did not show the exact location of the tank, but a site visit identified an area of patched concrete which indicates the former UST excavation. A monitoring well was also identified in close proximity to the patched area. Photographs of the area surrounding UST 1191-1 are shown in Figure 1.5.

- **USTs 1411-1, 1141-2, and 1141-3:** Building 1411, the AGE refueling facility, had three 2,000-gallon steel USTs. UST 1411-1 stored jet fuel, UST 1411-2 stored diesel fuel, and UST 1411-3 stored gasoline. All three USTs were installed in 1963 and removed in April 1996 by Jacobs Engineering Group, Inc. (Jacobs). The area is currently covered with an 8-inch layer of concrete. Photographs of the area surrounding USTs 1411-1, 1411-2, and 1411-3 are shown in Figure 1.6.

- **UST 1427-1:** UST 1427-1 was a 1,000-gallon steel UST used for storing diesel fuel. The UST was installed in 1976 and removed in November 1990. As-built drawings accurately located the former UST on the northwest side of Building 1427, the radar approach control (RAPCON) support facility, and a monitoring well was discovered near the site. Photographs of the area surrounding UST 1427-1 are shown in Figure 1.7.

- **USTs 1750-1 and 1750-2:** Building 1750, the communication relay station, had an 8,000-gallon fiberglass UST (1750-1) and a 20,000-gallon steel UST (1750-2).[1] Both USTs were located near the southwest corner of Building 1750 and were used for the storage of diesel fuel. UST 1750-2 was installed in 1957 and was abandoned in place in September 1992. UST 1750-1 was installed in 1986 and was removed in May 1996 by Jacobs. Photographs of the area around USTs 1750-1 and 1750-2 are shown in Figure 1.8. Building 1750 and its associated structures no longer exist.

- **UST 4115-1:** UST 4115-1 was a 600-gallon steel diesel tank near Building 4115, the former ground control approach (GCA) site. UST 4115-1 was installed in 1968 and was removed in January 1991. Although the exact location of the former UST was not identified, review of as-built drawings and a site visit to the

[1] The 20,000-gallon steel UST was identified in the Jacobs 1997 report as Tank 1750-1. However, the TNRCC identified this UST as 1750-2. This document will refer to the 20,000-gallon UST as 1750-2.

remaining foundation with Navy personnel identified an approximate area where the UST was located. Photographs of the area surrounding UST 4115-1 are shown in Figure 1.9.

- **UST 4136-1:** UST 4136-1 was a 100-gallon steel diesel tank located outside Building 4136, the tactical air navigation (TACAN) station. This UST was installed in 1980 and removed in January 1991. A site visit to the current TACAN area, which was built over the former location, identified an approximate location where the UST may have been. Photographs of the area surrounding UST 4136-1 are shown in Figure 1.10. An existing tank, UST 4136-2, was installed in 1991 southwest of Building 4136. This UST is a 300-gallon fiberglass tank, which is used for storing diesel fuel. UST 4136-2 does not require an investigation, but is included in Figure 1.10 for informational purposes only.

- **USTs GCA-1 and GCA-2:** Two USTs were identified by the TNRCC Petroleum Storage Tanks Summary Listing as GCA-1 and GCA-2. There was no information on the TNRCC list regarding the tanks except that they may have contained jet fuel (GCA-1) and gasoline (GCA-2) and that they were abandoned on an unknown date. Interviews with Navy personnel indicated that any USTs associated with the GCA site would be small and possibly located near a backup generator at either end of the runway. Navy personnel questioned the existence of these two USTs, stating that it would not be typical to abandon a small UST that could be easily removed. In addition, Navy personnel explained that all USTs on a military base are identified with the number of the building they serve and that the existence of these tanks is questionable due to the lack of a building number and any additional information. A search of Air Force and Navy records in conjunction with additional personnel interviews did not reveal any additional information concerning these two tanks. The suspected locations of GCA-1 and GCA-2 are shown in Figure 1.3 where the two former GCA sites existed. Due to a lack of specific information regarding these two USTs, photographs of their suspected locations have not been provided.

1.4 DESCRIPTION OF CURRENT STUDY

The 12 USTs included in this investigation consist of 9 USTs that were removed, and 3 USTs that were abandoned in place. An investigation will be conducted at each site in an effort to either provide evidence in support of closure by the TNRCC for the 12 removed/abandoned USTs, or determine if remediation is warranted.

The results of the investigations proposed in the WP may not provide complete delineation of the nature and extent of the contamination present at each of the subject USTs. If further delineation of contamination is required at any of the UST sites in this study, additional soil borings and/or monitoring wells will be installed, and existing monitoring wells may be sampled in order to complete characterization of the contaminants. When delineation of the contamination is complete at each UST site, the results of previous investigations will be compiled with the results of the investigation outlined in Section 3.4 of this WP, Field Investigation Tasks, and presented in an

SI report with a discussion of the TNRCC regulation that is appropriate for closure at each of the sites. The results of previous investigations, along with the results of the investigation outlined in Section 3.4 of this WP, will be used to determine which course of action is appropriate to receive closure at each UST site.

1.4.1 Preliminary Investigation

Soil and groundwater samples were collected during the removal of five of the USTs and near one of the USTs abandoned in place. The analytical results from these samples were compared to TNRCC action levels for LPST sites (Table 1.2) in order to determine if any corrective action is required under the TNRCC LPST program. However, analytical data was found to be insufficient in order to properly document the soil and/or groundwater conditions at the time of removal. These results are discussed in greater detail in Section 3.4 of the WP. No analytical data was collected at the time of removal/abandonment of the remaining six USTs.

Figure 1.11 illustrates the UST closure process for each removed/abandoned UST. Each UST site will require a preliminary investigation of the site-specific soil conditions in order to characterize a contaminant source and provide an evaluation of the nature and extent of any contamination detected. The results of the samples collected during the investigation will be compared to the TNRCC action levels (TNRCC, 1996a) in order to obtain closure under the TNRCC LPST program. If contamination is encountered from any of the removed/abandoned USTs above the action levels, then a Release Determination Report will be filed with the TNRCC along with a Technical Memorandum to indicate a proposed plan of action. The site will then be deemed an LPST site, assigned an LPST number by the TNRCC, and a Plan A evaluation will be recommended.

1.4.2 Plan A Evaluation

If analytical results of the preliminary investigation are above TNRCC action levels, a site investigation will be conducted in accordance with TNRCC's LPST Plan A site evaluation as required by Title 30 Texas Administrative Code and the Texas Water Code. This Plan A site evaluation is fully integrated within the TNRCC LPST program for risk-based corrective action (RBCA) sites. Figure 1.12 illustrates how a site assessment integrates with the overall RBCA program. Figure 1.13 details the essential steps of the Plan A site evaluation process.

The Plan A site evaluation includes a site investigation of leaking storage tank sites with cleanup levels based on specific methods, conservative assumptions regarding potential human exposure, and site-specific factors. Once a site is deemed an LPST site, it is recommended to undergo a Plan A evaluation (TNRCC, 1994). The Plan A site evaluation will be conducted using the following guidance documents:

- Texas Natural Resource Conservation Commission, Petroleum Storage Tank Division, 1996a, RG-17: Action Levels for LPST Sites (TNRCC, 1996a).

- Texas Natural Resource Conservation Commission, 1995, RG-175: Guidance for Risk-Based Assessment at LPST Sites in Texas, Emphasizing Initial Investigations and Plan A Evaluation (TNRCC, 1995).

- Texas Natural Resource Conservation Commission, Leaking Petroleum Storage Tank Program, 1994, RG-36: Risk-Based Corrective Action for Leaking Storage Tank Sites (TNRCC, 1994).

Both screening and definitive analytical results from previous investigations were considered to identify contaminated areas at each former/abandoned UST location. Section 3.4 of this WP discusses these results in more detail. For the purpose of assessing contamination at each location, soil concentrations from previous investigations were compared to the screening level listed in TNRCC RG-17. Maximum site contaminant levels detected during the site investigations will be compared with the appropriate Plan A target concentrations for the site. Target concentrations for soil will be chosen based on adequate protection for current and future land uses, and protection of potable groundwater resources (TNRCC, 1994).

A conservative preliminary assessment of relevant factors (such as potential receptors, migration pathways, etc.) suggests that maximum contaminant concentrations detected during field activities be compared with either Plan A Category I or Category II target concentrations. The presence of free product will disqualify the site for closure under Plan A (TNRCC, 1994). Table 1.3 contains Plan A Category I and Category II target concentrations.

If the analytical results of this investigation are below the appropriate Plan A target concentrations and the contamination is delineated to the appropriate target concentrations, each former UST site will be recommended for closure under a Plan A site evaluation. In this case, a site assessment report will be completed and submitted to the TNRCC. In the event that additional investigation is required to complete the delineation of the nature and extent of contamination at any of the UST locations under investigation, additional borings and/or wells will be installed. The results of the entire investigation will be presented in an SI report with a discussion of what future requirements could be necessary for closure. These future requirements could include a post-Plan A/pre-Plan B exit criteria study, or a Plan B risk-based corrective action study.

1.5 PROJECT OBJECTIVES

This investigation is intended to determine if hazardous constituents have been released to the environment from the subject sites. If a release is confirmed, the investigation will continue in order to determine the nature and extent of the contamination. Since these sites are generally very small, an extensive soil boring/monitoring well network is not justified.

The three primary objectives identified for this project are as follows:

- Confirm whether or not the USTs at the GCA site existed. Conduct a visual inspection and a geophysical survey in the areas where the abandoned USTs may exist.

- Determine if a release from the USTs has occurred. Soil samples will be collected, and at some sites, existing monitoring wells will be sampled to determine if a release has occurred. Additional borings/monitoring wells will be advanced and sampled as necessary to ensure that the extent of any potential contamination is evaluated.

- If contamination is encountered, the nature and extent of the contamination must be characterized. This will be accomplished by defining the vertical and lateral extent of chemicals that exceed TNRCC action levels for LPST sites. Field methods that will be utilized include soil boring installation, monitoring well installation, and groundwater sampling from new and existing monitoring wells.

The data collected from previous investigations associated with five of the USTs that were removed and one of the USTs that was abandoned in place was considered to be insufficient to seek closure from the TNRCC. In addition, no analytical data was found documenting the removal or abandonment of the remaining USTs. As a result, the appropriate number of samples will be collected to determine the status of each site. The analytical results collected during the investigation will be compared to the TNRCC Action Levels for LPST Sites (Table 1.2) to determine if any corrective action is required for the USTs.

The field investigation for this project will include each of the following tasks:

- **UST 4136-1:**

  Conduct a soil gas survey, using carbonated soil gas samplers, in an effort to pinpoint the former UST excavation. Collect soil samples from the area surrounding the former UST excavation for comparison to the TNRCC action levels.

- **UST 1040-1 and UST 4115-1:**

  Collect soil samples from the area surrounding the former UST excavations from which no analytical data to be associated with the tank removal activities was found. Compare soil data to the TNRCC action levels.

- **UST 1191-1, UST 1427-1, and USTs 1750-1 and 1750-2:**

  Collect soil samples from the area surrounding the former UST excavations to use in conjunction with the original analytical results for comparison to the TNRCC action levels.

- **USTs 1411-1, 1411-2, and 1411-3:**

  Collect groundwater samples from the existing monitoring wells surrounding former UST excavations to use in conjunction with the original analytical results for comparison to the TNRCC action levels.

- **GCA-1 and GCA-2:**

  Conduct a visual inspection to identify any surface features generally associated with a UST, such as depressions, stressed or dead vegetation, etc., and sweep the area using an electromagnetic (EM) system, in an effort to locate the abandoned USTs at the GCA site. If the USTs are located, collect soil samples from the area surrounding the abandoned USTs for comparison to the TNRCC action levels.

If the analytical results of this investigation are below the TNRCC action levels for LPST sites, the former UST sites will be recommended for closure without additional corrective action. In the event that the analytical results exceed the TNRCC action levels for LPST sites, a Plan A investigation will be proposed as outlined in Section 1.4.2. The results of the entire investigation will be presented in an SI report with a discussion of any additional requirements for closure.

TAB

Tables

Table 1.1
Underground Storage Tanks to be Investigated
NAS Fort Worth JRB, Texas

UST No.	Location	Capacity (gallons)	Tank Type	Contents	Installed	Status
1040-1	Water-Fire Pump Station	400	Steel	Diesel	1955	Removed June 1994
1191-1	Vehicle Maintenance Shop	500	Steel	Waste Oil	1983	Removed October 1993
1411-1	AGE Refueling Facility	2,000	Steel	Jet Fuel	1963	Removed April 1996
1411-2	AGE Refueling Facility	2,000	Steel	Diesel	1963	Removed April 1996
1411-3	AGE Refueling Facility	2,000	Steel	Gasoline	1963	Removed April 1996
1427-1	RAPCON Support	1,000	Steel	Diesel	1976	Removed November 1990
1750-1	Communication Relay Station	8,000	Fiberglass	Diesel	1986	Removed May 1996
1750-2	Communication Relay Station	20,000	Steel	Diesel	1957	Abandoned September 1992
4115-1	Former GCA Site	600	Steel	Diesel	1968	Removed January 1991
4136-1	TACAN Station	100	Steel	Diesel	1980	Removed January 1991
GCA-1	Former GCA site	Unknown	Unknown	Jet Fuel	Unknown	Abandoned (Unknown Date)
GCA-2	Former GCA site	Unknown	Unknown	Gasoline	Unknown	Abandoned (Unknown Date)

Sources: CH2M Hill Site Characterization Summary Informal Technical Information Report, November 1996.
TNRCC Petroleum Storage Tanks Detail Listing, January 23, 1997.
Navy Environmental Office, Mr. Les Bowers, February 19, 1998.
Navy Environmental Office, Mr. Lance Key, July 28, 1998.

Table 1.2
TNRCC Action Levels and Screening Levels for LPST Sites

Constituents	Soil Action Levels (mg/kg)		Groundwater Action Levels (mg/L)
	Fine-Grained Soil*	Coarse-Grained Soil*	
Benzene	0.50	0.50	0.005
Ethylbenzene	70	10	0.70
Toluene	100	20	1.0
Total xylenes	560	70	10
Acenaphthene	314	314	0.010
Anthracene	13	13	0.010
Benzo[*a*]anthracene	0.877	0.877	0.010
Benzo[*b*]fluoranthene	0.877	0.877	0.010
Benzo[*k*]fluoranthene	8.77	8.77	0.010
Benzo[*a*]pyrene	0.0877	0.0877	0.010
Chrysene	7.2	7.2	0.010
Dibenz[*a*,*h*]anthracene	0.0877	0.0877	0.010
Fluoranthene	156	156	0.010
Fluorene	247	247	0.010
Indeno(1,2,3-cd)pyrene	0.877	0.877	0.010
Naphthalene	389	389	0.010
Pyrene	99	99	0.010
SCREENING LEVELS			
Total petroleum hydrocarbons (TPH) for middle distillate releases**	500	500	5
Total petroleum hydrocarbons (TPH) for gasolene releases**	100	100	5

* Apply the fine-grained soil standard to sites dominated with clays and silts. Apply the coarse-grained soil standards to sites dominated with sands, gravels, and rock units.

** Apply the middle distillate TPH standard to diesel, kerosene, jet fuel, hydraulic oil, and used oil releases. Apply the gasoline standard to gasoline and aviation gasoline releases. At sites where both gasoline and middle distillate releases have occurred in the same area or tank hold, the gasoline standard will apply.

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
Source: Texas Natural Resource Conservation Commission, PST Division, 1996a, RG-17: Action Levels for LPST Sites (TNRCC, 1996a).

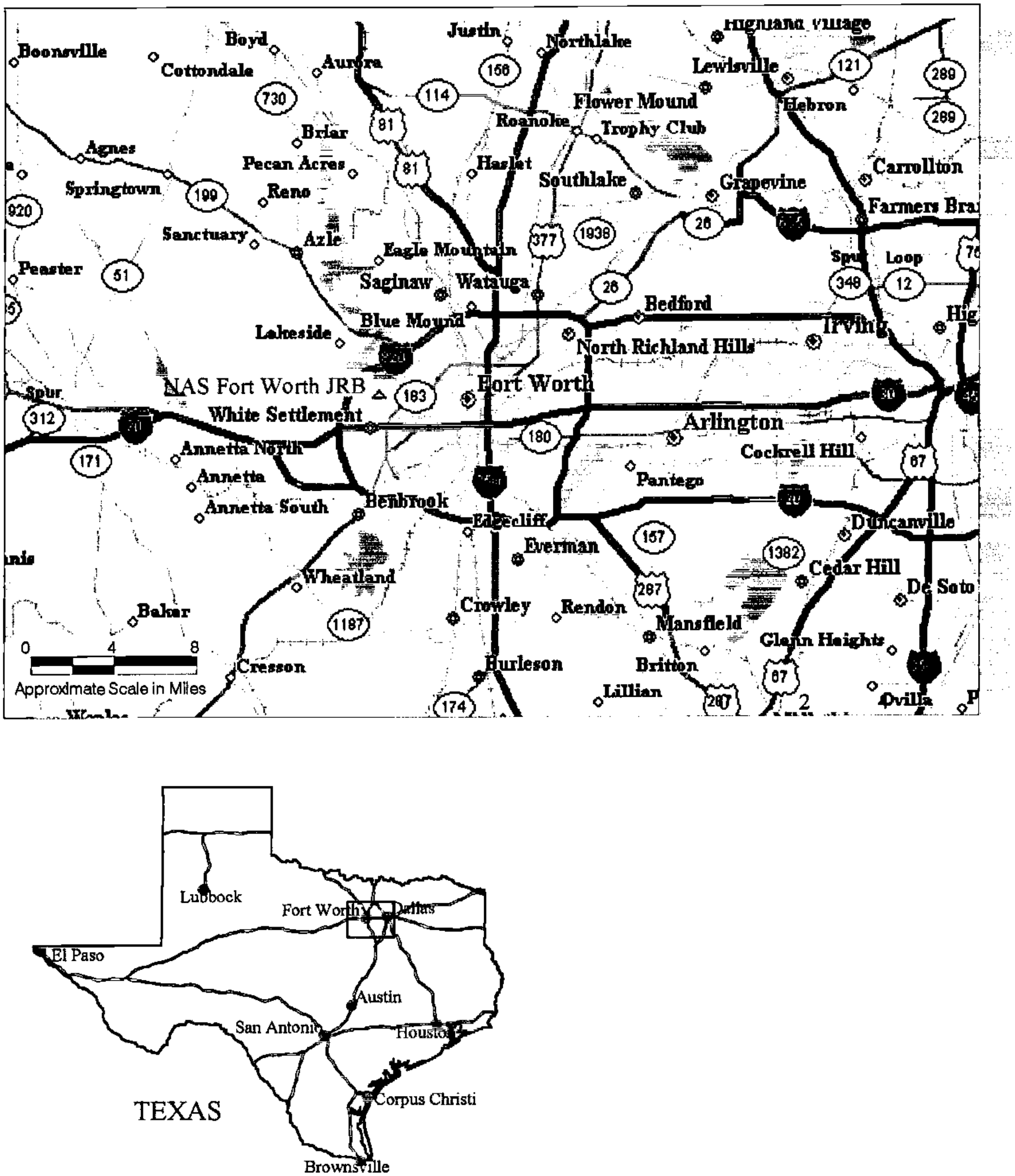
Table 1.3
Plan A Category I and II Target Concentrations

Parameter	Soil (mg/kg)		Groundwater (mg/L)	
	Category I	Category II	Category I	Category II
Acenaphthene	314	314	2.19	2.19
Acetone	22	22	3.650	3.65
Anthracene	13	13	11.000	11
Benzene	0.13	0.74	0.005	0.0294
Benzo[*a*]anthracene	3.2	32	0.000117	0.00117
Benzo[*b*]fluoranthene	13	129	0.000117	0.00117
Benzo[*k*]fluoranthene	47	47	0.00117	0.0117
Benzo[*a*]pyrene	220	129	0.0002	0.000117
Chrysene	7.2	7.2	0.0117	0.117
Dibenz[*a, h*]anthracene	7.7	33	0.0000117	0.000117
Dichlorobenzene (1,2)	208	1,140	0.6	3.29
Dichlorobenzene (1,3)	208	1,140	0.6	3.25
Dichlorobenzene (1,4)	26	123	0.075	0.355
Ethylbenzene	160	1,193	0.7	3.65
Fluoranthene	156	156	1.46	1.46
Fluorene	247	247	1.46	1.46
Formaldehyde	46	46	7.3	7.3
Indeno(1,2,3cd)pyrene	17	17	0.000117	0.00117
Methyl Ethyl Ketone	142	142	21.9	21.9
Naphthalene	389	389	1.46	1.46
Pyrene	99	99	1.1	1.1
Toluene	69	503	1	7.3
Xylenes	568	968	10	73

Source: TNRCC, 1994 (RG-36).

TAB

Figures



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HYDROGEOLOGIC INC.

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Figure 1.1

Site Location Map
NAS Fort Worth JRB, Texas

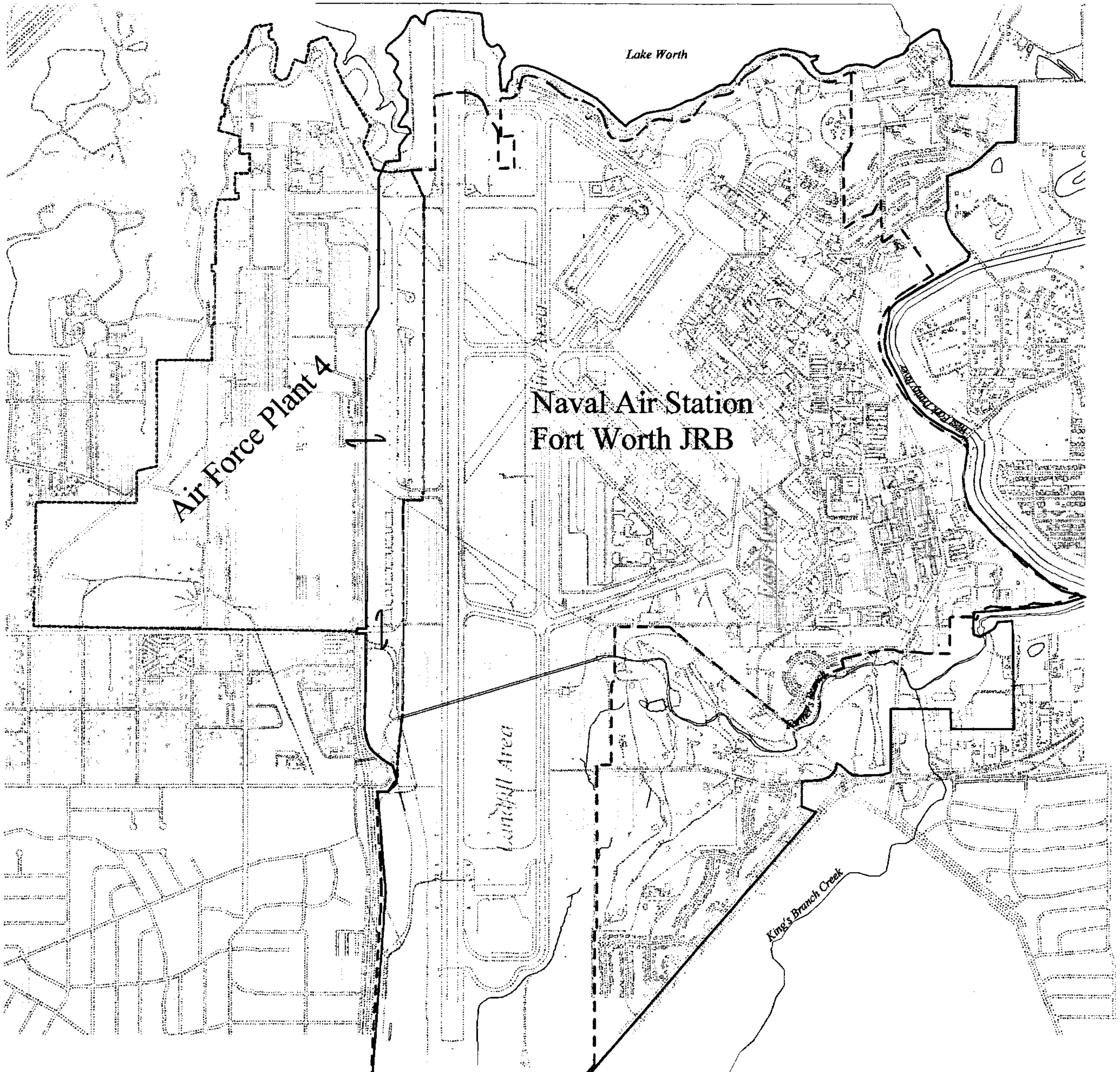

Figure 1.2

NAS Fort Worth JRB Base Boundaries

Air Force Center For Environmental Excellence
Brooks AFB, Texas

Legend

- - - - Boundary of NAS Fort Worth JRB
—— Former Property Boundary of Carswell Air Force Base
······ Property Boundary of Air Force Plant 4

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Revised: 05/24/99 ap
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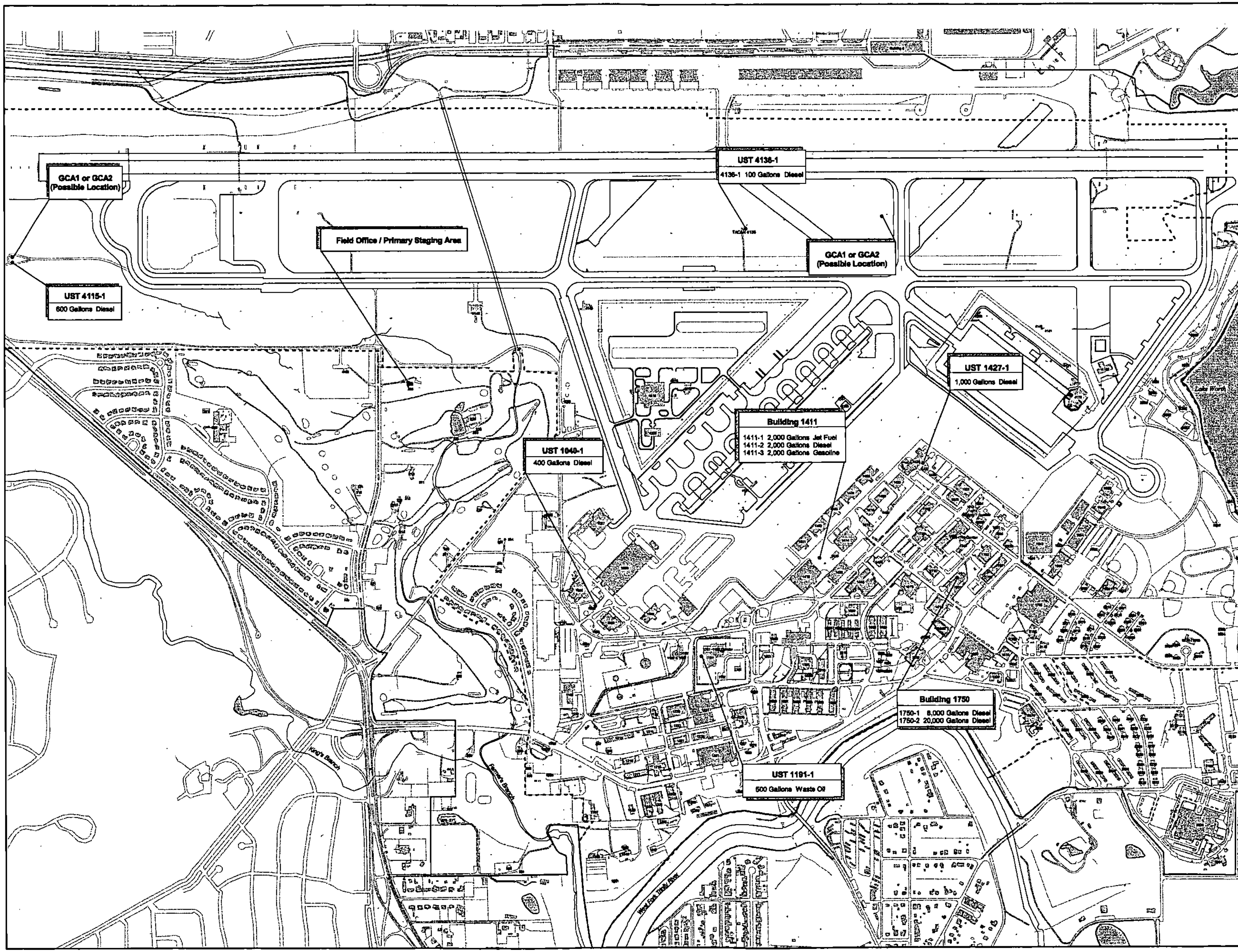

Figure 1.3

UST Locations
NAS Fort Worth JRB, Texas

Air Force Center for Environmental Excellence

Legend

- • Former Underground Storage Tank (UST) (Approximate Location)
- - - NAS Fort Worth JRB (Carswell Field)
- — Former Carswell Air Force Base
- Building/Facility
- Field Office / Primary Staging Area

N

0 500 1000
Scale in Feet

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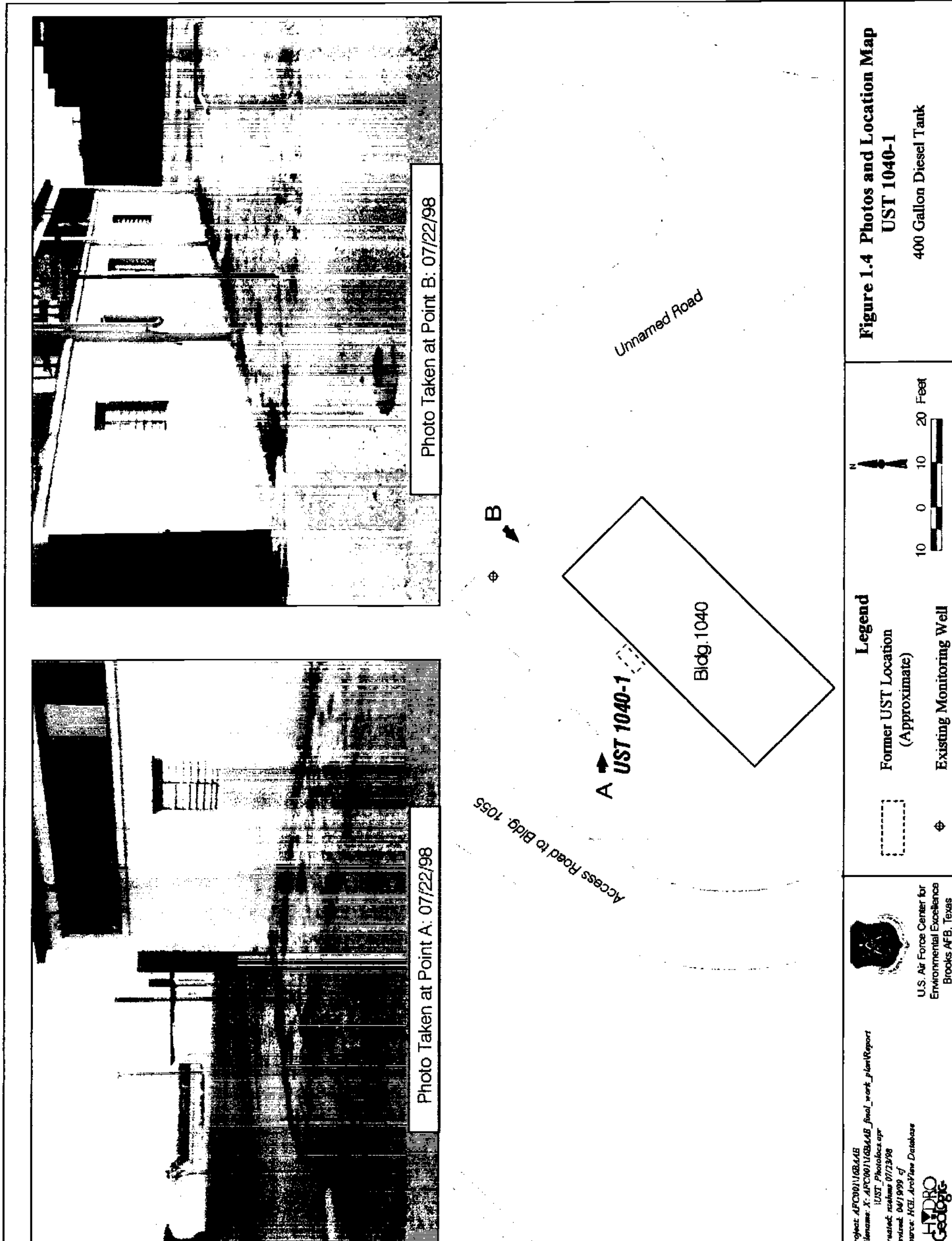
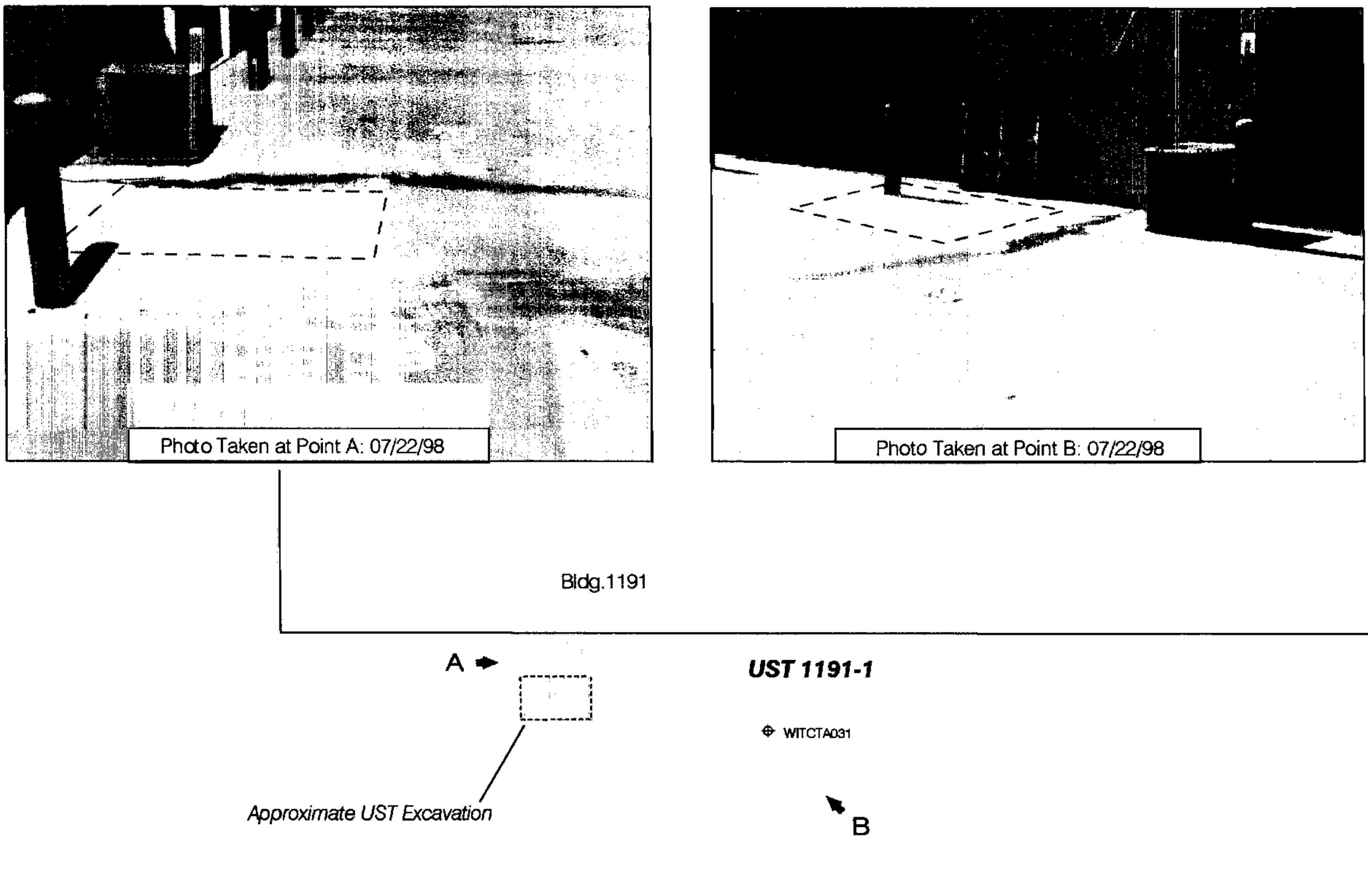


Figure 1.4 Photos and Location Map
UST 1040-1
400 Gallon Diesel Tank



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

Legend

Former UST Location (Approximate)

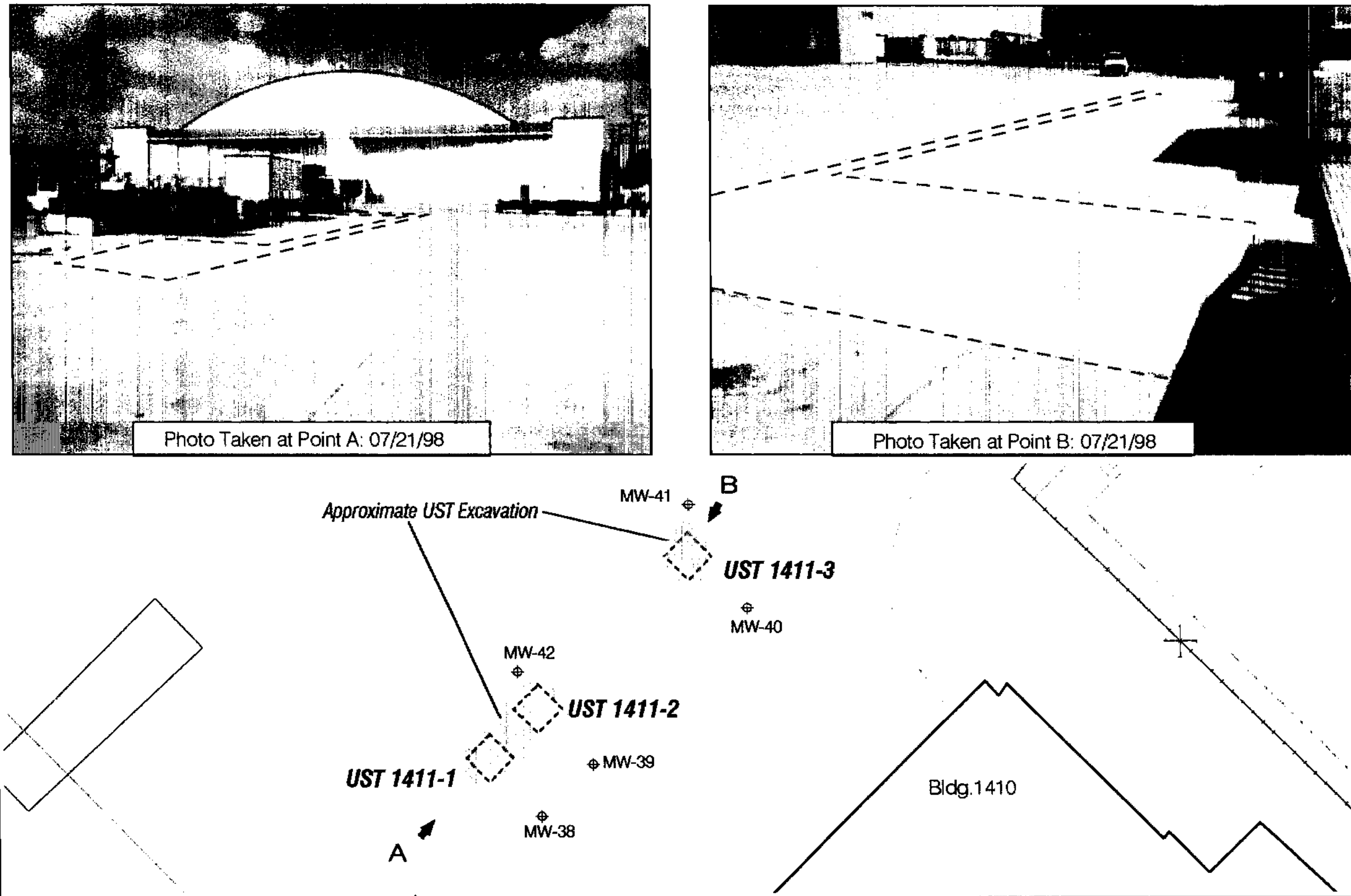
Existing Monitoring Well

N

10 0 10 Feet

Figure 1.5 Photos and Location Map
UST 1191-1

500 Gallon Waste Oil Tank



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Source: HGL ArcView Database

HYDRO GEOLOGIC

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Brooks AFB, Texas

Legend

Former UST Location (Approximate)

Existing Monitoring Wells

N

25 0 25
SCALE IN FEET

Figure 1.6 Photos and Location Map

UST 1411-1 2,000 Gallon Jet Fuel Tank
UST 1411-2 2,000 Gallon Diesel Tank
UST 1411-3 2,000 Gallon Gasoline Tank

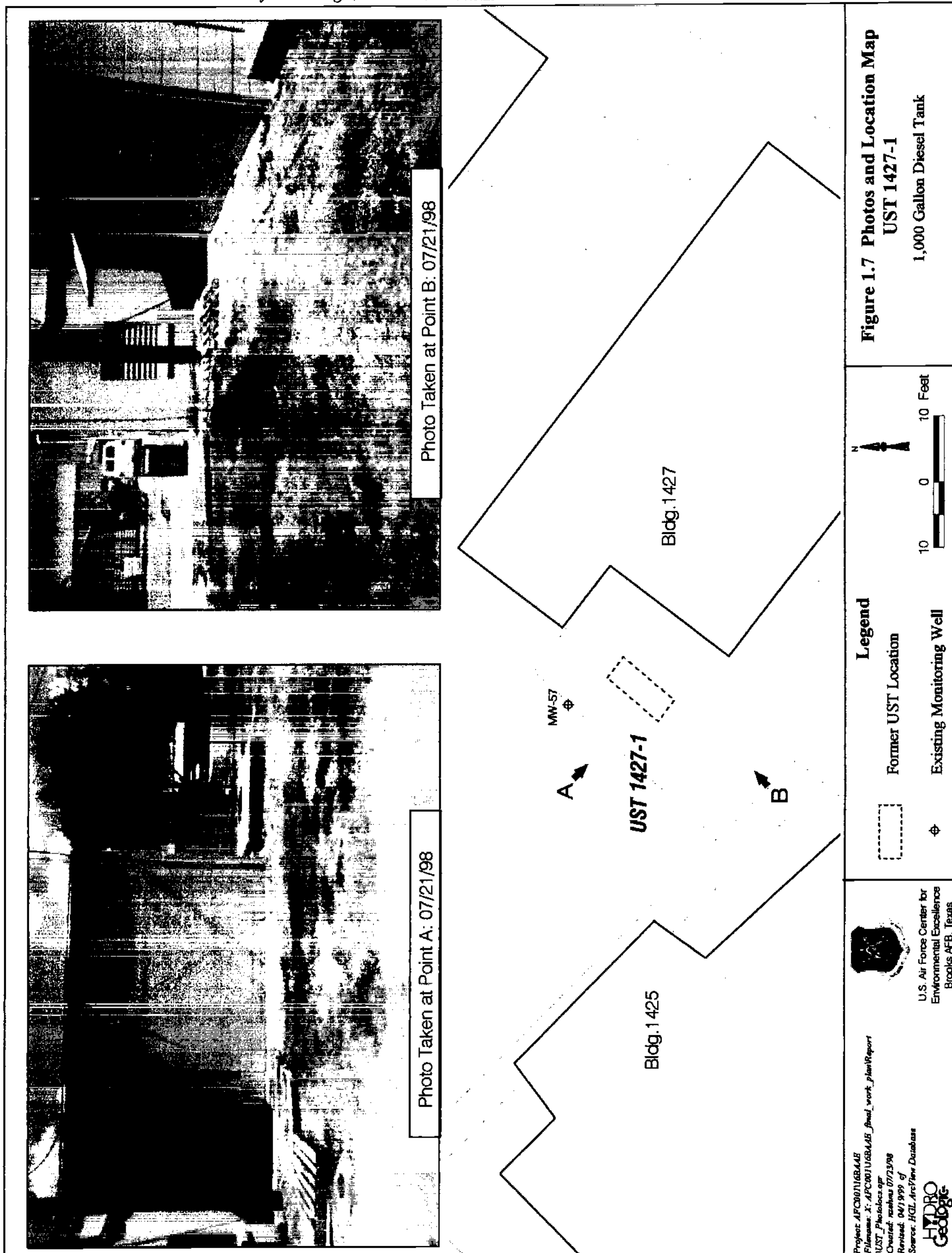


Figure 1.7 Photos and Location Map
UST 1427-1
1,000 Gallon Diesel Tank

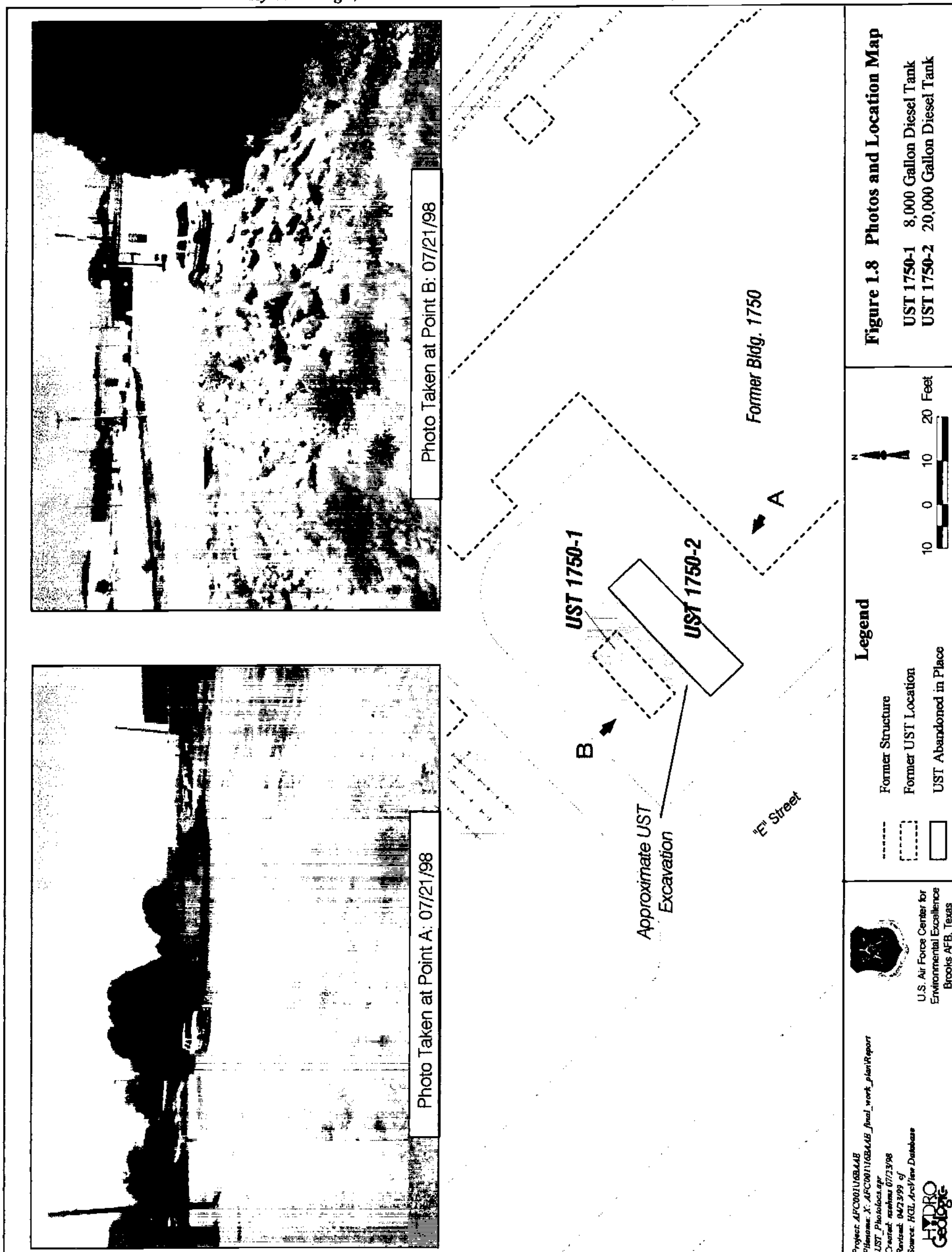
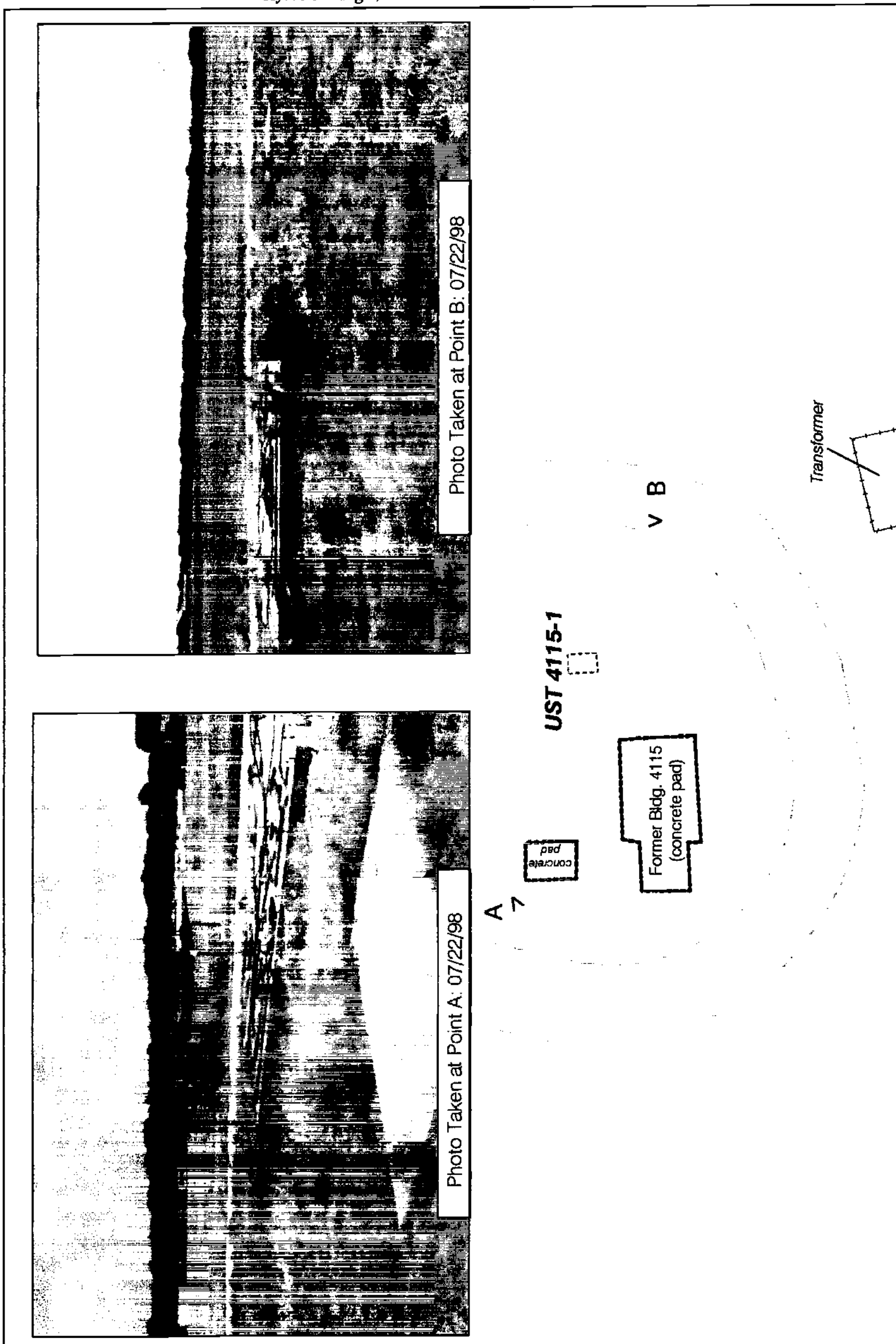


Figure 1.8 Photos and Location Map

UST 1750-1 8,000 Gallon Diesel Tank
UST 1750-2 20,000 Gallon Diesel Tank



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Former UST Location (Approximate)

10 0 10 20 Feet

N

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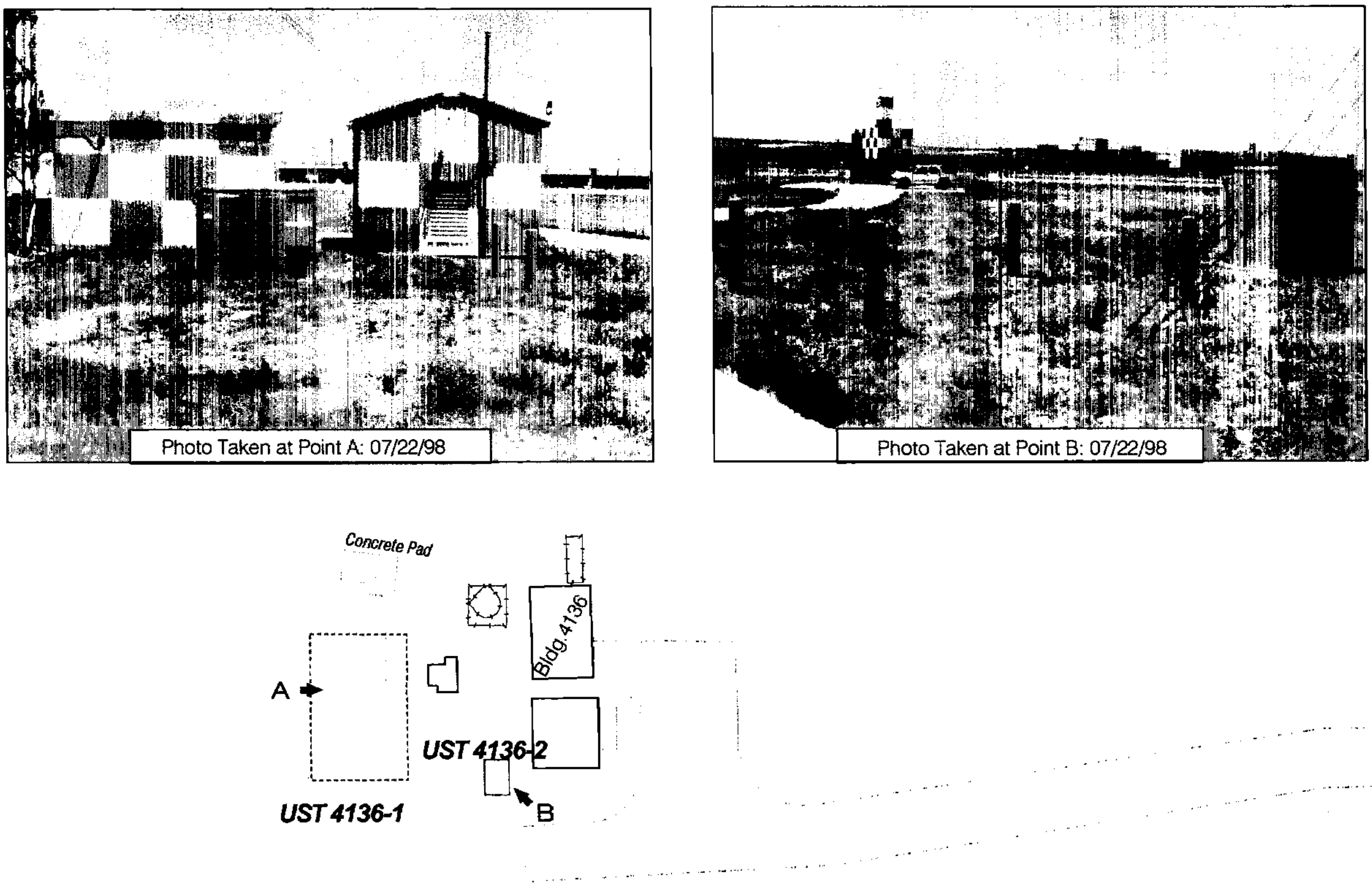
Figure 1.9 Photos and Location Map
UST 4115-1

600 Gallon Diesel Tank



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Revised: 04/19/99 cf
Source: HGL ArcView Database

HydroGeologic

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

Legend

Former UST Location (Approximate)

Active UST Location (Not under investigation)

N

10 0 10 20 Feet

Figure 1.10 Photos and Location Map
UST 4136-1

100 Gallon Diesel Tank

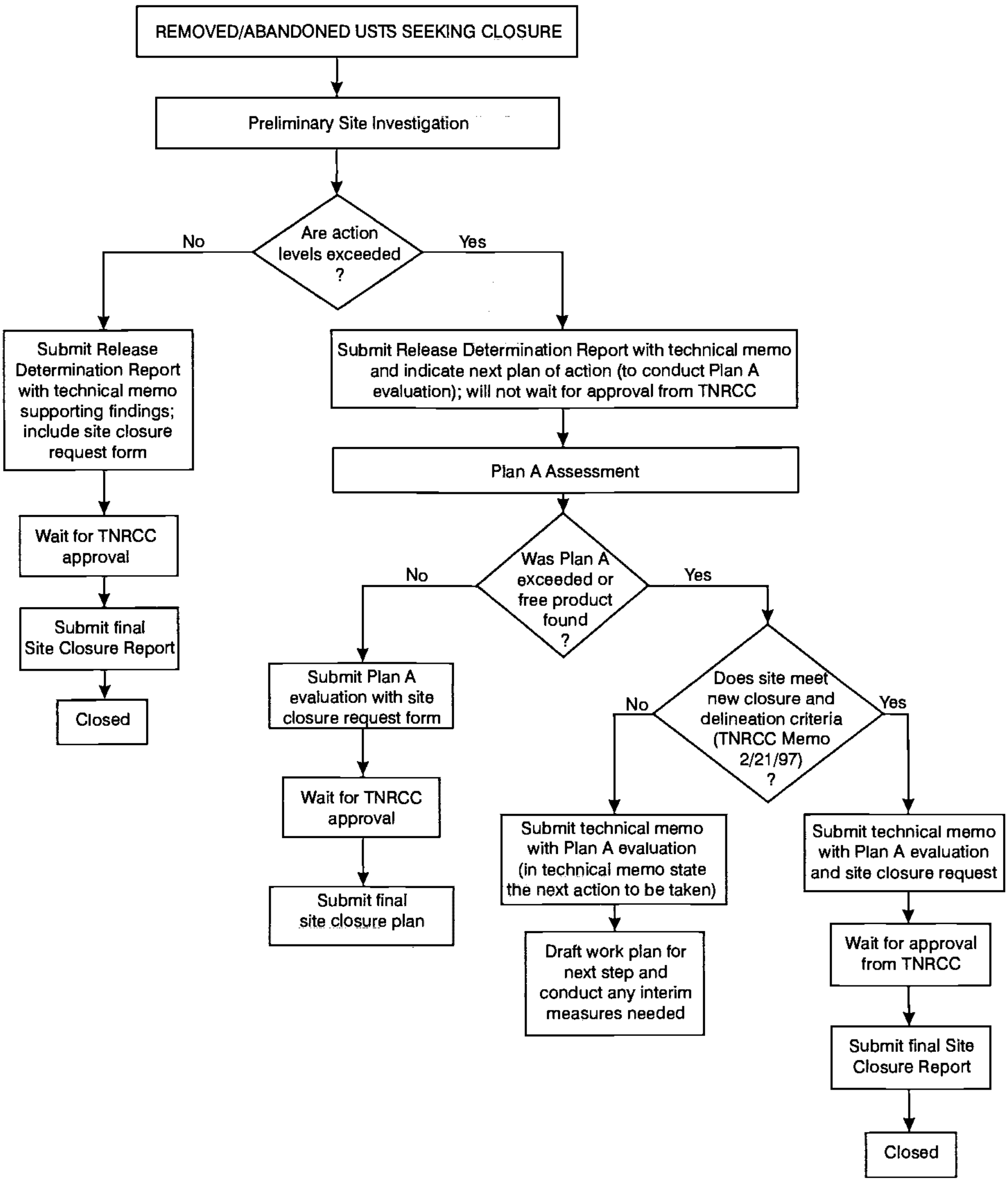

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Figure 1.11
UST Closure Process

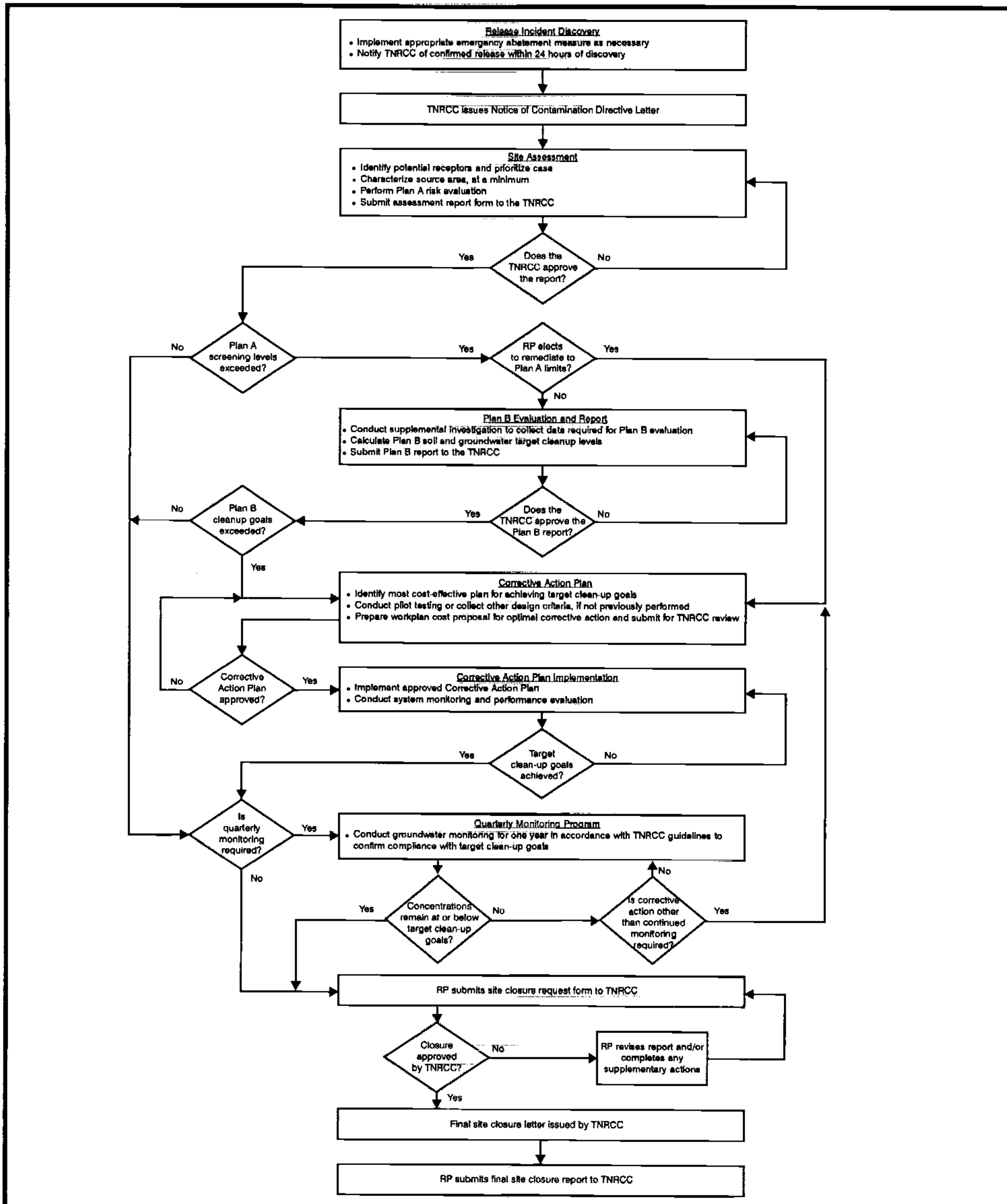

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Figure 1.12
Risk-Based Corrective Action Program

Source: TNRCC, 1995

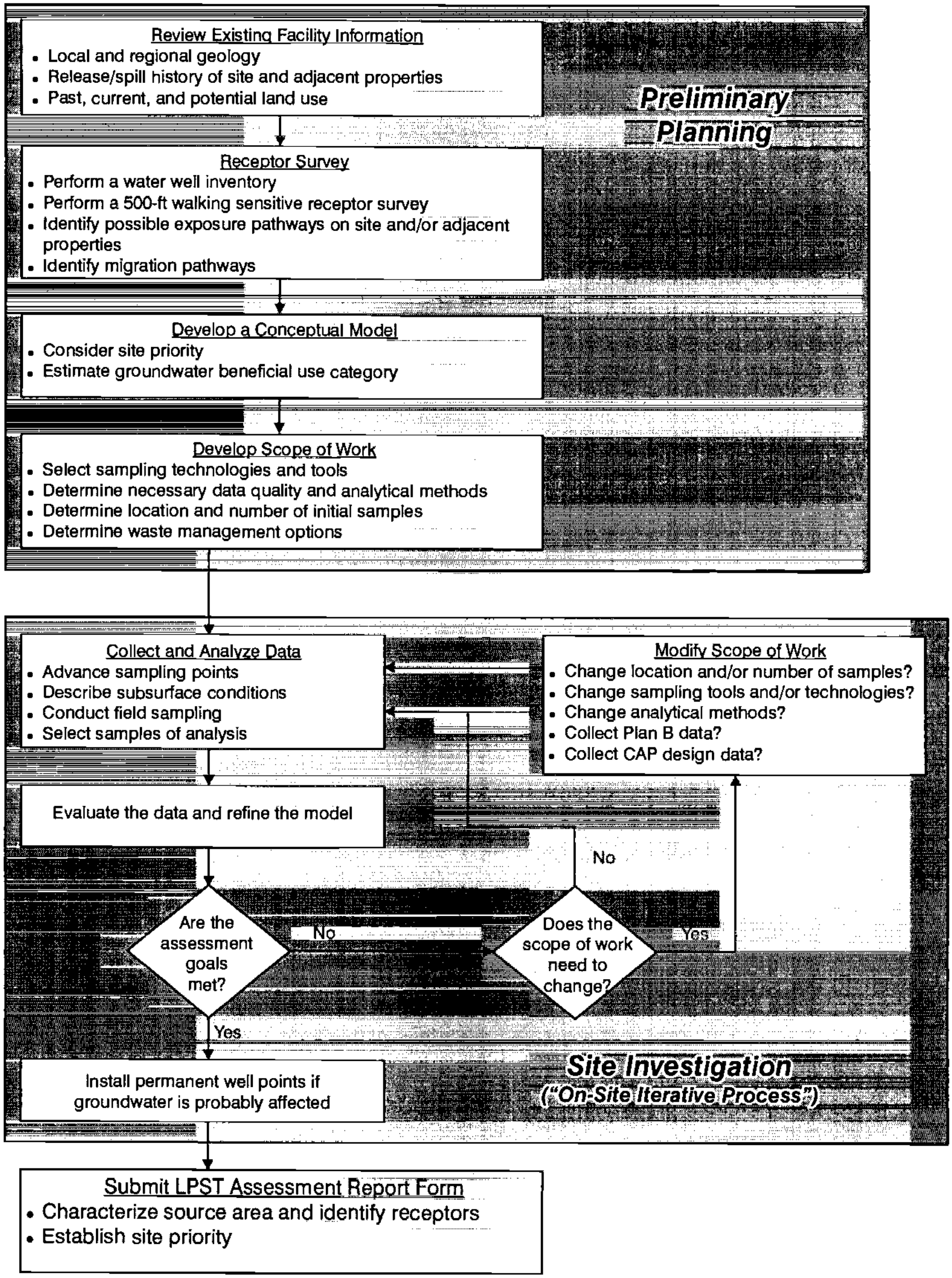

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Figure 1.13
Plan A Site Assessment Process

Source: TNRCC, 1995

TAB

Section 2.0

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 information has been primarily derived from the "Summary of Remediation Projects at AFP-4 CAFB" (ESE, 1994), the "Installation Restoration Program RI/FS, Stage 2 Draft Final Technical Report, CAFB, Volumes 1 and 2" (Radian, 1989), and the "Installation Restoration Program RI, Stage 2 Final Report, CAFB" (Radian, 1991).

2.1 INSTALLATION ENVIRONMENTAL SETTING

2.1.1 Physiographic Province

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

2.1.2 Regional Geology

The geologic units of interest for the region, from youngest to oldest, are as follows: (1) the Quaternary Alluvium (including fill material and terrace deposits), (2) the Cretaceous Goodland Limestone, (3) the Cretaceous Walnut Formation, (4) the Cretaceous Paluxy Formation, (5) the Cretaceous Glen Rose Formation, and (6) the Cretaceous Twin Mountains Formation. A generalized cross section of the geology beneath NAS Fort Worth JRB is presented in Figure 2.2 (Radian, 1989). The areal limits of surface exposure of these units at NAS Fort Worth JRB are shown in Figure 2.3. Cross section locations and individual cross sections at NAS Fort Worth JRB are presented in Figures 2.4 through 2.7 (CH2M HILL, 1996b). 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: (1) an upper perched-water zone occurring in the alluvial terrace deposits associated with the Trinity River,

(2) an aquitard of predominantly dry limestone of the Goodland and Walnut Formations, (3) an aquifer in the Paluxy Formation, (4) an aquitard of relatively impermeable limestone in the Glen Rose Formation, and (5) a major aquifer in the sandstone of the Twin Mountains Formation. 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 2.8 (Radian, 1989).

2.1.3.1 Alluvial Terrace Deposits

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

Recharge to the water-bearing deposits occurs through infiltration from precipitation and from surface water bodies. Extensive 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. This leakage was calculated to be in excess of approximately 115.5 million gallons in 1991 for NAS Fort Worth JRB and AFP-4 (GD Facility Management, 1992). This inflow of water to the shallow waterbearing unit effects local groundwater flow patterns and contamination transport, along with increasing the 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).

This flow between 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.

Potentiometric maps of NAS Fort Worth JRB and AFP-4 alluvial terrace groundwater are presented in Figure 2.9 (Jacobs, 1996) and Figure 2.10 (Jacobs, 1996). The data used to create these maps is also presented in Table 2.1. Both the July 1998 and January 1998 groundwater elevation data show an easterly trend in groundwater flow beneath the NAS Fort Worth JRB area toward the West Fork of the Trinity River.

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 "window area," 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 base property. All five monitoring wells that fully penetrate the Paluxy Aquifer on NAS Fort Worth JRB property are represented in cross sections (Figures 2.5 through 2.7). These wells are USGS01P, USGS05P, USGS06P, USGS07P, and Paluxy 1 (P1).

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).

2.1.3.6 Water Well Survey Results

An inventory of water supply wells within a one-half-mile radius of the NAS Fort Worth JRB boundary was conducted by HydroGeoLogic in 1997. Figure 2.11 illustrates the locations of 59 wells that were identified from Texas Water Commission records. All of these wells were installed and completed in the Paluxy Aquifer or the Twin Mountains Aquifer. No active water wells are located on NAS Forth Worth JRB property. Water is supplied to the base by the city of Fort Worth, which obtains water from Lake Worth.

2.1.4 Surface Water

Topographically, NAS Fort Worth JRB is fairly flat except for the lower lying areas along the tributaries of the Trinity River. The land surface slopes gently northeastward toward Lake Worth and eastward toward the West Fork of the Trinity River. Surface elevations range from about 690 feet above NGVD at the southwest corner of the base to approximately 550 feet above NGVD, along the eastern side of the base. Figure 2.12 is a section of the Lake Worth, Texas, U.S. Geological Survey topographic map showing the relief of the NAS Fort Worth JRB area.

NAS Fort Worth JRB is located within the Trinity River Basin, adjacent to Lake Worth. The lake is a man-made reservoir created by damming the Trinity River at a point just northeast of the base. The surface area of the lake is approximately 2,500 acres. Lake Worth receives a limited amount of stormwater runoff from NAS Fort Worth JRB during and immediately after rainfall events. 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 identified as an 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 stormwater discharge points that are subject to National Pollution Discharge Elimination System (NPDES) 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, 1989).

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, cotton-tail rabbits, gray squirrels, and opossums exist 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 the 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 the NAS Fort Worth JRB. The following populations that reside in the cities and villages are based on 1994 census data: White Settlement (city) - 16,502, Lake Worth (city) - 4,694, Westworth Village (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 composed 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 setting of NAS Fort Worth JRB.

2.2.1 Site-Specific Soils

The U.S. Soil Conservation Service has identified four major soil associations in the area of NAS Fort Worth JRB. The first association is the surficial soils of the nearly level to gently sloping clayey soils of the Sanger-Purves-Slidell Association. Second is the Aledo-Bolar-Sanger Association, which is located within the southwestern portion of the Sanger-Purves-Slidell Association and is characterized as an increasingly loamy clayey soil of gentle to moderate slope. The third association, the Bastsil-Silawa Association separates the Sanger-Purves-Slidell Association from the Frio-Trinity Association. The Bastsil-Silawa Association is characterized as a sandy clay loam of nearly level slope (ESE, 1994). The clayey soils of the Frio-Trinity Association make up the fourth soil association and are located along the flood plain of the West Fork of the Trinity River. Each of these soil associations is summarized in Table 2.2. The areal limits of each of these soil associations and their occurrence on-site are shown in Figure 2.13.

2.2.2 Site-Specific Geology

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

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

Goodland Limestone ranges from 20 to 25 feet. Below the Goodland Formation is the Walnut Formation (or Walnut Clay). The Walnut Formation is exposed in a small area along the shores of Lake Worth and Meandering Road Creek. This formation is a shell agglomerate limestone with varying amounts of clay and shale. It ranges in thickness from 25 to 35 feet throughout the site except where erosion has produced a few thinner areas. Subsurface investigations have located troughs and paleochannels that are eroded into the top of the bedrock at NAS Fort Worth JRB. These paleochannels are typical of an erosional surface modified by fluvial processes and are filled with sand and gravel deposits ranging in thickness from 15 to 35 feet (CH2M HILL, 1996b).

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

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

TAB

Tables

Table 2.1
Water Table Elevations for July 1997 and January 1998
NAS Fort Worth JRB, Texas

Well	Coordinates		Top of Casing Elevation (ft above msl)	Groundwater Elevation	
	Easting	Northing		January 1998 (ft above msl)	July 1998 (ft above msl)
15B	2301032.08	6963338.735	567.59	559.73	558.59
17I	2299626.674	6963642.662	578.13	568.35	564.74
17J	2299584.431	6963780.053	579.94	569.62	565.71
17K	2299799.209	6963578.343	575.47	566.91	563.72
17L	2299741.167	6963812.735	577.32	568.06	564.33
17M	2300037.62	6963761.95	574.28	566.29	562.89
BGSMW01	2299511	6964916.44	578.64	572.39	569.65
BGSMW02	2299618.19	6965006.79	577.57	567.18	564.61
BGSMW03	2299690.06	6965067.5	576.72	567.08	564.53
BGSMW04	2299589.5	6965084.53	578.49	567.54	564.90
BGSMW05	2299961.23	6965150.67	571.66	561.68	564.27
BGSMW06	2299910.09	6964981.31	576.51	566.95	564.51
BGSMW07	2299737.83	6964990.68	574.88	567.80	565.08
BSS-A	2300115.431	6965491.098	566.49	--	560.88
BSS-B	2300091.9	6965797.6	569.40	560.69	559.23
FT08-11A	2295876.4	6962318.1	608.15	599.00	595.59
FT08-11B	2295928.5	6962030.9	608.05	600.50	597.49
FT09-12A	2295439.2	6960549.8	635.38	620.39	617.23
FT09-12B	2295697.4	6960709.3	627.36	597.92	596.50
FT09-12C	2295771.5	6960590.3	627.86	597.48	595.70
FT09-12D	2295743.4	6960887.6	627.26	598.33	596.47
FT09-12E	2295821.2	6960701.1	627.34	597.57	596.10
GMI-04-01M	2296724.6	6960930.7	613.79	594.93	--
GMI-22-01M	2297688.4	6965108.03	606.62	--	--
GMI-22-02M	2296187.4	6966632.9	619.13	610.23	610.26
GMI-22-03M	2298539.4	6966219.9	608.03	587.84	587.39
GMI-22-04M	2297340.5	6967250.5	610.70	591.47	591.18
GMI-22-05M	2299432.1	6966940.3	584.28	574.18	571.88
GMI-22-06M	2298186.6	6967004.5	606.84	588.99	588.39
GMI-22-07M	2298322.5	6969018.7	605.66	590.65	589.98
GMI-22-08M	2298971.5	6970323.6	606.94	592.05	589.62
HM-110	2293163.2	6963667.5	637.33	615.33	612.94
HM-111	2293265.658	6963623.549	636.49	--	612.36
HM-112	2293141.648	6964217.563	638.06	--	614.90
HM-114	2294352	6963912.1	627.77	612.13	610.89
HM-116	2294283.7	6966411.4	634.06	613.18	612.75
HM-117	2294274.3	6967355.4	633.32	613.42	612.64
HM-118	2294780.5	6968035.2	626.23	612.73	--
HM-119	2294271.8	6968726	625.04	613.40	612.50
HM-120	2295343.2	6969489	616.84	615.29	611.17
HM-121	2295279.2	6967390.2	627.66	610.70	610.77

Table 2.1 (continued)
Water Table Elevations for July 1997 and January 1998
NAS Fort Worth JRB, Texas

Well	Coordinates		Top of Casing Elevation (ft above msl)	Groundwater Elevation	
	Easting	Northing		January 1998 (ft above msl)	July 1998 (ft above msl)
HM-122	2295260.535	6962891.108	619.44	--	--
HM-123	2295272.6	6961638.5	624.85	601.23	598.47
HM-124	2295223.3	6963957.8	623.26	610.70	608.69
HM-125	2295220.29	6965893.458	629.37	--	612.63
HM-126	2294300.2	6963121	622.99	611.56	609.32
HM-127	2294853.3	6961588.5	624.04	602.61	599.24
ITMW-01T	2298967.14	6961062.05	602.77	592.11	589.81
LF01-1A	2301249.8	6964466.4	570.27	541.11	--
LF01-1B	2301057.006	6964700.806	560.18	551.62	549.29
LF01-1C	2301376.05	6964438.037	562.15	549.79	543.14
LF01-1D	2301412.716	6964288.176	563.91	550.71	543.52
LF01-1E	2301174.3	6964606.025	562.11	549.92	543.45
LF03-3D	2293269.12	6962056.65	625.25	613.04	612.12
LF04-01	2295382.891	6961027.715	629.16	--	597.88
LF04-02	2296309.1	6961113.1	623.44	595.74	594.40
LF04-03	2296310.26	6961069.03	623.25	--	--
LF04-04	2297165.6	6960941.6	611.95	593.97	593.10
LF04-10	2297078.9	6960411.8	626.47	594.59	593.80
LF04-4A	2295852.984	6960300.484	625.84	617.57	612.09
LF04-4B	2296274.338	6960323.911	619.95	602.53	599.02
LF04-4C	2296593.501	6960604.002	612.96	595.30	594.14
LF04-4D	2296416.385	6960831.587	615.13	595.73	594.61
LF04-4E	2296410.998	6961036.036	618.49	595.65	593.59
LF04-4F	2296058.767	6961061.85	625.28	596.97	595.67
LF04-4G	2296658.929	6961224.127	619.75	594.61	593.72
LF04-4H	2296721.26	6960928.75	613.43	594.93	--
LF05-01	2294577.8	6962728.3	621.88	605.24	603.93
LF05-02	2295278.9	6962653.1	622.61	599.57	596.46
LF05-14	2296543.61	6961562.305	611.79	--	--
LF05-18	2297075.4	6961555.6	611.71	593.22	592.38
LF05-19	2297461.4	6961239.9	606.05	592.63	591.79
LF05-5A	2295580.898	6961438.557	623.00	600.29	597.74
LF05-5B	2296078.248	6961901.555	597.17	593.71	591.68
LF05-5C	2295993.73	6961720.051	608.56	598.80	596.72
LF05-5D	2295757.035	6961740.466	611.40	600.82	598.13
LF05-5E	2295550.36	6961177.867	626.70	601.04	597.78
LF05-5F	2296336.36	6961288.64	618.95	595.08	--
LF05-5G	2296536.324	6961581.317	615.28	594.54	593.94
LF05-5H	2296343.797	6961735.963	610.61	595.37	594.13
LSA1628-1	2297802.1	6967936.2	601.67	591.97	591.78

Table 2.1 (continued)
Water Table Elevations for July 1997 and January 1998
NAS Fort Worth JRB, Texas

Well	Coordinates		Top of Casing Elevation (ft above msl)	Groundwater Elevation	
	Easting	Northing		January 1998 (ft above msl)	July 1998 (ft above msl)
LSA1628-2	2297846.5	6967943.3	601.93	592.20	591.60
LSA1628-3	2297791.257	6967993.079	601.73	592.02	591.99
MW-1	2300345.606	6965853.592	560.64	--	--
MW-10	2300541.575	6965836.203	558.85	549.42	544.73
MW-11	2300791.955	6965706.661	558.17	534.88	531.76
MW-11A	2297057.278	6965810.342	612.17	589.91	589.85
MW-12	2300142.021	6966149.318	559.62	555.01	549.62
MW-12A	2295756.2	6961041.92	--	--	--
MW-13	2295736.39	6961035.09	--	--	--
MW-18	2295389.85	6963519.14	--	--	--
MW-19	2295368.85	6963512.61	--	--	--
MW-1A	2301542.45	6970397.32	--	--	--
MW-2	2300555.919	6965704.96	557.55	550.49	546.02
MW-20	2296878.439	6963365.698	611.38	592.02	--
MW-21	2296841.863	6963382.211	--	--	--
MW-3	2299750.342	6965242.674	576.48	566.33	563.83
MW-36	2299356.658	6965034.802	--	--	--
MW-37	2299384.988	6965061.349	590.53	581.81	581.61
MW-38	2298153.077	6965981.092	604.11	588.53	588.10
MW-39	2298171.115	6965999.012	--	--	--
MW-4	2300090.055	6965802.687	--	--	--
MW-40	2298224.978	6966053.097	--	--	--
MW-41	2298204.568	6966088.853	--	--	--
MW-42	2298144.896	6966031.035	--	--	--
MW-48	2295643.543	6968478.952	619.33	610.53	609.69
MW-49	2295623.167	6968470.498	--	--	--
MW-5	2300138.608	6965803.452	563.69	560.35	558.40
MW-50	2295621.7	6968528.648	--	--	--
MW-51	2295639.958	6968536.471	--	--	--
MW-52	2296182.561	6964355.172	--	--	--
MW-53	2296200.241	6964378.184	616.75	606.89	600.88
MW-56	2296055.932	6968789.529	614.32	607.00	606.74
MW-57	2297112.98	6967217.16	613.37	599.61	599.83
MW-57B	2296034.177	6968836.004	613.78	606.76	606.54
MW-58	2297175.216	6966950.884	--	--	--
MW-59	2297160.82	6966970.471	--	--	--
MW-6	2300173.696	6965734.917	562.87	561.21	558.25
MW-7	2300055.237	6965967.108	567.37	559.88	558.71
MW-8	2300491.789	6965584.178	557.04	553.62	549.34
MW-9	2300329.174	6966001.958	559.54	554.26	548.94

Table 2.1 (continued)
Water Table Elevations for July 1997 and January 1998
NAS Fort Worth JRB, Texas

Well	Coordinates		Top of Casing Elevation (ft above msl)	Groundwater Elevation	
	Easting	Northing		January 1998 (ft above msl)	July 1998 (ft above msl)
MW-IT-02T	2292594	6965339	647.09	615.63	614.87
MW1-16	2300066.63	6963755.16	--	--	--
MWMTAC-001	2296520.35	6959115.8	645.04	617.73	613.67
OT-15C	2300947.512	6963316.339	564.25	556.56	555.45
P5	2299737.38	6965287.56	--	--	--
PI-U9	2300053.58	6965632.91	--	--	--
RW-1	2296721.472	6960929.874	--	--	--
SAV-1	2300298.887	6965776.357	--	--	--
SAV-2	2300280.415	6965807.583	--	--	--
SD13-01	2300621.423	6963391.743	573.09	562.72	560.03
SD13-02	2300753.03	6963487.702	573.28	561.60	559.59
SD13-03	2300699.63	6963362.921	571.41	562.94	559.55
SD13-04	2300770.955	6963361.521	569.08	561.05	558.94
SD13-05	2300775.292	6963904.275	571.54	563.16	561.78
SD13-06	2300907.827	6963164.35	557.68	548.31	545.22
SD13-07	2301009.342	6963167.041	560.44	543.66	541.45
SPOT35-1	2296878.532	6966202.395	613.59	591.33	591.24
SPOT35-2	2296854.203	6966175.289	613.64	592.60	592.74
SPOT35-3	2296850.617	6966108.748	--	--	--
SPOT35-4	2296777.882	6966174.924	612.74	592.69	592.68
SPOT35-5	2296846.726	6966020.036	614.09	592.68	592.64
SPOT35-6	2296634.627	6966234.614	--	--	--
SPOT35-7	2296508.592	6966534.791	616.41	610.05	610.16
ST14-01	2300090.8	6963295.3	575.95	563.93	561.13
ST14-02	2300091.7	6963511.6	575.51	564.99	562.28
ST14-03	2299891.6	6964080	576.68	568.93	564.93
ST14-04	2300345.3	6963642.7	575.61	564.92	562.16
ST14-14	2299735.22	6964309.76	--	--	--
ST14-24	2299084.2	6964017.889	594.14	583.86	582.62
ST14-25	2299065.36	6964563.76	--	--	--
ST14-26	2299557.04	6964593.25	--	--	--
ST14-27	2300212.35	6964257.94	--	--	--
ST14-28	2300495.99	6963728.32	--	--	--
ST14-29	2300512.775	6963527.787	571.45	563.74	561.07
ST14-30	2300466.182	6963211.534	566.87	562.52	560.05
ST14-W05	2299093.85	6963726.062	593.63	585.89	584.71
ST14-W06	2299330.792	6963806.563	581.42	573.00	568.21
ST14-W07	2299393.809	6963614.609	579.96	569.80	565.40
ST14-W08	2299479.591	6964323.981	580.54	571.36	567.93
ST14-W09	2299550.097	6963471.685	575.54	569.01	564.79

Table 2.1 (continued)
Water Table Elevations for July 1997 and January 1998
NAS Fort Worth JRB, Texas

Well	Coordinates		Top of Casing Elevation (ft above msl)	Groundwater Elevation	
	Easting	Northing		January 1998 (ft above msl)	July 1998 (ft above msl)
ST14-W10	2299730.125	6963949.34	573.98	569.08	564.95
ST14-W11	2299657.972	6964128.603	576.31	570.61	566.46
ST14-W12	2299581.062	6963953.266	575.52	571.34	567.06
ST14-W13	2299776.442	6963695.163	574.49	567.38	563.67
ST14-W15	2299923.113	6963315.787	573.47	564.26	562.03
ST14-W16	2300128.304	6964064.608	573.62	567.08	564.03
ST14-W18	2300162.474	6963906.725	573.79	567.61	563.94
ST14-W19	2300203.607	6963699.799	573.31	564.57	562.61
ST14-W20	2300275.355	6964009.08	573.48	565.72	563.18
ST14-W21	2300242.02	6963417.822	572.88	564.53	561.61
ST14-W22	2301016.385	6963649.635	571.30	562.16	560.77
ST14-W23	2300410.368	6962949.056	565.60	563.19	557.68
ST14-W31	2300830.861	6963549.672	571.23	561.62	560.39
ST14-W32	2300815.069	6963239.017	--	--	--
TREE	2296603	6960929.688	--	--	--
TREE	2296542	6960604	--	--	--
USGS01P[1]	2297665.1	6970401.4	604.83	574.10	--
USGS01T	2297661.3	6970397.8	604.78	594.28	592.50
USGS02T	2300335.041	6970326.57	604.21	--	--
USGS03T	2300610	6968704.7	575.02	571.92	570.15
USGS04T	2299178.7	6968773	604.92	587.38	586.13
USGS05P[1]	2299736.772	6965287.814	576.77	--	--
USGS06P[1]	2297558.4	6963786.2	606.71	548.76	--
USGS06T	2297542.1	6963777.9	606.67	589.59	588.33
USGS07P[1]	2295250.6	6960165	632.10	546.10	--
USGS07T	2295246.5	6960182.5	632.43	624.14	620.86
W-153	2294096.2	6965106.3	631.57	612.71	612.47
WCHMHTA001	2293702.384	6966632.501	639.08	613.35	612.47
WCHMHTA002	2294818.468	6967545.100	631.32	612.31	611.81
WCHMHTA003	2295039.039	6967958.333	631.00	611.68	611.34
WCHMHTA004	2295041.059	6967949.303	631.25	611.69	611.33
WCHMHTA005	2295662.842	6967495.679	626.95	610.51	610.61
WCHMHTA006	2295671.903	6967494.615	626.73	610.47	610.58
WCHMHTA007	2295910.42	6967910.326	623.93	610.04	610.14
WCHMHTA008	2295862.693	6968694.421	622.85	610.20	610.04
WCHMHTA009	2296663.993	6968444.685	615.55	609.50	607.63
WCHMHTA010	2296660.061	6968440.059	615.35	609.48	609.61
WCHMHTA011	2297328.375	6969295.196	605.80	593.75	593.79
WCHMHTA012	2297691.142	6968645.437	605.85	592.36	592.40
WCHMHTA013	2300051.586	6967055.521	578.26	--	561.09

Table 2.1 (continued)
Water Table Elevations for July 1997 and January 1998
NAS Fort Worth JRB, Texas

Well	Coordinates		Top of Casing Elevation (ft above msl)	Groundwater Elevation	
	Easting	Northing		January 1998 (ft above msl)	July 1998 (ft above msl)
WCHMHTA014	2294337.637	6971208.882	619.11	608.40	609.75
WHGLTA002	2296111.39	6962377.91	608.52	597.17	594.49
WHGLTA003	2298029.84	6961043.88	614.22	593.14	592.12
WHGLTA004	2295760.62	6962943.38	614.35	597.97	595.82
WHGLTA005	2301043.78	6963469.85	570.56	--	558.87
WHGLTA007	2301093.17	6963162.46	552.88	--	537.42
WHGLTA008	2300016.84	6963955.17	572.37	--	564.20
WHGLTA009	2297528.7	6965211.65	612.09	--	596.66
WHGLTA010	2296770.93	6965580.03	618.13	--	593.05
WHGLTA011	2295873.87	6968356.67	619.71	--	607.13
WHGLTA012	2297740	6965920.84	606.64	--	588.57
WHGLTA013	2297177.07	6965957.77	611.13	--	589.67
WHGLTA014	2297373.92	6966295.34	610.26	--	589.84
WHGLTA201	2298660.88	6963198.14	603.21	--	584.53
WHGLTA202	2298832.59	6963326.21	603.45	--	584.54
WHGLTA203	2298400.38	6963058.53	600.98	--	584.78
WHGLTA204	2298104.66	6963625.62	605.57	--	587.85
WHGLTA302	2294422.27	6962602.64	621.70	--	603.81
WHGLTA303	2294400.77	6962351.21	622.77	--	601.36
WHGLTA601	2297473.69	6962752.66	600.00	--	584.57
WHGLTA602	2297625.01	6965211.65	612.09	--	588.86
WHGLTA603	2297727.19	6962713.38	600.92	--	584.20
WHGLTA604	2297530.02	6963195.39	607.43	--	587.81
WHGLTA701	2295332.86	6961835.73	623.08	--	598.75
WHGLTA702	2295882.07	6961920.16	609.41	--	597.70
WHGLTA703	2295741.23	6961680.7	615.07	--	598.22
WHGLTA704	2295831.51	6962141.07	608.84	--	598.30
WITCTA001	2296446.73	6969591.007	610.85	595.87	595.17
WITCTA002	2296135.475	6969258.49	613.36	609.69	608.55
WITCTA003	2297405.052	6969111.3	607.58	594.29	593.99
WITCTA004	2297490.47	6968938.831	606.62	593.99	593.87
WITCTA005	2298166.787	6968458.461	602.81	591.44	590.84
WITCTA006	2298261.857	6968425.939	602.76	591.15	590.60
WITCTA007	2298432.068	6968309.561	603.03	589.58	588.79
WITCTA008	2298030.119	6967939.663	600.62	592.96	592.33
WITCTA009	2298232.895	6967860.597	597.15	592.11	590.89
WITCTA010	2298752.182	6967693.534	600.31	586.45	585.79
WITCTA011	2297357.309	6967455.258	610.27	593.93	593.92
WITCTA012	2298224.392	6967348.773	599.93	590.29	589.65
WITCTA013	2297750.979	6967015.62	605.39	590.89	590.43

Table 2.1 (continued)
Water Table Elevations for July 1997 and January 1998
NAS Fort Worth JRB, Texas

Well	Coordinates		Top of Casing Elevation (ft above msl)	Groundwater Elevation	
	Easting	Northing		January 1998 (ft above msl)	July 1998 (ft above msl)
WITCTA014	2297417.505	6966903.565	611.74	591.56	591.34
WITCTA015	2298395.024	6966332.667	606.84	589.34	588.85
WITCTA016	2298061.326	6966238.285	607.85	589.65	589.27
WITCTA017	2299305.778	6967298.148	592.94	584.65	584.11
WITCTA019	2298838.013	6963107.247	600.82	586.85	585.58
WITCTA020	2296316.788	6963895.317	616.78	597.68	594.74
WITCTA021	2298718.156	6963794.398	604.19	589.02	588.48
WITCTA022	2298742.854	6963649.916	604.17	587.61	586.59
WITCTA024	2298956.02	6965971.777	604.86	588.37	587.85
WITCTA025	2299534.282	6966004.916	595.20	585.47	584.54
WITCTA026	2299480.089	6965456.85	584.37	578.97	578.34
WITCTA027	2299510.856	6965193.741	581.44	572.07	568.76
WITCTA028	2300621.253	6965160.619	558.11	554.60	547.09
WITCTA031	2299152.204	6964689.931	592.10	588.44	587.91
WITCTA032	2299195.636	6964500.665	587.37	581.04	579.90
WITCTA033	2300475.241	6964323.666	574.06	565.29	563.89
WITCTA034	2300951.486	6963956.683	571.95	564.27	562.71
WITCTA035	2299093.681	6963387.121	599.37	586.60	585.49
WITCTA036	6963181.649	2299629.281	578.57	--	--
WITCTA037	2297784.441	6963424.036	604.19	590.70	--
WITCTA039	2295415.407	6962339.771	619.47	603.11	600.27
WJETA530	2296533.87	6959546.93	639.39	609.88	608.31
WJETA531	2295893.78	6958908.59	644.17	628.83	622.08
WJETA534	2296341.54	6958941.15	647.38	622.99	617.46
WJETA535	2296794.44	6959722.27	634.61	605.43	604.80
WP07-10A	2295807.3	6961290	626.50	599.61	597.41
WP07-10B	2296040.4	6961277.5	624.22	597.34	596.19
WP07-10C	2296062.4	6961575.6	617.18	597.55	596.05

Notes:
[1] Elevations are reported in feet above mean sea level (ft above msl). These wells are screened in the Paluxy Aquifer. The groundwater elevations obtained at these wells are not used to construct the groundwater contour maps.

Table 2.2
Soil Associations at
NAS Fort Worth JRB, Texas

Association	Description	Thickness (inches)	Percent Clay <2 mm (%)	pH	Permeability (cm/sec)	Available Water Capacity (in/in)
Sanger-Purves-Slidell: Clayey soils of nearly level to gently sloping uplands	Clay loam Clay over bedrock Silty clay	8 - 80	35 - 60	7.4-8.4	$<4.2\times10^{-5}$ to 3×10^{-4}	0.12 - 0.20
Aledo-Bolar-Sanger: Loamy and clayey soils of gently sloping to moderately steep uplands	Clay loam over bedrock Clay loam	8 - 70	20 - 60	7.9-8.4	$<4.2\times10^{-5}$ to 9×10^{-4}	0.05 -0.18
Frio-Trinity: Clayey soil on nearly level flood plains	Silty clay or loam Clay	25 - 75	35 - 80	7.4-8.4	$<4.2\times10^{-5}$ to 3×10^{-4}	0.11 - 0.20
Bastsil-Silawa: Loamy soils on nearly level to sloping stream terraces	Sandy clay loam	40 - 80	7 - 35	4.5-7.8	9×10^{-4} to 3×10^{-3}	0.08 - 0.17

cm/sec = centimeter per second
in/in = inches per inch

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

TAB

Figures

Figure 2.1
Lake Worth Topographic Map-Regional

Air Force Center for Environmental Excellence
Brooks AFB, Texas

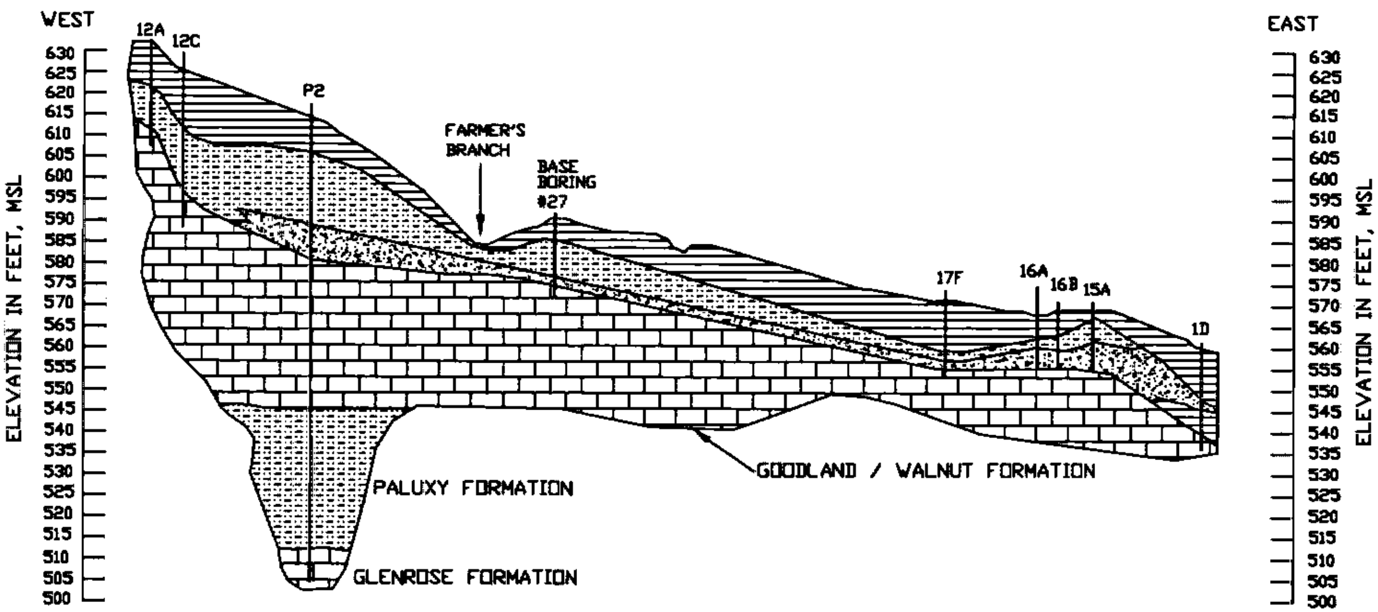
0 1 2
SCALE IN MILES
Scale 1:100,000

Filename: X:\AFC001\16BAAE_final_work_plan\Report\Fig2-1.cdr
Created by: M. Lawlor 6/12/97
Revised: 05/24/99 ap
Map Source: USGS, 1985

Figure 2.2

Generalized Geologic
Cross Section
NAS Fort Worth JRB, Texas

Air Force Center
For Environmental Excellence
Brooks AFB, Texas



Legend

- Clay and Fill Material
- Sand
- Gravel
- Limestone And Shale

800 400 0 800
HORIZONTAL SCALE IN FEET

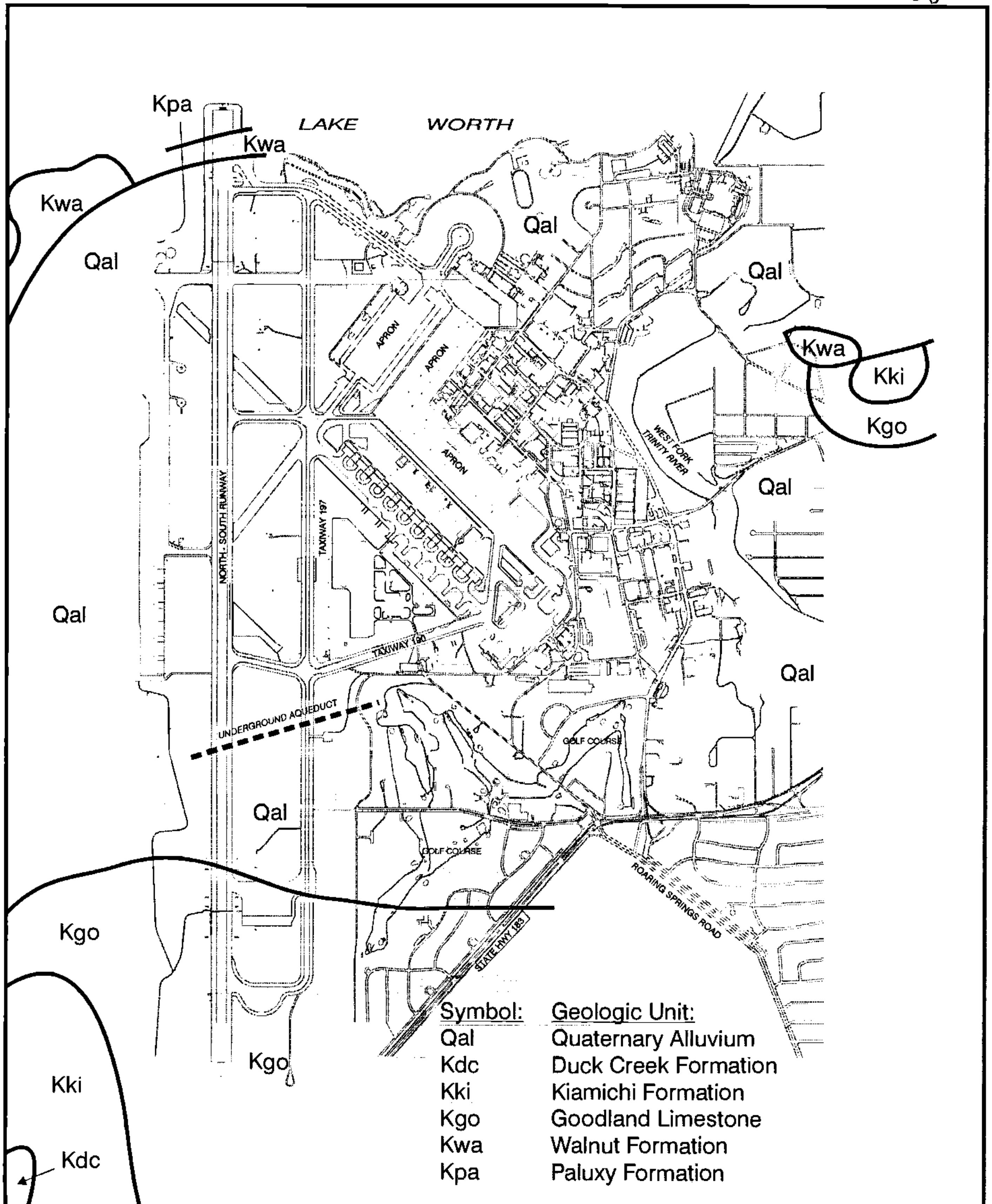
N

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

Filename: X:\APC001\16BAAE_final_work_plan\Report\Fig2-2.dwg
Created by: M. Lawlor 06/12/98
Revised: 05/24/99 sp
Source: USACE, 1993

HYDRO GeoLogic Inc.

480 63



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Created by: M Lawlor 06/12/97
Revised: 05/26/99 ap
Source: Radian, 1989

HYDRO GeoLogic INC.

Legend

0 1000 2000
SCALE IN FEET

N

Figure 2.3

Aerial Distribution of Geologic Units at NAS Fort Worth JRB, Texas

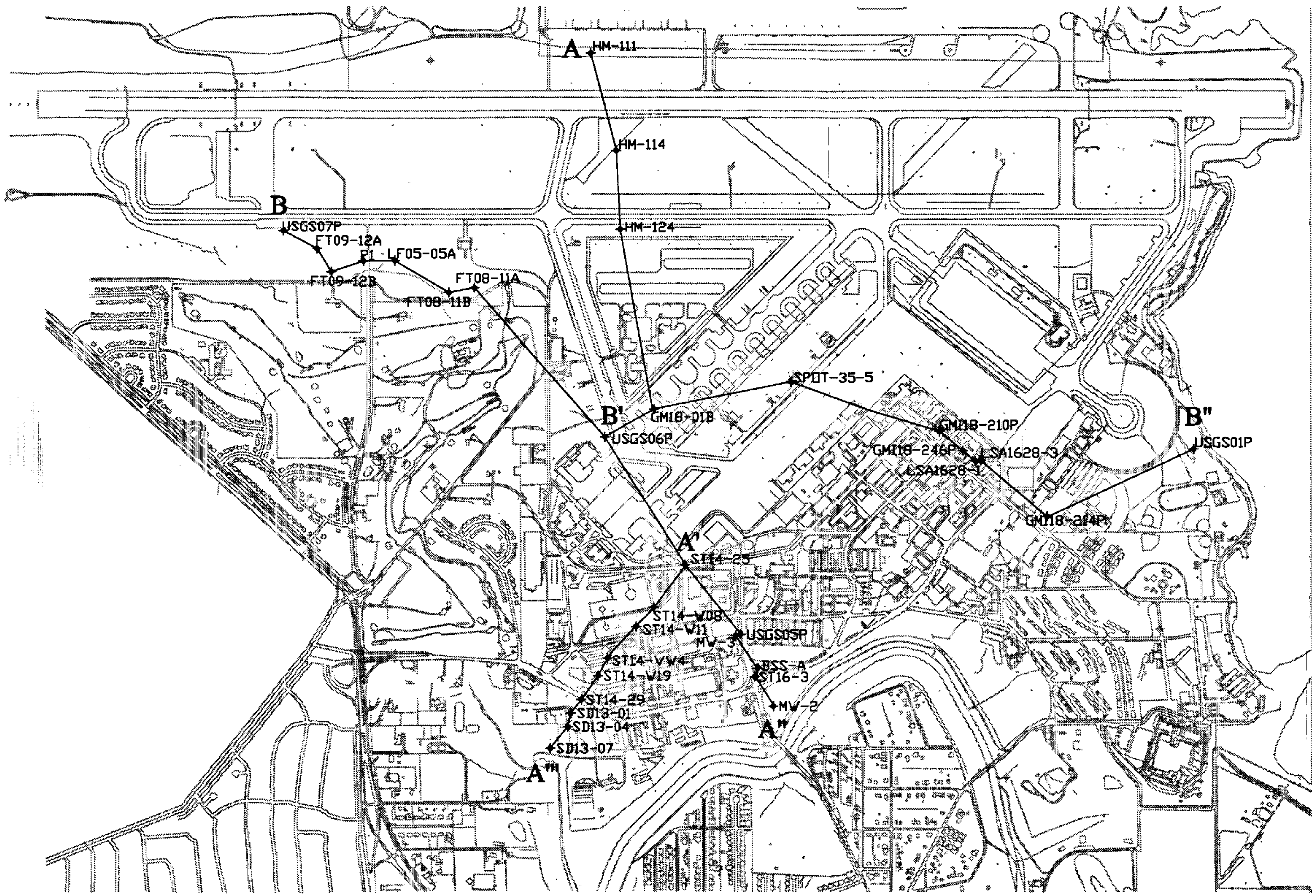


Figure 2.4

Cross Section Locati n Map

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

Legend

USGS01P Boring Location

A A' Cross Section Line

N

0 500 1000 2000
SCALE IN FEET

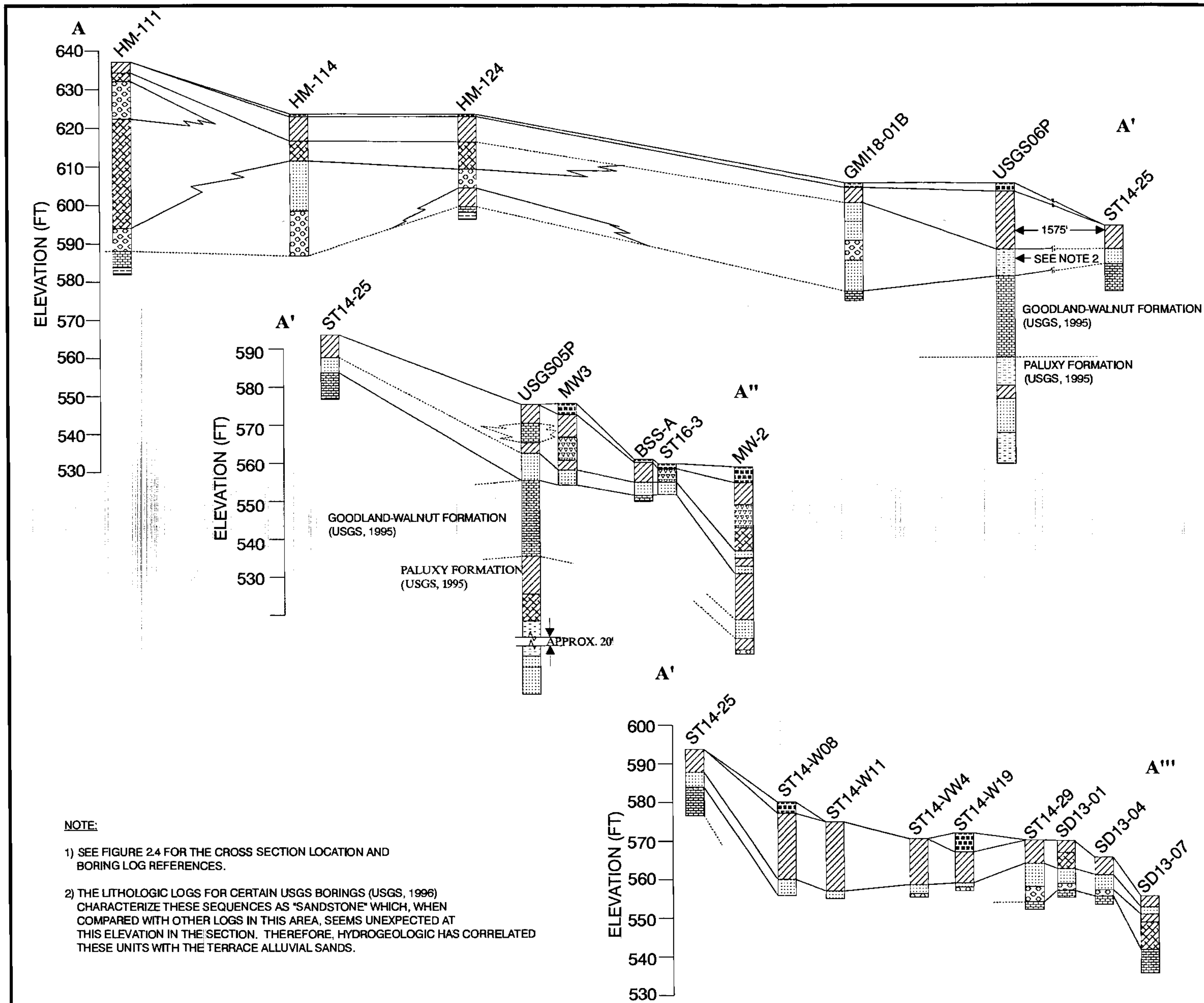
Filename: X:\AFC001\16BAAE_final_work_plan\Report\fig 2-4.dwg
Project: AFC001-16BAAC
Created: 06/12/97 M. Lawlor
Revised: 05/24/99 ap
Source: JACOBS, 1996

HYDRO GeoLogic INC.

Figure 2.5

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

Air Force Center For Environmental Excellence Brooks AFB, Texas



Legend

- Stratigraphic Contact
- Inferred Stratigraphic Contact
- Fine- to Coarse-Grained Sand, Clayey Sand, Silty Sand, Gravelly Sand
- Clay, Silty Clay, Sandy Clay
- Silt, Clayey Silt, Sandy Silt
- Gravelly Clay or Clay w/Limestone
- Fill, Soil, Gravel, Rock
- Coarse Gravel, Silty Gravel, Sandy Gravel
- Limestone
- Claystone/Mudstone/Shale
- Sandstone

0 600 1200
HORIZONTAL SCALE IN FEET

NOTE:

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

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

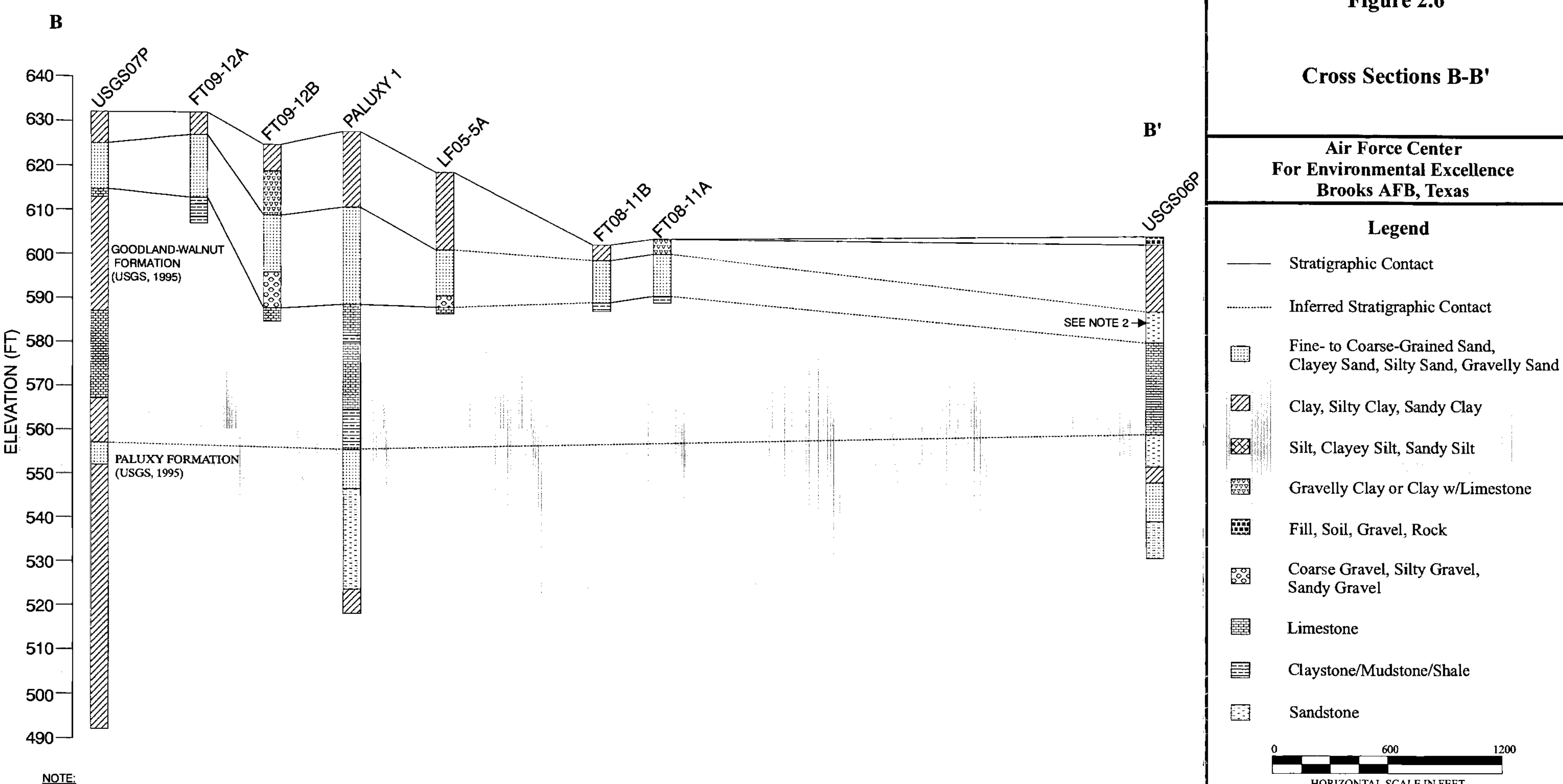
Filename: X:AFC001\16BAAE_final_work_plan\Report\Figure_2-5.cdr
Project: AFC001-15BAAE
Created by: M. Lawlor 6/12/97
Revised: 05/24/99 ap
Source: CH2M HILL, 1996 b

HydroGeoLogic, Inc.—Final Work Plan
NAS Fort Worth JRB, Texas

Figure 2.6

Cross Sections B-B'

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



NOTE:

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

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

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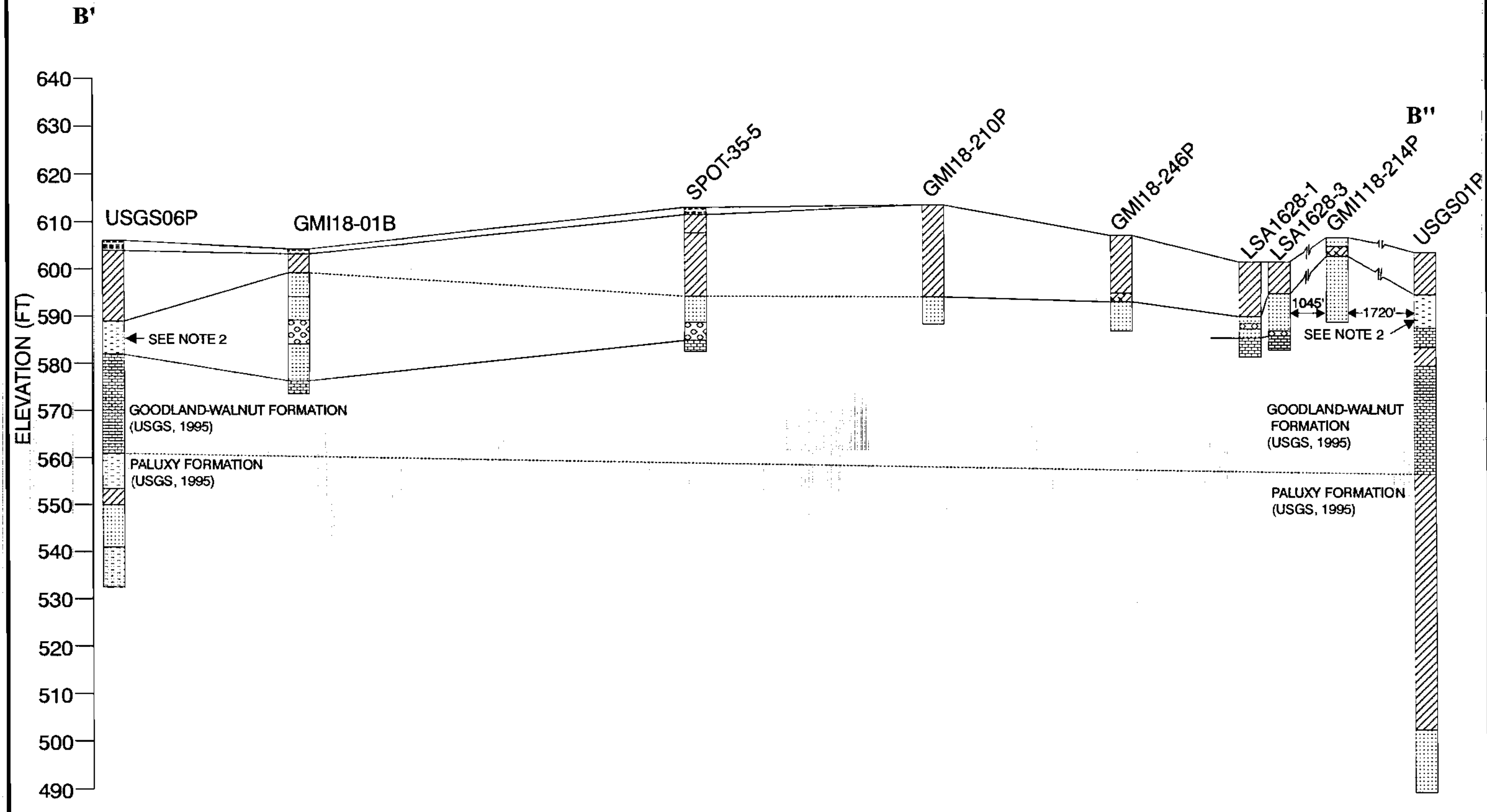
Revised: 05/25/99 ap
Source: CH2M HILL, 1996 b



NOTE:

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

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

Figure 2.7

Cross Sections B'-B''

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

Legend

- Stratigraphic Contact
- Inferred Stratigraphic Contact
- Fine- to Coarse-Grained Sand, Clayey Sand, Silty Sand, Gravelly Sand
- Clay, Silty Clay, Sandy Clay
- Silt, Clayey Silt, Sandy Silt
- Gravelly Clay or Clay w/Limestone
- Fill, Soil, Gravel, Rock
- Coarse Gravel, Silty Gravel, Sandy Gravel
- Limestone
- Claystone/Mudstone/Shale
- Sandstone

0 600 1200
HORIZONTAL SCALE IN FEET

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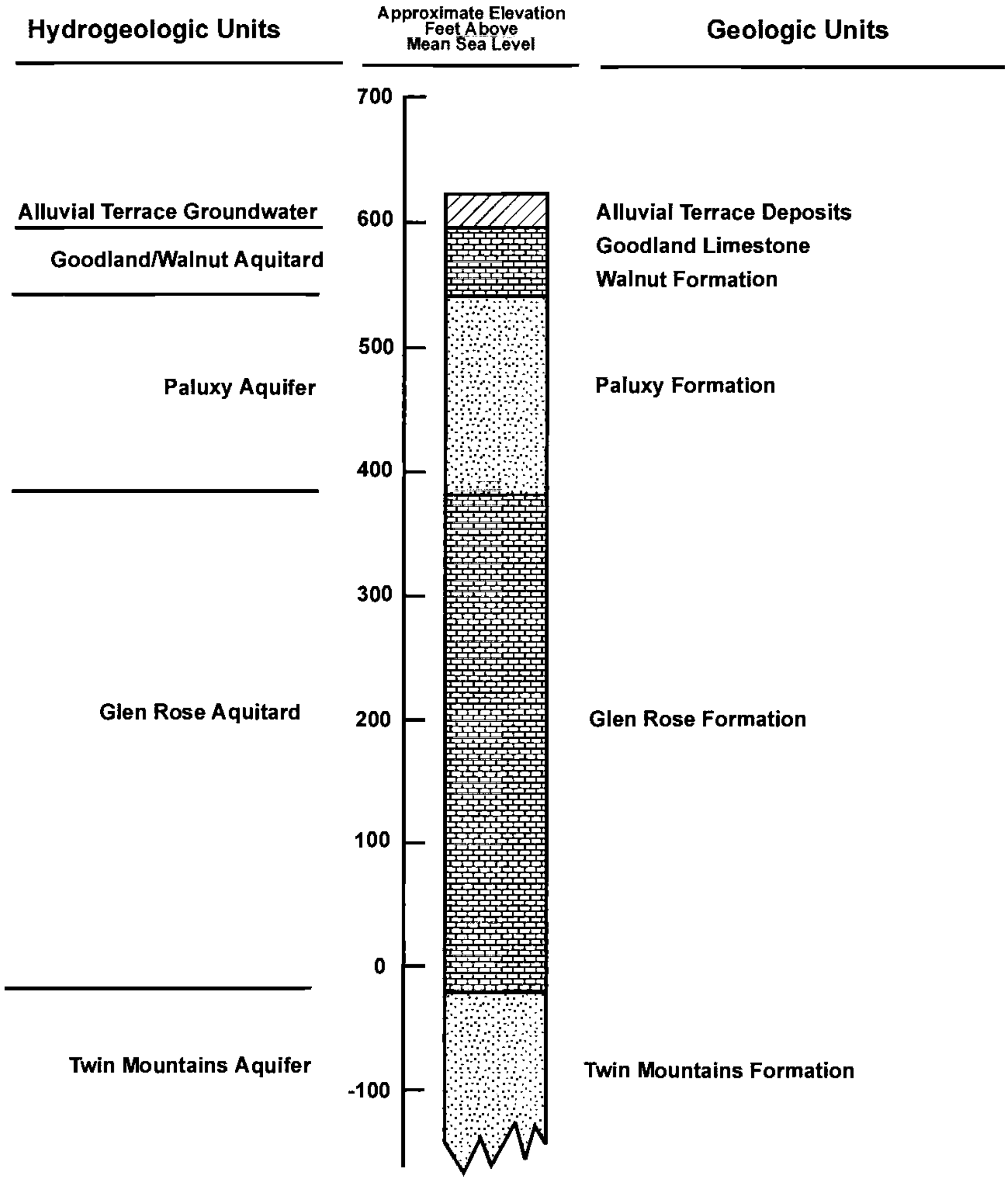
Project: AFC001-15BAAE
Created by: M. Lawlor 6/12/97
Revised: 05/25/99 ap
Source: CH2M HILL, 1996 b

HYDRO GeoLogic Inc



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Created by: M. Lawlor 06/12/97
Revised: 05/26/99 ap
Source: Radian, 1989

HYDRO GeoLogic INC

Legend

- Alluvium
- Limestone
- Sandstone

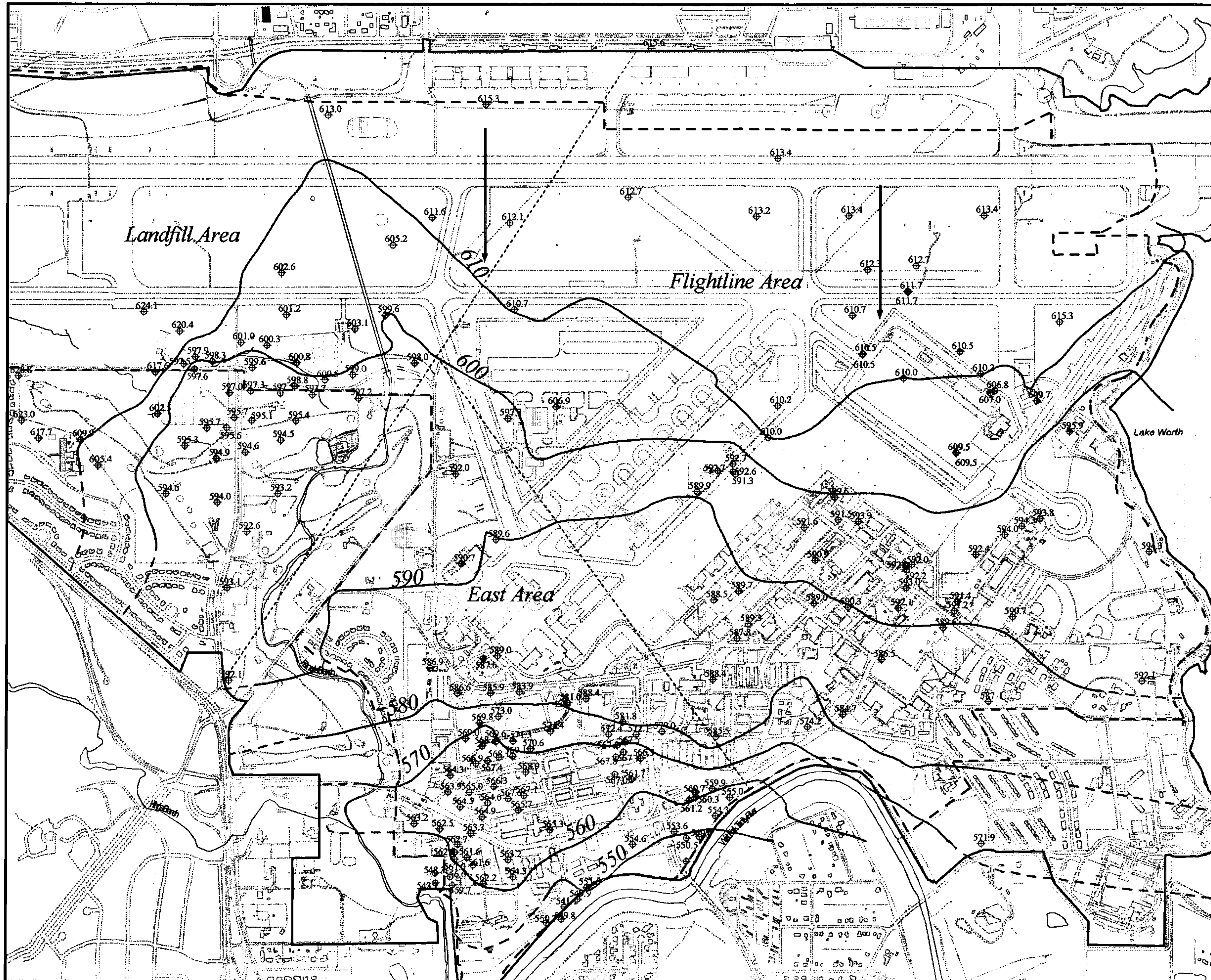
Figure 2.8

Stratigraphic Column Correlating Hydrogeologic Units and Geologic Units at NAS Fort Worth JRB, Texas

Figure 2.9

Water Level Elevations January 1998

Air Force Center For Environmental Excellence
Brooks AFB, Texas



Legend

- NAS Fort Worth JRB (Carswell Field)
- Former Carswell Air Force Base
- 600 Groundwater Elevation Contour (Feet Above Mean Sea Level)
- Generalized Groundwater Flow
- Groundwater Management Areas

N

0 500 1000 2000
SCALE IN FEET

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Revised: 04/20/99 cf
Map Source: HydroGeoLogic, Inc GIS Database

HYDROGEOLOGIC INC.

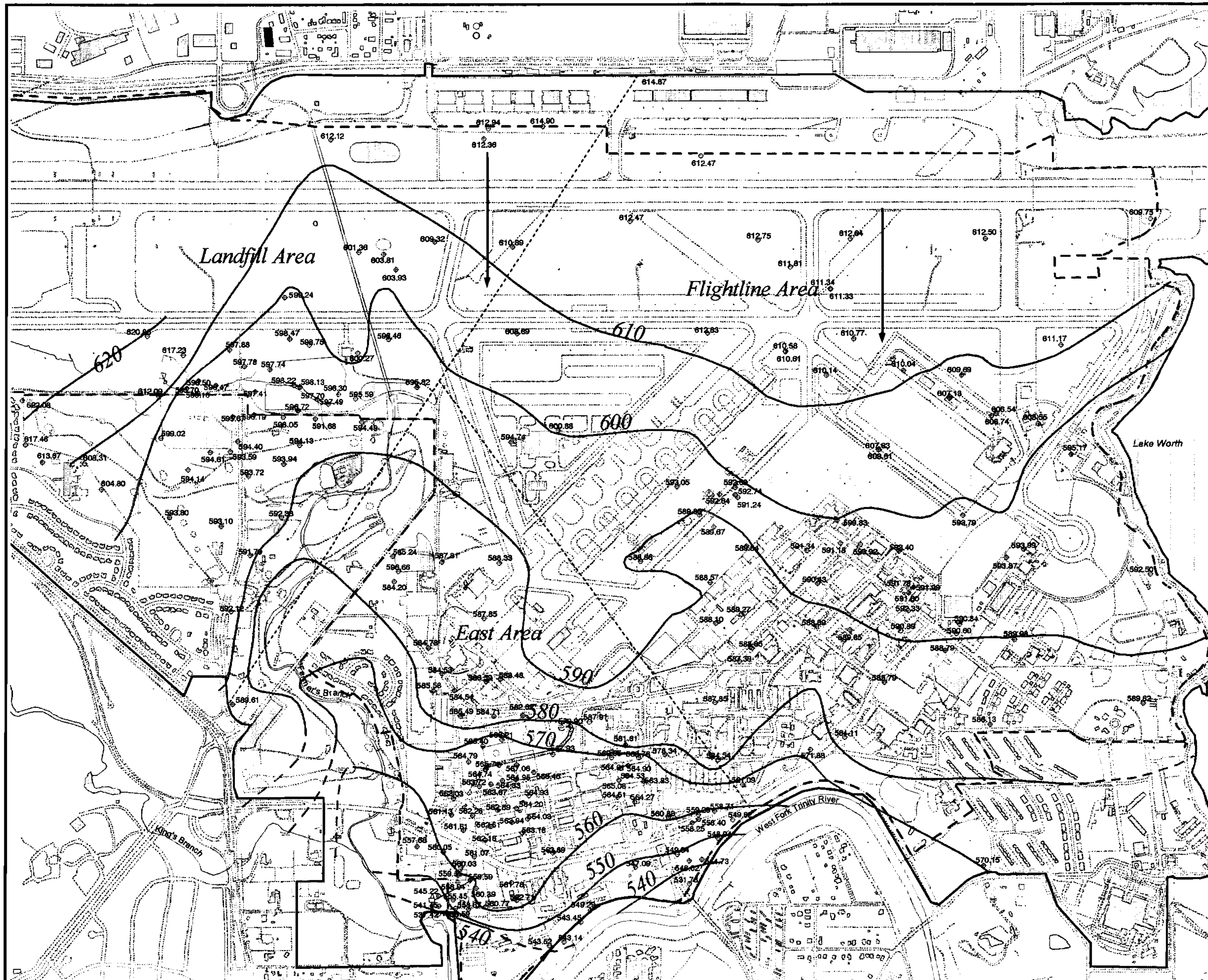

Figure 2.10

**Water Level Elevations
July 1998**

Air Force Center For
Environmental Excellence
Brooks AFB, Texas

Legend

- - - NAS Fort Worth JRB (Carswell Field)

—— Former Carswell Air Force Base

600 Groundwater Elevation Contour (Feet Above Mean Sea Level)

→ Generalized Groundwater Flow

Groundwater Management Areas

N

0 500 1000 2000
SCALE IN FEET

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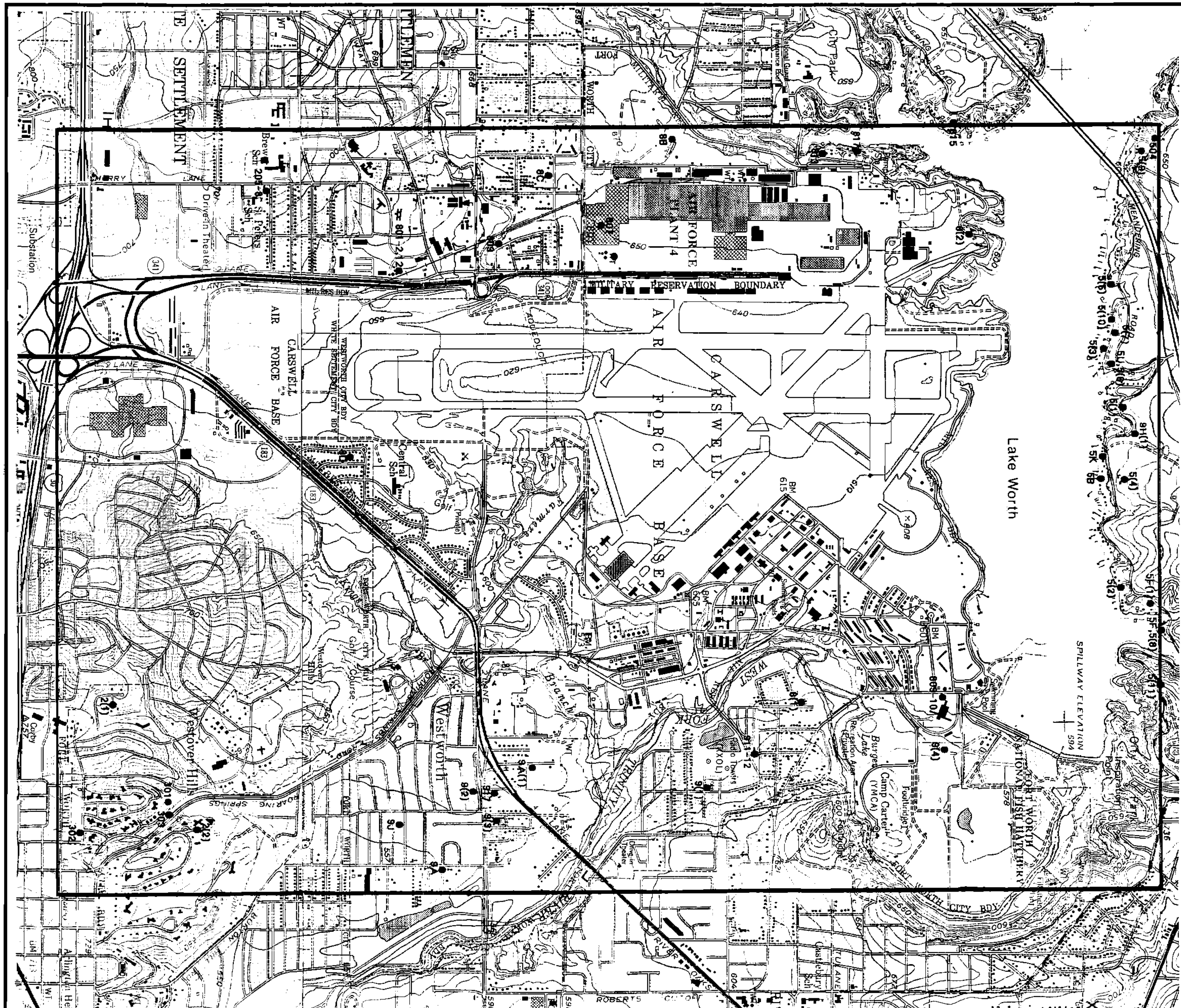
Created: 10/09/98 nzehms
Revised: 04/20/99 cf
Map Source: HydroGeoLogic, Inc GIS Database

HYDROGEOLOGIC INC.



HydroGeoLogic, Inc.—Final Work Plan
NAS Fort Worth JRB, Texas

Figure 2.11

Water Well Receptor Survey Within ½ Mile of NAS Fort Worth JRB, Texas

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

Legend

- 917 — Water Well Location
- 7(1) — Water Well Location Identifying Multiple Wells
- —— ½ Mile Boundary Outside NAS Fort Worth JRB (Approximate)

N

0 .5 1
SCALE IN MILES

Contour Interval: 10 feet

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Revised: 05/26/99 th
Source: USGS 1981 & 1982

HYDROGEOLOGIC INC.

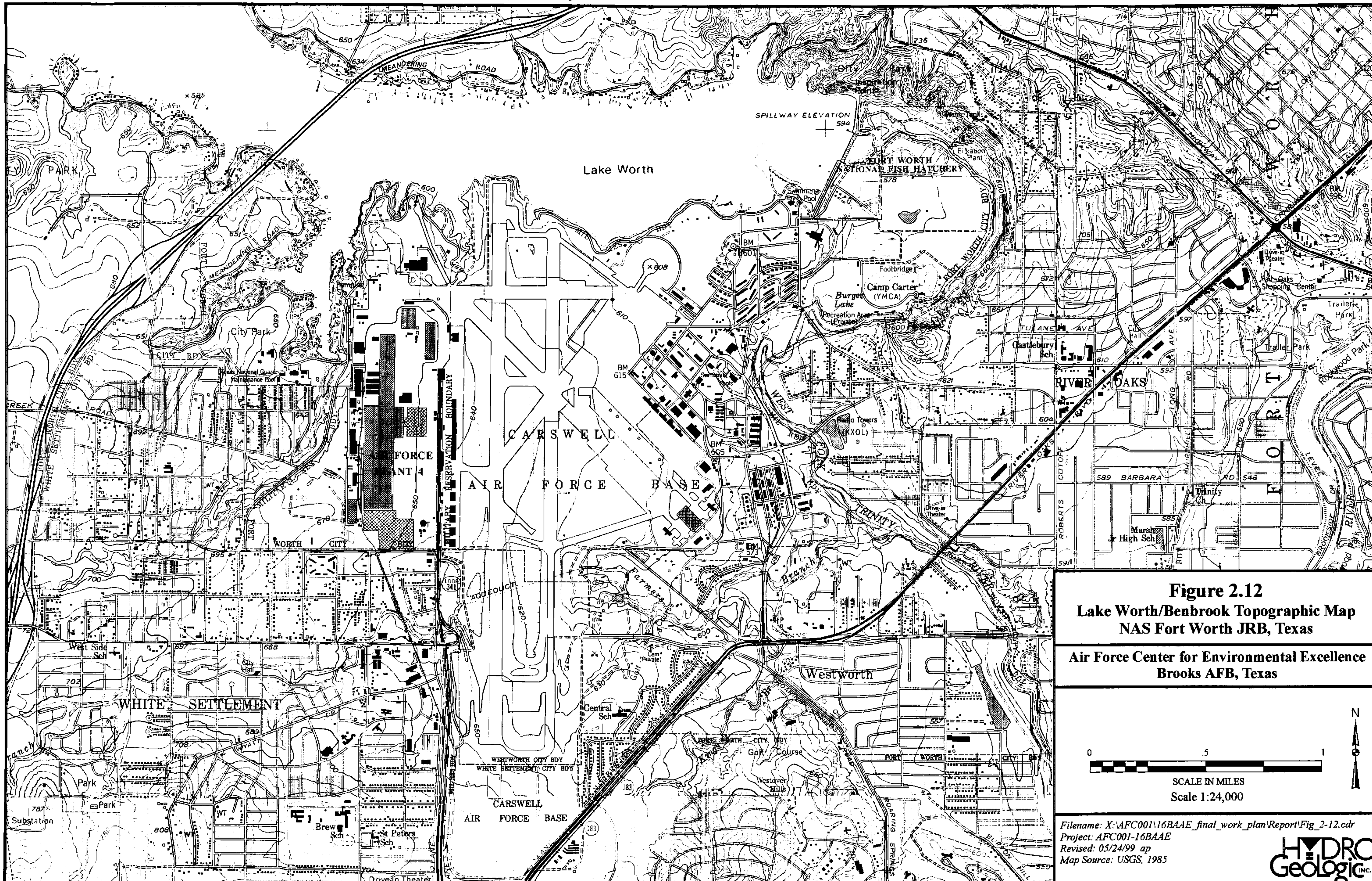

Figure 2.12
Lake Worth/Benbrook Topographic Map
NAS Fort Worth JRB, Texas

Air Force Center for Environmental Excellence
Brooks AFB, Texas

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SCALE IN MILES
Scale 1:24,000

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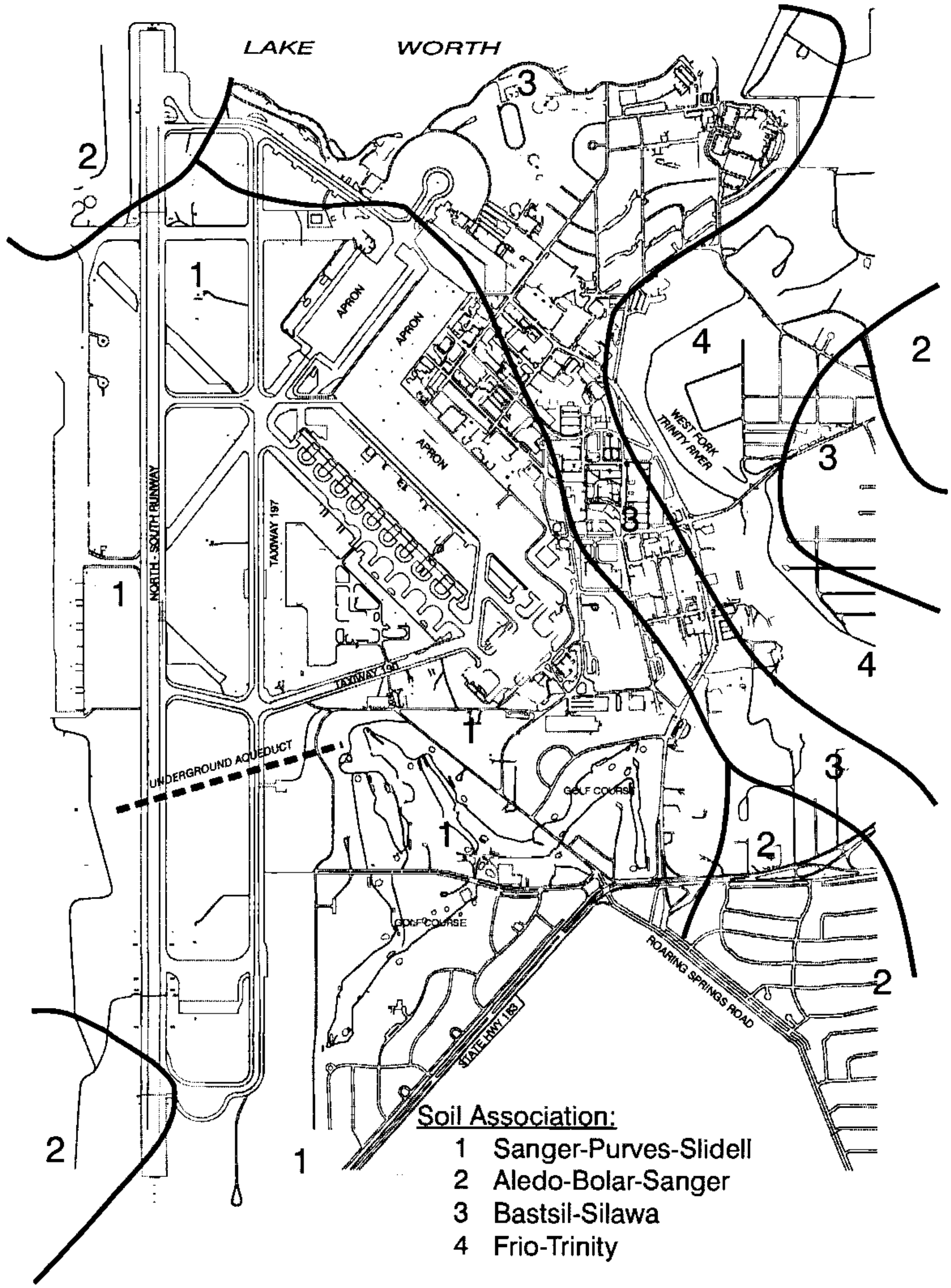
Revised: 05/24/99 ap
Map Source: USGS, 1985

HYDROGEOLOGIC INC.



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Created by: M. Lawlor 06/12/97
Revised: 05/24/99 ap
Source: Radian, 1989

HYDRO GeoLogic

Figure 2.13
Soil Association Map
NAS Fort Worth JRB, Texas

TAB

Section 3.0

3.0 DATA GAPS IDENTIFICATION AND PROPOSED SAMPLING ACTIVITIES

The following sections present the conceptual site model, the ARARs, the data needs, a summary of previous investigations, and the proposed field investigation tasks planned for each former/abandoned UST location.

3.1 CONCEPTUAL SITE MODEL DEVELOPMENT

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

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

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

The conceptual model for each UST site will be developed by addressing potential or suspected sources of contamination, concentrations of the constituents from each UST in the terrace alluvium soil and groundwater, rates and routes of exposure, and potential receptors. Because all of the sites in this investigation have either been removed or emptied of their contents, filled with concrete, and abandoned in place, the source of contamination no longer exists.

3.2 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS IDENTIFICATION

As mandated by CERCLA, ARARs are required to be addressed and satisfied by remedial actions. Federal statutes specifically cited in CERCLA include the Solid Waste Disposal Act; RCRA; the Toxic Substances Control Act; the Safe Drinking Water Act; the Clean Air Act; the Clean Water Act; the Endangered Species the Act; the Fish and Wildlife Coordination Act; and the Marine Protection Research and Sanctuaries Act. CERCLA also mandates that state ARARs must be met if they are more stringent than Federal ARARs. The ultimate objective of this project is to obtain site closure under the TNRCC LPST program. The TNRCC LPST program is, therefore, the primary regulatory driver for this project.

The following requirements comprise the three general types of ARARs:

- Chemical-specific requirements are usually health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment.

- Location-specific requirements are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they occur in special locations.

- Action-specific requirements are usually technology-based requirements or limitations on actions taken with respect to hazardous wastes.

3.3 IDENTIFICATION OF DATA NEEDS

Information from previous investigations indicates that contamination may be present around USTs 1191-1, 1411-1, 1411-2, 1411-3, 1427-1, 1750-1, and 1750-2. Sampling will be performed at these sites to confirm any contamination detected in previous studies, to identify the source of any potential contamination, and to define the magnitude and spatial extent of any impact to the soil or groundwater beneath the sites.

Because USTs 1040-1, 4115-1, and 4136-1 have not been previously investigated, this preliminary investigation is intended to determine if the USTs have resulted in impacts to the soil or groundwater at the sites.

There is little information in regards to USTs GCA-1 and GCA-2, and their existence is questionable. A preliminary investigation at each former GCA site will be performed to confirm the existence of these USTs, and if so, determine if the USTs have resulted in impacts to the soil or groundwater at the site.

If contamination present in samples collected during the preliminary investigation exceeds TNRCC action levels at any of the UST sites, the investigation at that site will be expanded into a Plan A evaluation in order to determine the extent of the contamination. Physical and chemical analysis of the soil and groundwater beneath the sites will also be obtained to better understand the properties of these media.

In order to accomplish the project objectives presented in Section 1.5 of the WP, the extent of contamination, if any, around each UST site must be determined. If contaminant concentrations do not exceed TNRCC action levels, then the site may be suitable for closure. If contamination is present above TNRCC action levels, then the nature and extent of the contamination must be characterized and the source must be determined. This will be accomplished by conducting a Plan A evaluation as discussed in Section 1.4.2 of the WP. Field methods for this investigation include conducting a geophysical survey to locate the USTs in question, advancing soil borings using direct push technology (DPT), sampling existing monitoring wells, and possible monitoring well installation using hollow-stem augers if contamination levels warrant a Plan A investigation.

3.4 FIELD INVESTIGATION TASKS

The following sections describe the investigations proposed for each UST site. The proposed soil boring locations may change slightly due to site-specific conditions such as utilities, fences, and buildings encountered during the field implementation. New monitoring wells may be installed and sampled if contamination levels warrant a Plan A investigation.

3.4.1 UST 1040-1

A 400-gallon steel UST used for storing diesel fuel was located on the northwest side of Building 1040. This UST was installed in 1955 and was removed from service in June 1994.

3.4.1.1 Site Investigation History

There were no previous investigations conducted at this UST site. No documentation was discovered to indicate that the tank had leaked. No reports describing the removal, excavation, or sampling activity were located, and the TNRCC records search conducted by the Navy determined that a closure report had not been submitted. A visual inspection of the site noted the presence of an unmarked monitoring well near the northeast corner of Building 1040 and some stressed vegetation in the former location of the UST.

3.4.1.2 Proposed Activities

The proposed method of site characterization for UST 1040-1 includes the advancement of four soil borings, as accessibility permits, in and around the former UST excavation. Locations of the proposed soil borings are illustrated in Figure 3.1. The initial soil boring will be advanced in the approximate center of the former tank pit in order to determine the depth of the excavation. Three additional soil borings will be advanced along each exposed side of the former excavation. Each soil boring will be advanced to the top of the water table for soil characterization and contaminant delineation.

Three soil samples will be collected from each soil boring. These samples include one sample at the surface, one sample in the area above the water table that exhibits the greatest potential for contamination, and one sample in the unsaturated soil immediately above the water table. Each soil boring will be sampled continuously and field screened with a photoionization detector (PID). Each interval will be logged according to American Society for Testing and Materials (ASTM) methods. Soil samples selected for chemical analysis will be analyzed for volatile organic compounds (VOCs) by EPA SW 846 Analytical Method 8260B, using Method 5035 Extraction (8260B/5035); total petroleum hydrocarbons (TPH) by Texas method 1005 (1005); and polynuclear aromatic hydrocarbons (PAHs) by EPA SW 846 Method 8310 (8310) in accordance with TNRCC RG-175. All samples will be submitted to an analytical laboratory in accordance with the Final Basewide QAPP requirements (HydroGeoLogic, 1998a). If a particular analyte exceeds its TNRCC action level, the site will be investigated under a Plan A evaluation as per Section 1.4.2 of this WP.

The analytical results obtained from the samples collected at the proposed soil borings are intended to determine whether any release from the former UST location has impacted the soil surrounding the site. A summary of the proposed sampling and analysis activities is presented in Tables 3.1 through 3.3 of the WP.

If necessary, additional soil borings may be installed to delineate the extent of any contamination above the TNRCC action levels originating from the former UST location. In addition, the existing monitoring well may be sampled or new monitoring wells may be installed and sampled if contamination levels warrant a Plan A investigation.

3.4.2 UST 1191-1

UST 1191-1 was a 500-gallon steel waste oil tank located on the south side of Building 1191, the vehicle maintenance shop. This UST was installed in 1983 and was removed from service in October 1993.

3.4.2.1 Site Investigation History

A search of Air Force, Navy, and TNRCC records did not reveal any reported leaks or overfills at this site. A large black stain is present at the surface on the west side of the former tank pit, but appears to originate from the building's bay doors.

Although there were no previous investigations directly associated with the removal of this UST, IT initiated a site investigation in 1997 to determine whether contamination had been released to the surrounding environment from the nearby OWS located on the west side of Building 1191. (ITC, 1997a). This investigation included two soil borings (SB119103 and SB119104) and one monitoring well (WITCTA031) on the east and west sides of UST 1191-1. The soil and groundwater samples were analyzed for VOCs, semivolatile organic compounds (SVOCs), RCRA metals, and pesticides/polychlorinated biphenyls (PCBs). Soil boring and monitoring well locations are depicted in Figure 3.2. Sample results were compared to background levels established by Jacobs (1998) for metals and to TNRCC action levels for LPST sites for organic compounds. Results of the 1997 sample analysis are summarized in Table 3.4.

Soil analysis showed concentrations above background levels for silver (0.56 milligrams per kilogram [mg/kg]) in SB119103 and methylene chloride (0.0012 mg/kg), *m*- and *p*-xylene (0.0035 mg/kg), calcium (404,000 mg/kg), and silver (2 mg/kg) in SB119104. Groundwater sampled from monitoring well WITCTA031 contained concentrations of several VOCs above practical quantitation limits (PQLs) including *cis*-1,2-dichloroethene (*cis*-1,2-DCE) (0.69 milligrams per liter [mg/L]), methylene chloride (0.29 mg/L), and vinyl chloride (2.2 mg/L). Concentrations of both *cis*-1,2-DCE and vinyl chloride exceeded their respective maximum contaminant level (MCL) of 0.07 mg/L and 2.2 mg/L. Methylene chloride does not have an MCL. Concentrations of aluminum (0.0517 mg/L), manganese (1.72 mg/L), and iron (5.35 mg/L) all exceeded their respective MCLs. SVOCs and pesticides/PCBs were not detected above the laboratory PQL in the groundwater samples.

Although sample analysis showed no contamination above TNRCC action levels, the results of this sampling event confirm that there may be some contamination present in the soil and groundwater near UST 1191-1. This contamination may be associated with the OWS at Building 1191. The data provided from this previous investigation does not provide adequate coverage to determine if the waste oil handled at UST 1191-1 has resulted in a release of hazardous constituents to the environment. Data gaps exist at the site because the soil specifically associated with the UST was not characterized for TPH, PAHs, or benzene, toluene, ethylbenzene, and xylenes (BTEX). Additional sampling will be necessary to determine if a release has occurred from UST 1191-1.

3.4.2.2 Proposed Activities

A preliminary site investigation will be conducted to determine what further action, if any, is required at UST 1191-1 in order to obtain closure from the TNRCC. Four soil borings will be advanced around the former UST in order to determine if a release had occurred in the past. The initial soil boring will be advanced in the approximate center of the former tank pit in order to determine the depth of the excavation. The remaining three soil borings will be advanced on the north, east, and south sides of the former excavation. SB119104 will suffice as an existing soil boring along the western wall of the excavation since no organic compounds were detected in that sampling event. Each soil boring will be sampled continuously and field screened with a PID, and each interval will be logged according to ASTM methods. Locations of the proposed soil borings are depicted in Figure 3.2.

Three soil samples will be collected from each soil boring. These samples include one sample at the surface, one sample in the area above the water table that exhibits the greatest potential for contamination, and one sample in the unsaturated soil immediately above the water table. Soil samples selected for chemical analysis will be analyzed for VOCs (8260B/5035), TPH (418.1/1005), and PAHs (8310) in accordance with TNRCC RG-175. All samples will be submitted to an analytical laboratory in accordance with the Final Basewide QAPP requirements (HydroGeoLogic, 1998a). If a particular analyte exceeds its corresponding TNRCC action level, the site will be investigated under a Plan A evaluation as per Section 1.4.2 of this WP.

The analytical results obtained from samples collected at the proposed soil boring locations are intended to determine whether the contamination found in the OWS investigation is associated with any release from the subject UST. In addition, the sample results from the proposed soil borings are intended to determine whether a release from UST 1191-1 has impacted the soil surrounding the site. A summary of proposed sampling and analysis activities is presented in Tables 3.1 through 3.3 of the WP.

If necessary, additional soil borings may be installed to delineate the extent of any contamination above the TNRCC action levels originating from the UST. In addition, the existing monitoring well may be sampled or additional monitoring wells may be installed and sampled if contamination levels warrant a Plan A investigation.

3.4.3 USTs 1411-1, 1411-2, and 1411-3

Building 1411, the AGE refueling facility, had three 2,000-gallon, steel USTs located adjacent to the flightline, approximately 100 feet northwest of Building 1410. Two pump islands had formerly been located over the tanks and were used for fueling flightline vehicles. The entire area was paved with approximately twelve inches of nonreinforced concrete. UST 1411-1 stored jet fuel, UST 1411-2 stored diesel fuel, and UST 1411-3 stored gasoline. All three USTs were installed in 1963 and were removed in 1996 (Jacobs, 1997).

3.4.3.1 Site Investigation History

The UST removal was documented by Jacobs in their report entitled "Final Removal/Upgrade of Underground Storage Tanks, Technical Report, Volumes I, II, and III, March 1997." During the initial removal activities, each UST excavation measured approximately 11 feet deep, by 13 feet wide, by 15 feet long. All of the associated piping was removed and no groundwater was encountered during excavation. Although no holes were observed in any of the USTs, stained soils and fuel odors were noticed in all three of the excavations. On the day following the removal of the USTs, heavy rain accumulated approximately 3 to 5 feet of rainwater runoff from the surrounding concrete into each excavation. Free product was observed on the water in the excavation of 1411-3 and a sheen was reported on the water in the excavation of 1411-2 (Jacobs, 1997).

Due to the presence of contamination in Jacobs' initial site observations, each UST excavation was overexcavated approximately 2 feet into its original bottom and sidewalls. Soil samples were collected from 2 feet beyond the original excavation depth and 2 feet into the original sidewalls before overexcavation was performed, with the exception of sample TE-1411-3SE which was collected approximately 3 feet into the southeast sidewall of excavation 1411-3. The locations of these soil samples are shown in Figure 3.3. All samples were analyzed for BTEX and methyl tert-butyl ether (MTBE) by EPA method SW8020, SVOCs by method SW8270, and TPH by method E418.1. As a result of the overexcavation, each excavation was extended to a depth between 10 and 13.2 feet. In addition, the concrete surface was removed between excavations 1411-1 and 1411-2 and all of the soil between the two excavations was removed to a depth of 12 feet (Jacobs, 1997). Analytical results of the samples taken from the area around USTs 1411-1, 1411-2, and 1411-3 were compared to TNRCC action levels for LPST sites, and are summarized in Tables 3.5, 3.6, and 3.7 respectively.

Soil samples contained concentrations of TPH above TNRCC action levels in all three of the UST excavations. UST 1411-1 contained concentrations of TPH in all of the samples collected. Two of the samples, TE-1411-1SW and TE-1411-1NE, contained TPH concentrations that exceeded the TNRCC action level of 500 mg/kg at 670 mg/kg and 2,340 mg/kg, respectively. UST 1411-2 contained high concentrations of TPH in two of the samples collected, TE1411-2SW (2,450 mg/kg) and TE1411-2BOT (1,070 mg/kg). UST 1411-3, the gasoline tank, contained TPH concentrations above the TNRCC action level of 100 mg/kg for gasoline releases. TPH concentrations ranged from 170 mg/kg in sample TE-1411-3NWA to 1,180 mg/kg in sample TE-1411-3BOTA (Jacobs, 1997). Benzene was not detected in any of the excavations. Toluene, ethylbenzene, MTBE, and total xylenes were each reported, but concentrations did not exceed

TNRCC action levels. Several VOCs were also detected below the TNRCC action levels. These were primarily fuel-related compounds (Jacobs, 1997).

The excavated soil was sampled at a frequency of approximately one sample per 50 cubic yards to characterize the soil for disposal. The samples were analyzed for methods SW8020 for BTEX and E418.1 for TPH. Analytical results indicated that 9 of the 10 samples collected from the excavated materials contained TPH concentrations above the TNRCC action levels for soil contaminated by gasoline releases (100 mg/kg). None of the samples contained concentrations exceeding the action levels for BTEX. As a result, all of the excavated material was disposed of off-site, and replaced with clean fill. Tank fluid and the accumulated rainwater was also removed and disposed of before backfilling began. Before closing the excavations, polyethylene plastic liners were placed in the excavations to separate the clean fill from the native soils. The excavations were finished to the original grade with an 8-inch concrete surface (Jacobs, 1997).

Although several TPH results from each excavation were above TNRCC action levels, the two highest results of these samples TE-1411-1NE (2,340 mg/kg) and TE1411-2SW (2,450 mg/kg), represent soil between the excavations of UST 1411-1 and 1411-2. This portion of soil was removed by overexcavation and replaced with clean fill (Jacobs, 1997). The residual concentrations of TPH above TNRCC action levels confirm that there may be some contamination present in the soil near the associated USTs. However, further soil sampling will not be necessary, since the source of this contamination has been removed and the excavation has been covered with an 8-inch concrete layer, which is sufficiently large enough in area to prevent any future surface flow from leaching around the former UST excavations. As an alternative to a soil investigation, the groundwater will be sampled from existing monitoring wells at the site in order to determine if a release has occurred from the USTs. This groundwater investigation will provide adequate information to determine if the waste from the subject USTs resulted in a release of hazardous constituents to the environment.

3.4.3.2 Proposed Activities

A preliminary site investigation will be conducted to determine what further action, if any, is required at USTs 1411-1, 1411-2, and 1411-3 in order to obtain closure from the TNRCC. Groundwater samples will be collected from the five existing monitoring wells at the site, MW-38, MW-39, MW-40, MW-41, and MW-42. The locations of these wells are presented in Figure 3.3.

Groundwater samples will be analyzed for VOCs (8260B/5035), TPH (418.1/1005), and PAHs (8310) in accordance with TNRCC RG-175. All samples will be submitted to an analytical laboratory and analyzed in accordance with the Final Basewide QAPP requirements (HydroGeoLogic, 1998a). If a particular analyte exceeds its TNRCC action level, then the site will be investigated under a Plan A evaluation as per Section 1.4.2 of this WP.

The groundwater analytical results are intended to determine whether the contamination found in the previous investigation is associated with any release from the subject USTs into the groundwater. A summary of proposed sampling and analysis activities is presented in Tables 3.1 through 3.3 of the WP.

If necessary, soil sampling may be required to delineate the extent of any groundwater contamination above the TNRCC action levels originating from the USTs. In addition, new monitoring wells may be installed and sampled if contamination levels warrant a Plan A investigation.

3.4.4 UST 1427-1

One 1,000-gallon steel diesel fuel UST was located adjacent to the northwest side of Building 1427. The tank was installed in 1976 and was removed in November 1990 by Eagle Construction and Environmental Services, Inc. (Eagle, 1990).

3.4.4.1 Site Investigation History

Building 1427, the RAPCON Support Facility, had a 1,000-gallon steel UST for storing diesel fuel, in support of the emergency generator. During the tank excavation soil and groundwater were sampled to determine whether contamination had been released to the surrounding environment from the UST. Samples were collected from each of the four sides and from the bottom of the excavation. The soil and groundwater samples were analyzed for BTEX and TPH. Results of these samples are shown in Table 3.8. TPH was identified above the TNRCC action level in the bottom soil sample at a concentration of 1,100 mg/kg. In addition, TPH was detected at 10 mg/L in the groundwater sampled from monitoring well MW-57, located north of the former tank pit (Figure 3.4). This result was twice the action level of 5 mg/L established by the TNRCC. No BTEX concentrations exceeded the TNRCC action levels for soil or groundwater.

The data provided from the removal activities suggest that this UST site may require a Plan A evaluation. However, the samples collected were not analyzed for PAHs. In addition, the groundwater samples were collected from an upgradient monitoring well, which suggests that the contamination found in the groundwater was from an upgradient source. Additional sampling will be necessary to determine if a release has occurred from UST 1427-1.

3.4.4.2 Proposed Activities

A preliminary site investigation will be conducted to determine what further action, if any, needs to be conducted at UST 1427-1 in order to seek closure from the TNRCC. In order to determine if there had been a release from the UST, one initial soil boring will be advanced in the approximate center of the former tank pit in order to determine the depth of the original excavation. Four additional soil borings will be advanced; one along each of the four sides of the excavation. Each soil boring will be drilled to the top of the water table, sampled continuously for lithologic characterization according to ASTM methods, and field screened using a PID to determine the volatile organic concentration. Locations of the proposed soil borings are depicted in Figure 3.4.

Three soil samples will be collected from each soil boring. These samples include one sample at the surface, one sample in the area above the water table that exhibits the greatest potential for contamination, and one sample in the unsaturated soil immediately above the water table. Soil samples selected for chemical analysis will be analyzed for VOCs (8260B/5035), TPH

(418.1/1005), and PAHs (8310) and analyzed in accordance with TNRCC RG-175. All samples will be submitted to an analytical laboratory and analyzed in accordance with the Final Basewide QAPP requirements (HydroGeoLogic, 1998a). If a particular analyte exceeds its TNRCC action level, then the site will be investigated under a Plan A evaluation as per Section 1.4.2 of this WP.

The analytical results obtained from samples collected at the proposed soil borings are intended to determine whether the contamination found in the previous investigation is associated with any release from the subject UST. A summary of proposed sampling and analysis activities is presented in Tables 3.1 through 3.3 of the WP.

If necessary, additional soil borings may be installed to delineate the extent of any contamination above the TNRCC action levels originating from the UST. In addition, monitoring wells may be installed and sampled if contamination levels warrant a Plan A investigation.

3.4.5 USTs 1750-1 and 1750-2

Two USTs were utilized at the communication relay station, Building 1750. UST 1750-1 was an 8,000-gallon fiberglass tank, and 1750-2 was a 20,000-gallon steel tank. Both USTs were located on the northwest side of Building 1750 and were used to store diesel fuel. UST 1750-1 was installed in 1986 and was removed in May 1996. UST 1750-2 was installed in 1957 and was abandoned in place in September 1992.

3.4.5.1 Site Investigation History

No documentation was found to indicate that a release had occurred from either UST. During the removal efforts of UST 1750-1, soils from the side walls, and associated pipeline area of the former tank pit were sampled and analyzed for TPH, BTEX, and SVOCs. A sample was not collected from the southeast side wall because UST 1750-2 was exposed on this side of the excavation and there was no soil left on the side wall to sample. In addition, no soil samples were collected from the base of the excavation due to the infiltration of groundwater. Instead, one groundwater sample was collected from the base of the excavation. Results of these samples are shown in Table 3.9, and the sampling locations are shown in Figure 3.5. TPH was detected in all of the samples in amounts ranging from 6.82 mg/kg to 75.7 mg/kg; well below the TNRCC action level of 500 mg/kg. In addition, several SVOCs were detected in the pipeline soil boring (TE-1750-2P). Of these SVOCs, benzo[*a*]pyrene (0.696 mg/kg) exceeded the TNRCC action level of 0.0877 mg/kg. Benzo[*g,h,i*]perylene (0.394 mg/kg) and phenanthene (1.3 mg/kg) were also detected in the sample collected from the pipeline area, but these compounds do not have an action level for comparison. No BTEX was detected in any of the soil samples. No constituents were detected above their respective action level in the groundwater sample. Although the previous investigation did not encompass UST 1750-2 during the excavation activities for UST 1750-1, the abandoned UST 1750-2 was observed to be filled with concrete and properly abandoned in place (Jacobs, 1997).

The sampling results obtained from previous investigations are sufficient to confirm that no release occurred from UST 1750-1. However, sample results obtained from the soil boring located in the area of the supply lines indicate that there may be some contamination of the soil in this area. In addition, no analytical sampling has been completed for the abandoned UST 1750-2. Additional sampling around the locations of the former supply lines associated with both USTs in conjunction with initial sampling around UST 1750-2 will be necessary to collect sufficient analytical data to compare to TNRCC action levels.

3.4.5.2 Proposed Activities

A preliminary site investigation will be conducted to determine what further action, if any, needs to be conducted at USTs 1750-1 and 1750-2 in order to obtain closure from the TNRCC. A total of six soil borings will be installed in the location of the UST site to determine if either UST had released waste oil into the environment. One soil boring will be advanced in the center of the former UST 1750-1 location to supplement the results of the previous investigation, and one soil boring will be advanced in the area of the former fuel supply lines. The remaining four soil borings will be installed on each side of UST 1750-2. All soil borings will be advanced to the top of the water table, sampled continuously for lithologic characterization according to ASTM methods, and field screened using a PID to determine the volatile organic concentration. Locations of the proposed soil borings are depicted in Figure 3.5.

Three soil samples will be collected from each of the six soil borings. These samples include one sample at the surface, one sample in the area above the water table that exhibits the greatest potential for contamination, and one sample in the unsaturated soil immediately above the water table. Soil samples selected for chemical analysis will be analyzed for VOCs (8260B/5035), TPH (418.1/1005), and PAHs (8310) in accordance with TNRCC RG-175. All samples will be submitted to an analytical laboratory and analyzed in accordance with the Final Basewide QAPP requirements (HydroGeoLogic, 1998a). If a particular analyte exceeds its corresponding TNRCC action level, then the site will be investigated under a Plan A evaluation as per Section 1.4.2 of this WP.

The analytical results obtained from samples collected at the proposed soil borings are intended to determine whether the contamination found in the previous investigation is associated with a release from either of the subject USTs. A summary of proposed sampling and analysis activities is presented in Tables 3.1 through 3.3 of the WP.

If necessary, additional soil borings may be installed to delineate the extent of any contamination above the TNRCC action levels originating from the UST. In addition, monitoring wells may be installed and sampled if contamination levels warrant a Plan A investigation.

3.4.6 UST 4115-1

UST 4115-1 was a 600-gallon steel diesel UST located near the southwest corner of Building 4115. This UST was installed in 1968 and was removed in January 1991.

3.4.6.1 Site Investigation History

There were no previous investigations conducted at this UST site. No documentation was discovered to indicate that a release has ever occurred from the tank. No reports describing the removal, excavation, or sample results could be located, and the TNRCC records search conducted by the Navy determined that a closure report had not been submitted.

3.4.6.2 Proposed Activities

A preliminary site investigation will be conducted to determine what action, if any, is required for UST 4115-1 in order to obtain closure from the TNRCC. An initial soil boring will be advanced in the approximate center of the former UST location in order to determine the depth of the original excavation. Four additional soil borings will be advanced adjacent to the four sides of the former tank pit. Each soil boring will be drilled to the top of the water table, sampled continuously for lithologic characterization according to ASTM methods, and field screened using a PID to determine the volatile organic concentration. Locations of the proposed soil borings are depicted in Figure 3.6.

Three soil samples will be collected from each of the five soil borings. These samples include one sample at the surface, one sample in the area above the water table that exhibits the greatest potential for contamination, and one sample in the unsaturated soil immediately above the water table. Soil samples selected for chemical analysis will be analyzed for VOCs (8260B/5035), TPH (418.1/1005), and PAHs (8310) in accordance with TNRCC RG-175. All samples will be submitted to an analytical laboratory and analyzed in accordance with the Final Basewide QAPP requirements (HydroGeoLogic, 1998a). If a particular analyte exceeds its TNRCC action level, then the site will be investigated under a Plan A evaluation as per Section 1.4.2 of this WP.

The analytical results obtained from samples collected at the proposed soil borings are intended to determine if any contamination found is associated with a release from the subject UST. A summary of proposed sampling and analysis activities is presented in Tables 3.1 through 3.3 of the WP.

If necessary, additional soil borings may be installed at a later date to delineate the extent of any contamination above the TNRCC action levels originating from the UST. In addition, monitoring wells may be installed and sampled if contamination levels warrant a Plan A investigation.

3.4.7 UST 4136-1

A 100-gallon steel diesel UST was located approximately 25 feet west-southwest of Building 4136. This UST was installed in 1980 and was removed from service in January 1991. The exact location of the UST has not been determined. Although as-built drawings show the location of UST 4136-1 in relation to the former TACAN site, this area has been re-graded and a new TACAN area has been constructed over the former site. A site visit to the current TACAN area identified an approximate location where the UST is suspected to have been. A new UST, 4136-2, is located southwest of Building 4136, but is not included in this investigation. This UST has been included in the text and figures for informational purposes only.

3.4.7.1 Site Investigation History

No previous investigations have been conducted at this UST site. No documentation was discovered to indicate that a release has ever occurred from the tank. No reports describing the removal, excavation, or sampling activity were located, and the TNRCC records search conducted by the Navy determined that a closure report had not been submitted.

3.4.7.2 Proposed Activities

A preliminary site investigation will be conducted to determine what further action, if any, needs to be conducted at UST 4136-1 in order to obtain closure from the TNRCC. Before the the extent of the potential contamination can be investigated, the location of the former UST must be determined. A 30- by 20-foot grid will be used at the site with the intention of encompassing the suspected UST location. A total of eight carbonated soil gas samplers will be inserted into the soil at locations both around the perimeter and within the center of the grid (Figure 3.7). The soil gas samplers will be installed in shallow boreholes below the surface, exposing the collector to the soil gas of the subsurface environment. Results from these soil gas samplers are anticipated to establish the UST excavation enabling accurate placement of the soil boring locations during the UST investigation.

If the results of the soil gas samples determine the location of the former UST, a total of five soil borings will be advanced, one in the center and one along each side of the former UST excavation. If the results from the soil gas samples do not determine the location of the UST excavation, the number of soil borings may increase to a total of 12 soil borings—1 soil boring every 10 feet within the 30- by 20-foot grid— in order to fully characterize the area in which the former UST was most likely to have been located[2]. Each soil boring will be drilled to the top of the water table, sampled continuously for lithologic characterization according to ASTM methods, and field screened using a PID to determine the volatile organic concentration. The proposed soil-gas probe and soil boring locations are depicted in Figure 3.7.

Three soil samples will be collected from each soil boring. These samples include one at the surface, one sample in the area above the water table that exhibits the greatest potential for contamination, and one sample in the unsaturated soil immediately above the water table. Soil samples selected for chemical analysis will be analyzed for VOCs (8260B/5035), TPH (418.1/1005), and PAHs (8310) in accordance with TNRCC RG-175. All samples will be submitted to an analytical laboratory and analyzed in accordance with the Final Basewide QAPP requirements (HydroGeoLogic, 1998a). If a particular analyte exceeds its TNRCC action level, then the site will be investigated under a Plan A evaluation as per Section 1.4.2 of this WP.

The analytical results obtained from samples collected at the proposed soil borings are intended to determine if any contamination identified is associated with a release from the subject UST.

[2] Due to the absence of installation/removal records, and the replacement of the former structures with new grading and new buildings, the exact location of the former UST was not determined. As a result, the 12 proposed soil borings have been proposed in a grid formation in order to adequately cover the area where the UST was most likely to have existed.

A summary of proposed sampling and analysis activities is presented in Tables 3.1 through 3.3 of the WP.

If necessary, additional soil borings may be installed to delineate the extent of any contamination above the TNRCC action levels originating from the UST. In addition, monitoring wells may be installed and sampled if contamination levels warrant a Plan A investigation.

3.4.8 GCA-1 and GCA-2

Two USTs were identified by the TNRCC Petroleum Storage Tanks Summary Listing as GCA-1 and GCA-2. No additional information existed on the TNRCC list regarding the tanks except that they contained jet fuel (GCA-1) and gasoline (GCA-2) and that they were abandoned on an unknown date.

3.4.8.1 Site Investigation History

Interviews with Navy personnel indicated that any USTs associated with the GCA site would be small and possibly located near a backup generator at either end of the runway. Navy personnel questioned the existence of these two USTs, stating that it would not be typical to abandon a small UST which could be easily removed. In addition, Navy personnel explained that all USTs on a military base are identified with the number of the building they serve and that the existence of these tanks is questionable due to the lack of a building number and any additional information. A search of Air Force and Navy records in conjunction with personnel interviews did not reveal any further information concerning these USTS. A diesel mechanic, who worked at the former GCA site confirmed the existence of the former UST 4115-1 (discussed earlier in Section 3.4.6), which was removed in January of 1991. He did not know of any other USTs at the former GCA site.

There were no previous investigations conducted concerning these two USTs. No reports describing the abandonment or any associated sampling locations were identified. The TNRCC records search conducted by the Navy determined that a closure report had not been submitted for these USTs.

3.4.8.2 Proposed Activities

An investigation of the two possible former GCA sites will be conducted in order to determine if the abandoned USTs ever existed. A visual inspection will be conducted to identify any surface features generally associated with a UST, such as depressions, stressed or dead vegetation, etc., along with a geophysical survey. Proposed geophysical field activities to be conducted at the possible location(s) of GCA-1 and GCA-2 will include a metal detection survey utilizing an EM system. The Geonics EM61 is a time domain metal detector that detects both ferrous and non-ferrous metals. The response of an isolated buried metal object is a single, sharply-defined peak, facilitating quick and accurate location of the object. In addition, the EM61 is relatively insensitive to nearby cultural interferences such as fences, buildings, and power lines. Although if present, such objects could still obscure the location of an UST. Consequently, the EM61 is ideal for confirming the presence or absence of a steel UST.

Figures 3.8a and 3.8b illustrate the approximate locations and the spatial orientation of the grids to be surveyed at the possible location(s) of GCA-1 and GCA-2. A 240-foot by 240-foot grid is proposed at each site with the intention of encompassing the suspected USTs. The placement of each grid in Figures 3.8a and 3.8b was based on the likelihood that the abandoned USTs are located in the areas close to the former buildings at each GCA site. The generous size of the grid has been proposed in order to ensure that both USTs will be located if they exist at either site. However, the size of the grid may change due to the results of the visual inspection. Data will be digitally recorded approximately every foot except where prevented by obstructions. The results will be displayed as contour maps and 3-dimensional mesh diagrams to identify anomalous areas. If anomalies indicating USTs or associated piping are not identified, the USTs will be designated as non-existent tanks, and a letter will be submitted to the TNRCC outlining the steps taken to reach this determination.

If anomalies indicating abandoned USTs are identified at either site, then a preliminary investigation will be conducted to determine what further action, if any, needs to be taken at the abandoned USTs in order to obtain closure from the TNRCC. A total of four soil borings will be advanced around each side of each abandoned UST in order to determine if either UST had released diesel fuel into the environment. All soil borings will be advanced to the top of the water table, sampled continuously for lithologic characterization according to ASTM methods, and field screened using a PID to determine the volatile organic concentration.

Three soil samples will be collected from each soil boring. These samples include one at the surface, one sample in the area above the water table that exhibits the greatest potential for contamination, and one sample in the unsaturated soil immediately above the water table. Soil samples selected for chemical analysis will be analyzed for VOCs (8260B/5035), TPH (418.1/1005), and PAHs (8310) in accordance with TNRCC RG-175. All samples will be submitted to an analytical laboratory and analyzed in accordance with the Final Basewide QAPP requirements (HydroGeoLogic, 1998a). If a particular analyte exceeds its TNRCC action level, then the site will be investigated under a Plan A evaluation as per Section 1.4.2 of this WP.

The analytical results obtained from samples collected at the proposed soil borings are intended to determine if any contamination found is associated with a release from the subject UST. A summary of proposed sampling and analysis activities is presented in Tables 3.1 through 3.3 of the WP.

If necessary, additional soil borings may be installed to delineate the extent of any contamination above the TNRCC action levels originating from the UST. In addition, monitoring wells may be installed and sampled if contamination levels warrant a Plan A investigation.

TAB

Tables

Table 3.1
Field Activities Summary
NAS Fort Worth JRB, Texas

UST Site	Activity	Number
1040-1	Soil borings using DPT	4
	Sample existing monitoring well	1[1]
1191-1	Soil borings using DPT	4
	Sample existing monitoring well	1[1]
1411-1, 1411-2, and 1411-3	Soil borings using DPT	0
	Sample existing monitoring well	5
1427-1	Soil borings using DPT	5
	Sample existing monitoring well	1[1]
1750-1 and 1750-2	Soil borings using DPT	6
4115-1	Soil borings using DPT	5
4136-1	Soil borings using DPT	5[2]
GCA-1 and GCA-2	Soil borings using DPT	8[2]

[1] Existing monitoring well(s) are located in the area of the former UST excavation and may be utilized as part of this investigation.
[2] The exact number of proposed soil borings may increase or decrease based on the results.
DPT = Direct-Push Technology

Table 3.2
Soil Sampling Analysis Summary
NAS Fort Worth JRB, Texas

Site	Analytical Method			Soil	Equipment	Ambient	Trip	Field	MS/	Total
	VOC	PAH	TPH	Borings	Blanks[1]	Blanks[2]	Blanks[3]	Duplicates[4]	MSD[5]	Samples
1040-1	12	12	12	4	1	1	1	1	1	41
1191-1	12	12	12	4	1	0	1	1	1	40
1411-1, 1411-2, and 1411-3	0	0	0	0	0	0	0	0	0	0
1427-1	15	15	15	5	1	0	1	1	1	49
1750-1 and 1750-2	18	18	18	6	1	0	1	2	1	59
4115-1	15	15	15	5	1	0	1	2	1	50
4136-1	15	15	15	5[6]	1	0	1	2	1	50
GCA-1 and GCA-2	24	24	24	8[6]	1	0	1	2	1	77
Total	111	111	111	37	7	1	7	11	7	366

[1] A maximum of one equipment blank will be taken per day.
[2] Ambient blanks will only be collected if VOCs are detected by a PID during the acquisition of a sample.
[3] One trip blank will accompany each cooler that contains samples to be analyzed for VOCs.
[4] Field duplicates will be collected on a 10 percent basis.
[5] Matrix spike/matric spike duplicates (MS/MSDs) will be collected on a 5 percent basis.
[6] The exact number of proposed soil borings may increase or decrease based on the results of the preliminary investigation.

Equipment Blanks = A maximum of one equipment blank will be taken per day, per analysis, regardless of media sampled.
Field Duplicates = Collected on a 10 percent basis of investigation samples.
Trip Blanks = One trip blank will be included per cooler when at least one sample is analyzed for VOCs from that cooler.
Ambient Blanks = One ambient blank will be collected at the beginning of the field investigation for soil and groundwater.

Table 3.3
Groundwater Sampling Analysis Summary
NAS Fort Worth JRB, Texas

Site	Analytical Method			Monitoring Wells	Equipment Blanks[2]	Ambient Blanks[3]	Trip Blanks[4]	Field Duplicates[5]	MS/ MSD[6]	Total Samples[7]
	VOC	PAH	TPH							
1040-1	1	1	1	1[1]	1	1	1	1	1	8
1191-1	1	1	1	1[1]	0	0	0	0	0	3
1411-1, 1411-2, and 1411-3	5	5	5	5	2	0	2	2	1	22
1427-1	1	1	1	1[1]	1	0	1	1	0	6
Total	8	8	8	8	4	1	4	4	2	39

1 Monitoring wells will be sampled only if soil samples exceed TNRCC action levels.
2 A maximum of one equipment blank will be taken per day.
3 Ambient blanks will only be collected if VOCs are detected by a PID during the acquisition of a sample.
4 One trip blank will accompany each cooler that contains samples to be analyzed for VOCs.
5 Field duplicates will be collected on a 10 percent basis.
6 Matrix spike/matric spike duplicates (MS/MSDs) will be collected on a 5 percent basis.
7 Total number of samples includes samples obtained from existing monitoring wells that may not be sampled due to their proximity to the former UST.

Equipment Blanks = A maximum of one equipment blank will be taken per day, per analysis, regardless of media sampled.
Field Duplicates = Collected on a 10 percent basis of investigation samples.
Trip Blanks = One trip blank will be included per cooler when at least one sample is analyzed for VOCs from that cooler.
Ambient Blanks = One ambient blank will be collected at the beginning of the field investigation for soil and groundwater.

Table 3.4
1997 Analytical Results of Building 1191
NAS Fort Worth JRB, Texas

Compounds Analyzed	Comparison Values			Sample Results			
	Surface Soil (mg/kg)	Sub-Surface Soil (mg/kg)	Groundwater (mg/L)	SB119103 (1-3') (mg/kg)	SB119104 (1-3') (mg/kg)	SB119104 (3-5') (mg/kg)	WITCTA031 (mg/L)
Pesticides/PCBs (SW8080)							
alpha-Chlordane	NV	NV	NV	ND	ND	0.004	ND
Dieldrin	NV	NV	NV	ND	ND	0.00035	ND
gamma-Chlordane	NV	NV	NV	ND	ND	0.00027	ND
VOCs (SW8260a)							
cis-1,2-Dichloroethene	PQL[2]	PQL[2]	PQL[2]	ND	ND	ND	0.69
Methylene chloride	PQL[2]	PQL[2]	PQL[2]	ND	ND	0.0012	0.29
— and p-Xylene	PQL[2]	PQL[2]	PQL[2]	ND	ND	0.0035	ND
Toluene	20[1]	20[1]	1.0[1]	ND	ND	0.035	ND
Vinyl Chloride	PQL[2]	PQL[2]	PQL[2]	ND	ND	ND	2.2
SVOCs (SW8270)							
Di-n-butyl phthalate	PQL[2]	PQL[2]	PQL[2]	ND	ND	1.5	ND
1,1,2,2-Tetrachloro ethane	NV	NV	NV	ND	ND	0.2	ND
Metals (SW6010/SW7471)							
Aluminum	22,035[2]	17,180[2]	1.332[2]	6,840	617	5,580	ND
Arsenic	5.855[2]	5.533[2]	0.0049[2]	ND	ND	ND	0.0517
Molybdenum	1.46[2]	1.930[2]	0.0144[2]	0.51	0.58	ND	0.0029
Potassium	2,895[2]	1,717[2]	15.03[2]	1,090	206	821	1.31
Sodium	25,800[2]	53,200[2]	167.2[2]	90.5	109	41.6	42.7
Beryllium	1.02[2]	0.957[2]	0.0003[2]	0.47	0.13	0.39	ND
Cobalt	11.05[2]	6.191[2]	0.0089[2]	3.6	0.56	2.9	ND
Chromium	21.056[2]	16.31[2]	0.006[2]	7.6	3	8.3	ND
Cadmium	0.5562[2]	0.5891[2]	0.0005[2]	ND	0.3	ND	ND

Table 3.4 (continued)
1997 Analytical Results of Building 1191
NAS Fort Worth JRB, Texas

Compounds Analyzed	Comparison Values			Sample Results			
	Surface Soil (mg/kg)	Sub-Surface Soil (mg/kg)	Groundwater (mg/L)	SB119103 (1-3') (mg/kg)	SB119104 (1-3') (mg/kg)	SB119104 (3-5') (mg/kg)	WITCTA031 (mg/L)
Metals (SW6010/SW7471)							
Calcium	167,788[2]	272,000[2]	266.3[2]	12,000	404,000	5,510	111
Zinc	38.8[2]	31.27[2]	0.118[2]	17.9	3.8	14.4	0.0056
Vanadium	46.26[2]	37.39[2]	0.0123[2]	15.3	ND	13.3	ND
Copper	17.373[2]	13.72[2]	0.0028[2]	5	12.6	3.9	ND
Barium	233[2]	128.1[2]	0.587[2]	37.5	10.6	37.6	1.49
Silver	0.213[2]	0.1277[2]	0.0002[2]	0.56	2	ND	ND
Nickel	14.6[2]	19.76[2]	0.0204[2]	6.7	2.1	5.7	ND
Manganese	849.1[2]	351.7[2]	0.175[2]	186	44.4	167	1.72
Iron	17,717[2]	15,224[2]	0.2239[2]	10,400	2,270	8,720	5.35
Lead	30.97[2]	12.66[2]	0.0016[2]	ND	ND	3.6	ND
Magnesium	3,003[2]	2,420[2]	37.8[2]	871	2,450	629	8.4
Mercury	0.14[2]	0.035[2]	0.0001[2]	0.01	ND	0.01	ND

[1] Soil and groundwater action levels for coarse-grained soils from TNRCC RG-17.
[2] UTLs as established by Jacobs (1998).
ND = No detect
NV = No comparison value
Outlined cells indicate concentrations above TNRCC action levels for LPST sites.
Shaded cells indicate concentrations above background or PQL.
Source: ITC Draft RECRA Facility Investigation, Sanitary Sewer System, September 1997.

Table 3.5
1997 Analytical Results of USTs 1411-1
NAS Fort Worth JRB, Texas

Compounds Analyzed	Comparison Values		Sample Results				
	Soil (mg/kg)	Groundwater (mg/L)	TE-1411-1NW 6.0 feet (mg/kg)	TE-1411-1SW 6.0 feet (mg/kg)	TE-1411-1SE 6.0 feet (mg/kg)	TE-1411-1NE 6.0 feet (mg/kg)	TE-1411-1BOT 6.0 feet (mg/kg)
TPH (E418.1)							
TPH[2]	500 [1]	5 [1]	10.4	670	231	2,340	46
BTEX and MTBE(SW8020)							
Benzene	0.5[1]	0.005[1]	ND	ND	ND	ND	ND
Ethylbenzene	10 [1]	0.7 [1]	ND	0.149	0.638	0.670	0.0025J
Toluene	20 [1]	1 [1]	ND	0.157	ND	ND	0.0025J
Total Xylenes	70 [1]	10 [1]	0.0014J	0.179	0.835	0.941	0.0037J
SVOCs (SW8270)							
2-Methylnaphthalene	NV	NV	NA	4.6	3.23	2.3	ND
Naphthalene	389 [1]	0.010 [1]	NA	3.68	1.6	1.44	ND
Dibenzofuran	NV	NV	NA	ND	ND	0.088J	ND
Fluoranthene	156 [1]	0.010 [1]	NA	ND	ND	0.107J	ND
Phenanthrene	NV	NV	NA	ND	ND	0.120J	ND

[1] Soil and groundwater action levels for coarse-grained soils from TNRCC RG-17.
[2] Soil and groundwater action levels for middle distillate releases from TNRCC RG-17.
J = Estimated concentration
NA = Not analyzed
ND = Not detected
NV = No comparison value
Outlined cells indicate concentrations above TNRCC action levels for coarse-grained soils from TNRCC RG-17.
Source: Removal/Upgrade of Underground Storage Tanks Technical Report Volume I of III, Jacobs Engineering Group Inc., March 1997

Table 3.6
1997 Analytical Results of USTs 1411-2
NAS Fort Worth JRB, Texas

Compounds Analyzed	Comparison Values		Sample Results				
	Soil (mg/kg)	Groundwater (mg/L)	TE-1411-2NE 6.0 feet (mg/kg)	TE-1411-2NW 6.0 feet (mg/kg)	TE-1411-2SE 6.0 feet (mg/kg)	TE-1411-2SW 6.0 feet (mg/kg)	TE-1411-2BOT 6.0 feet (mg/kg)
TPH (E418.1)							
TPH[2]	500 [1]	5 [1]	20.2	9.93J	17.4	2,450	1,070
BTEX and MTBE (SW8020)							
Benzene	0.5[1]	0.005[1]	ND	ND	ND	ND	ND
Ethylbenzene	10 [1]	0.7 [1]	ND	ND	ND	3.1	4.15
MTBE	NV	NV	ND	ND	ND	ND	0.061
Toluene	20 [1]	1 [1]	ND	ND	ND	0.158	2.85
Total Xylenes	70 [1]	10 [1]	0.0014J	ND	ND	8.48	20.3
SVOCs (SW8270)							
2-Methylnaphthalene	NV	NV	ND	ND	ND	4.96	5.34
Naphthalene	389 [1]	0.010 [1]	ND	ND	ND	4.1	4.27
Dibenzofuran	NV	NV	ND	ND	ND	ND	0.201J
Di-n-butyl phthalate	NV	NV	ND	ND	ND	0.127J	ND
Fluoranthene	156 [1]	0.010 [1]	ND	ND	ND	ND	0.175J
Fluorene	247 [1]	0.010 [1]	ND	ND	ND	ND	0.144J
Phenanthrene	NV	NV	ND	ND	ND	ND	0.256J
Pyrene	99 [1]	0.010 [1]	ND	ND	ND	ND	0.145J

[1] Soil and groundwater action levels for coarse-grained soils from TNRCC RG-17.
[2] Soil and groundwater action levels for middle distillate releases from TNRCC RG-17.
J = Estimated concentration
NA = Not analyzed
ND = Not detected
NV = No comparison value
Outlined cells indicate concentrations above TNRCC action levels for coarse-grained soils from TNRCC RG-17.
Source: Removal/Upgrade of Underground Storage Tanks Technical Report Volume I of III, Jacobs Engineering Group Inc., March 1997

Table 3.7
1997 Analytical Results of USTs 1411-3
NAS Fort Worth JRB, Texas

Compounds Analyzed	Comparison Values		Sample Results						
	Soil (mg/kg)	Ground water (mg/L)	TE-1411-3NW 6.0 feet (mg/kg)	TE-1411-3NE 6.0 feet (mg/kg)	TE-1411-3SW 6.0 feet (mg/kg)	TE-1411-3SE 6.0 feet (mg/kg)	TE-1411-3BOT 6.0 feet (mg/kg)	TE-1411-3NWA 6.0-7.0 feet (mg/kg)	TE-1411-3BOTA 2.0-12.0 feet (mg/kg)
TPH (E418.1)									
TPH[2]	100 [1]	5 [1]	556	7.58J	10	15.5	190	170	1,180
BTEX and MTBE (SW8020)									
Benzene	0.5[1]	0.005[1]	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	10 [1]	0.7 [1]	1.03	ND	ND	ND	ND	0.118	0.320
MTBE	NV	NV	ND	ND	0.003J	ND	ND	ND	ND
Total Xylenes	70 [1]	10 [1]	2.55	0.889	0.0011J	0.001J	ND	0.289	ND
SVOCs (SW8270)									
2-Methylnaphthalene	NV	NV	3.29	ND	ND	ND	0.338	NA	NA
Naphthalene	389 [1]	0.010 [1]	1.82	ND	ND	ND	ND	NA	NA
Fluoranthene	156 [1]	0.010 [1]	ND	ND	ND	ND	0.206J	NA	NA
Phenanthrene	NV	NV	ND	ND	ND	ND	0.184J	NA	NA
Pyrene	99 [1]	0.010 [1]	ND	ND	ND	ND	0.17J	NA	NA

[1] Soil and groundwater action levels for coarse-grained soils from TNRCC RG-17.
[2] Soil and groundwater action levels for gasoline releases from TNRCC RG-17.
J = Estimated concentration
NA = Not analyzed
ND = Not detected
NV = No comparison value
Outlined cells indicate concentrations above TNRCC action levels for coarse-grained soils from TNRCC RG-17.
Source: Removal/Upgrade of Underground Storage Tanks Technical Report Volume I of III, Jacobs Engineering Group Inc., March 1997

Table 3.8
1990 Analytical Results of UST 1427-1
NAS Fort Worth JRB, Texas

Compounds Analyzed	Comparison Values		Sample Results					
	Surface Soil (mg/kg)	Groundwater (mg/L)	North wall (mg/kg)	South wall (mg/kg)	East Wall (mg/kg)	West Wall (mg/kg)	Bottom (mg/kg)	Water (mg/L)
TPH								
TPH	500[1]	5[1]	48	18	270	140	1,100	10
BTEX								
Benzene	0.5[1]	0.005[1]	<0.02	<0.02	<0.02	<0.02	<0.02	<0.005
Toluene	20[1]	1[1]	<0.02	<0.02	<0.02	<0.02	<0.02	<0.005
Ethylbenzene	10[1]	0.7[1]	<0.02	<0.02	<0.02	<0.02	<0.02	<0.005
Total Xylenes	70[1]	10[1]	<0.02	<0.02	<0.02	<0.02	0.09	<0.005
Total BTEX	NV	NV	<0.02	<0.02	<0.02	<0.02	0.09	<0.005

[1] Soil and groundwater action levels for coarse-grained soils from TNRCC RG-17.
NV = No value
Outlined cells indicate concentrations above TNRCC action levels for LPST Sites.
Source: Eagle Construction and Environmental Services, Inc., Analytical Data, 1990.

Table 3.9
1996 Analytical Results of UST 1750-1
NAS Fort Worth JRB, Texas

Compounds Analyzed	Comparison Values		Sample Results				
	Surface Soil (mg/kg)	Groundwater (mg/L)	TE-1750-2N (mg/kg)	TE-1750-2W (mg/kg)	TE-1750-2E (mg/kg)	TE-1750-2P (mg/kg)	TE-1750-2GW (mg/L)
TPH (E418.1)							
TPH	500[1]	5[1]	6.82	8.79	8.65	75.7	0.310
SVOCs (SW8270)							
Benzo[*a*]anthracene	0.877[1]	0.01[1]	ND	ND	ND	0.851	ND
Benzo[*a*]pyrene	0.0877[1]	0.01[1]	ND	ND	ND	0.696	ND
Benzo[*b*]fluoranthene	0.877[1]	0.01[1]	ND	ND	ND	0.735	ND
Benzo[*g,h,i*]perylene	NV	NV	ND	ND	ND	0.394	ND
Benzo[*k*]fluoranthene	8.77[1]	0.01[1]	ND	ND	ND	0.641	ND
Chrysene	7.2[1]	0.01[1]	ND	ND	ND	0.824	ND
Fluoranthene	156[1]	0.01[1]	ND	ND	ND	2.330	ND
Indeno[1,2,3-cd]pyrene	0.877[1]	0.01[1]	ND	ND	ND	0.41	ND
Phenanthrene	NV	NV	ND	ND	ND	1.3	ND
Pyrene	99[1]	0.01[1]	ND	ND	ND	1.57	ND

[1] Soil and groundwater action levels for coarse-grained soils from TNRCC RG-17.
ND = No detect
NV = No value
Outlined cells indicate concentrations above TNRCC action levels for LPST sites.
Source: Removal/Upgrade of Underground Storage Tanks, Technical Report, March 1997, Jacobs Engineering Group Inc.

TAB

Figures

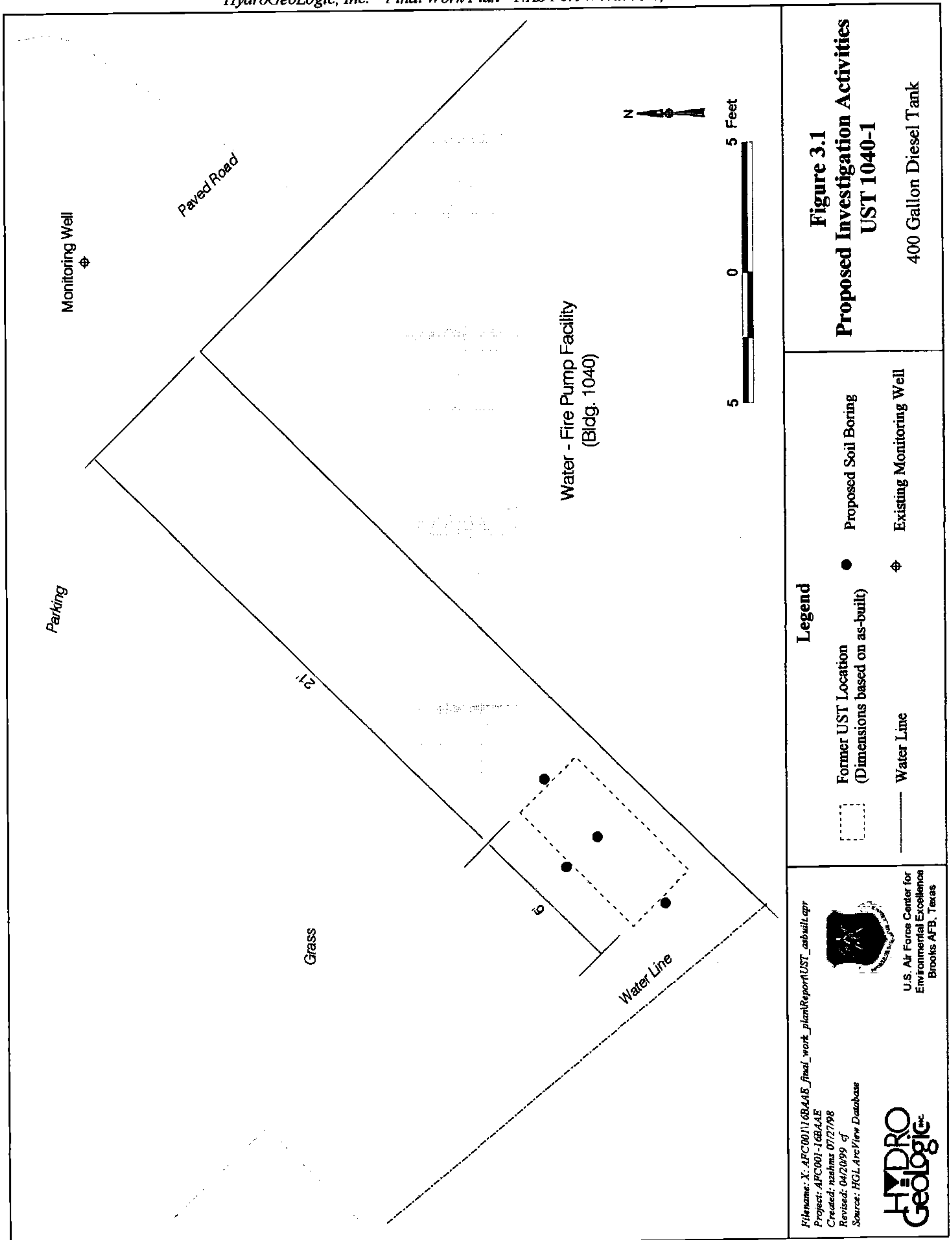
Figure 3.1
Proposed Investigation Activities
UST 1040-1
400 Gallon Diesel Tank
Legend
Former UST Location (Dimensions based on as-built)
Proposed Soil Boring
Water Line
Existing Monitoring Well
Monitoring Well
Paved Road
Parking
Grass
Water - Fire Pump Facility (Bldg. 1040)
Water Line
21'
6'
5
0
5 Feet
N
U.S. Air Force Center for Environmental Excellence Brooks AFB, Texas
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Project: AFC001-16BAAE
Created: nahms 07/27/98
Revised: 04/20/99 cf
Source: HGL ArcView Database
HYDRO GEOLOGIC INC

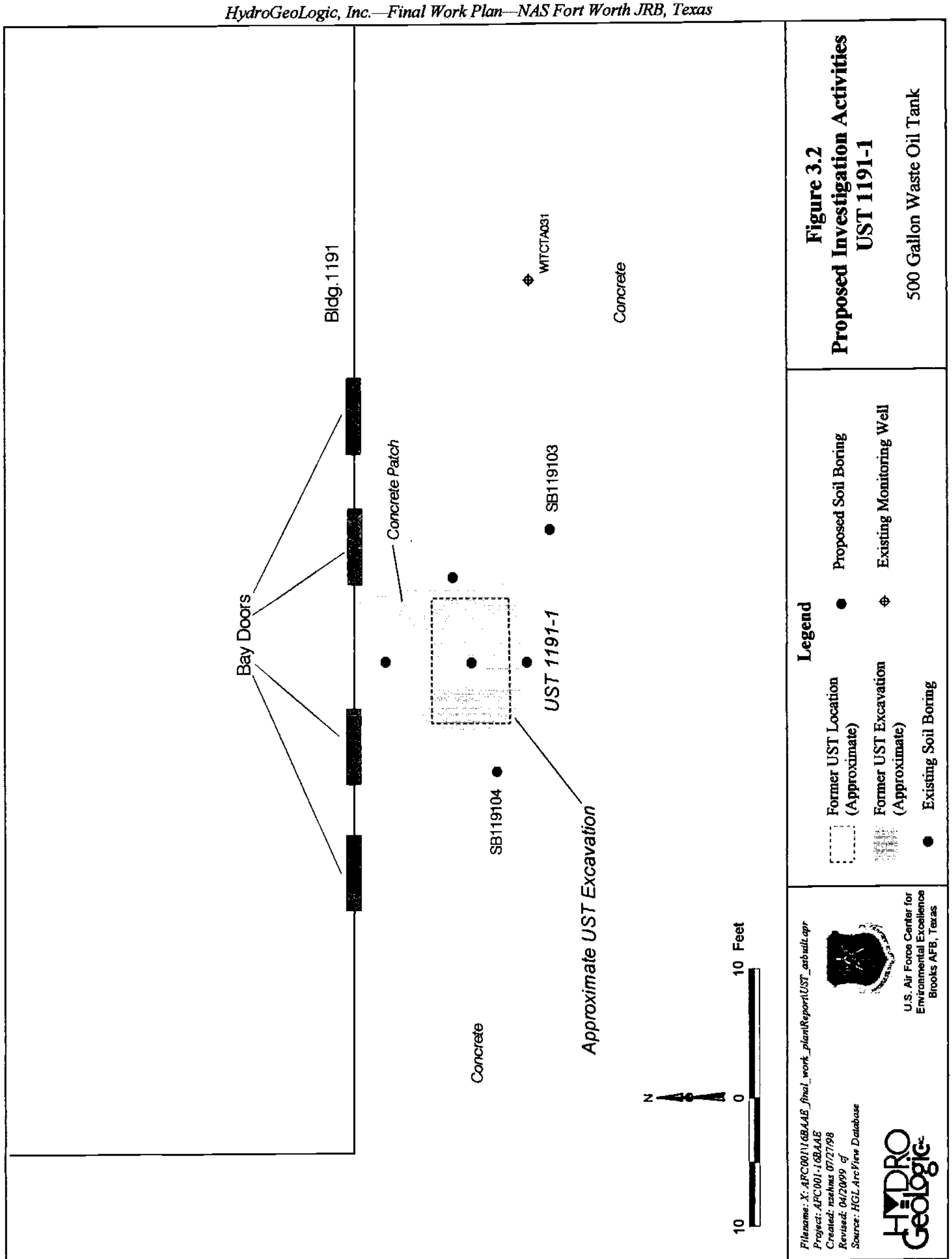
Figure 3.2
Proposed Investigation Activities
UST 1191-1
500 Gallon Waste Oil Tank
Legend
Proposed Soil Boring
Existing Monitoring Well
Former UST Location (Approximate)
Former UST Excavation (Approximate)
Existing Soil Boring
U.S. Air Force Center for Environmental Excellence Brooks AFB, Texas
Filename: X:AFC001\16BAAE_final_work_planReport\UST_asbuilt.apr
Project: AFC001-16BAAE
Created: mzehms 07/27/98
Revised: 04/20/99 cf
Source: HGL ArcView Database
HYDRO GeoLogic
Bldg.1191
Bay Doors
Concrete Patch
WTCTA031
Concrete
SB119103
SB119104
UST 1191-1
Approximate UST Excavation
Concrete
N
10
0
10 Feet

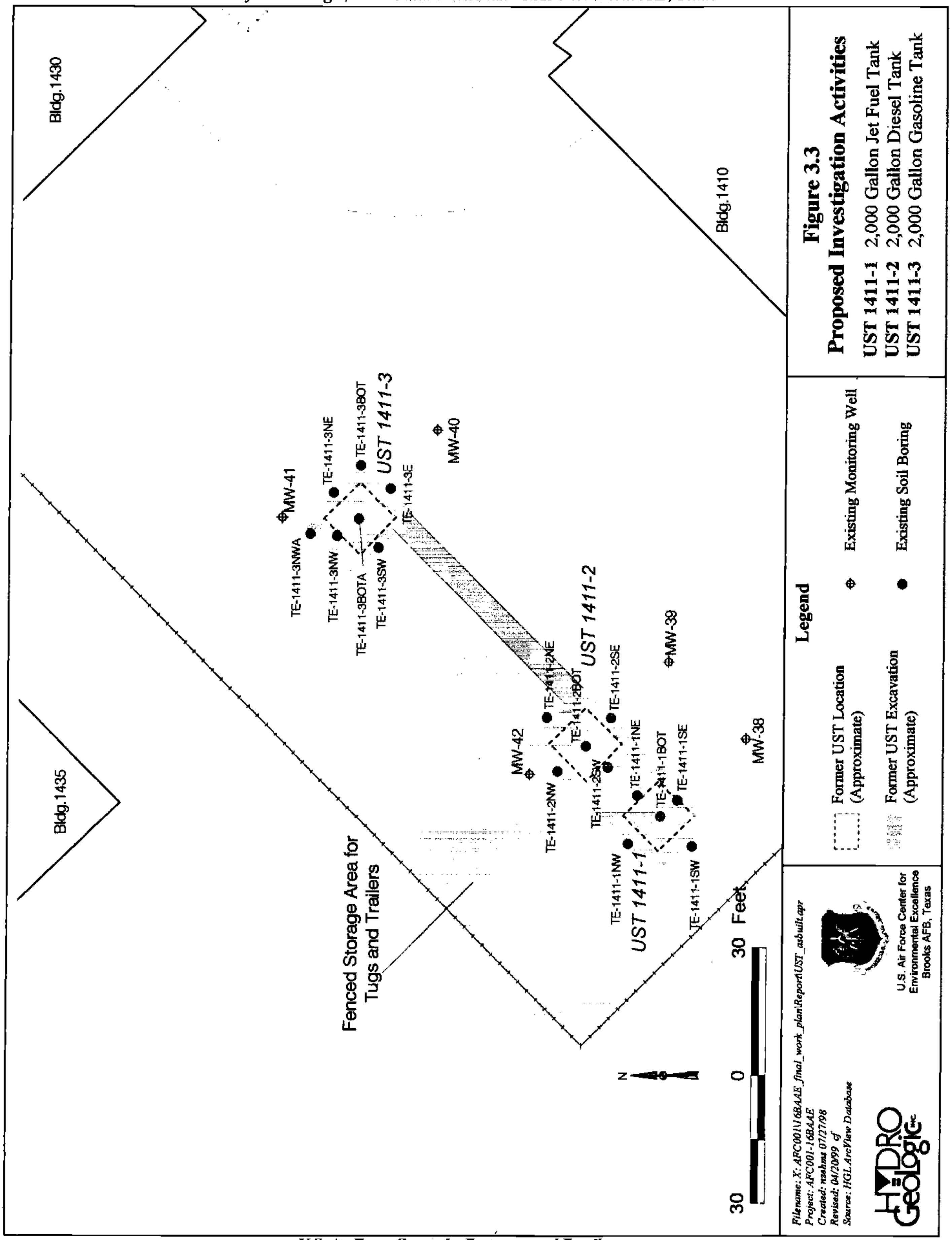

Figure 3.3
Proposed Investigation Activities

UST 1411-1 2,000 Gallon Jet Fuel Tank
UST 1411-2 2,000 Gallon Diesel Tank
UST 1411-3 2,000 Gallon Gasoline Tank

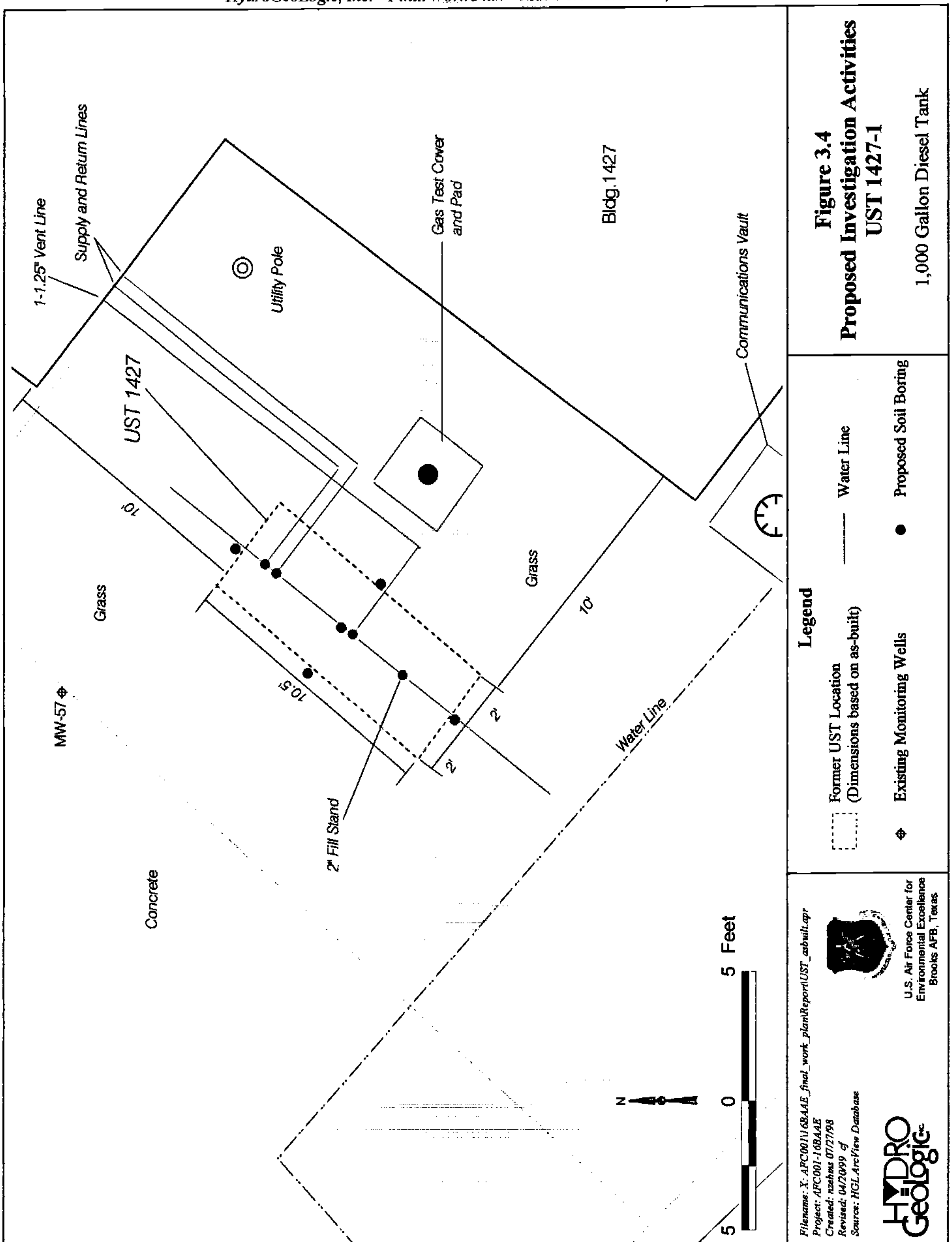

Figure 3.4
Proposed Investigation Activities
UST 1427-1
1,000 Gallon Diesel Tank

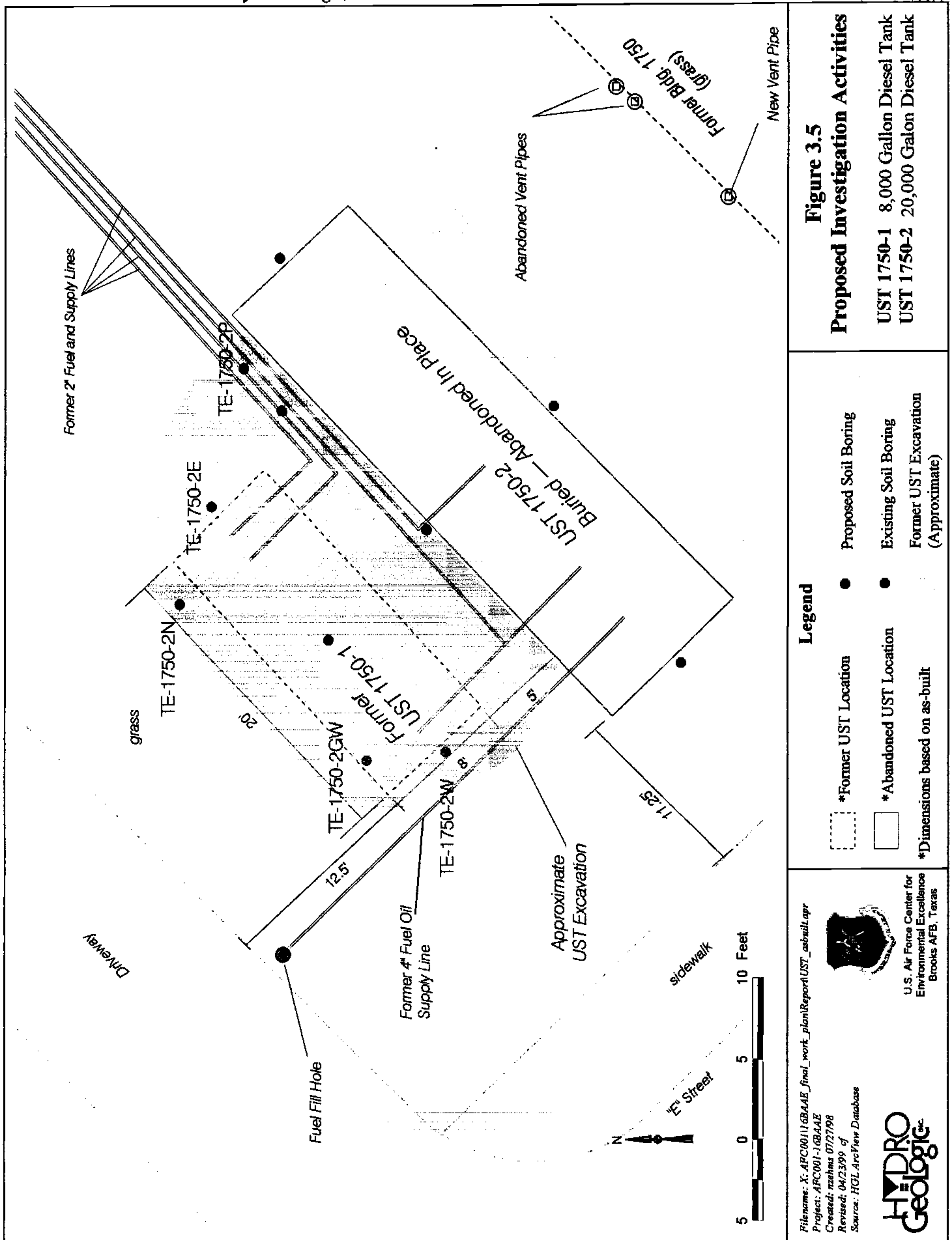

Figure 3.5
Proposed Investigation Activities

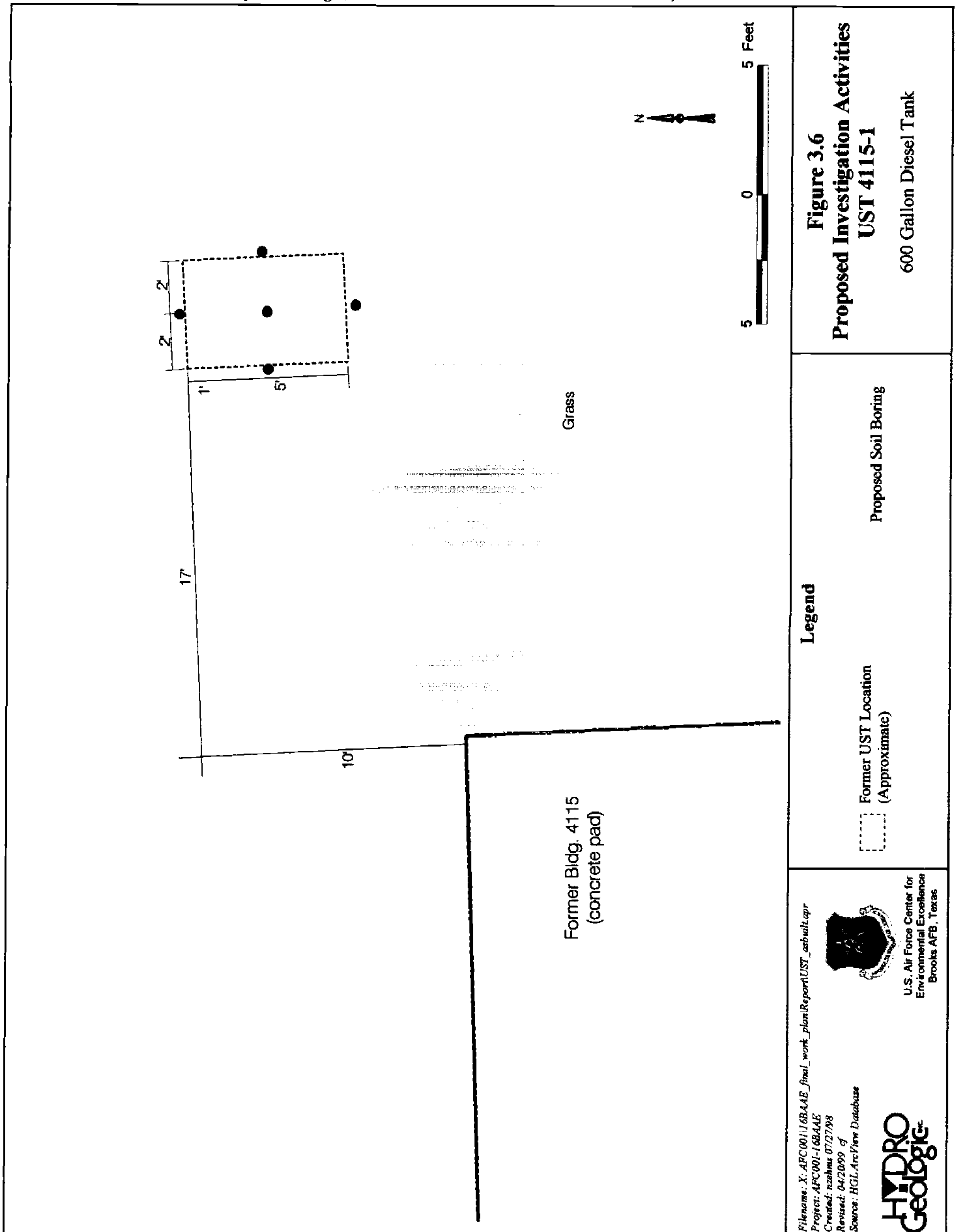

Figure 3.6
Proposed Investigation Activities
UST 4115-1
600 Gallon Diesel Tank

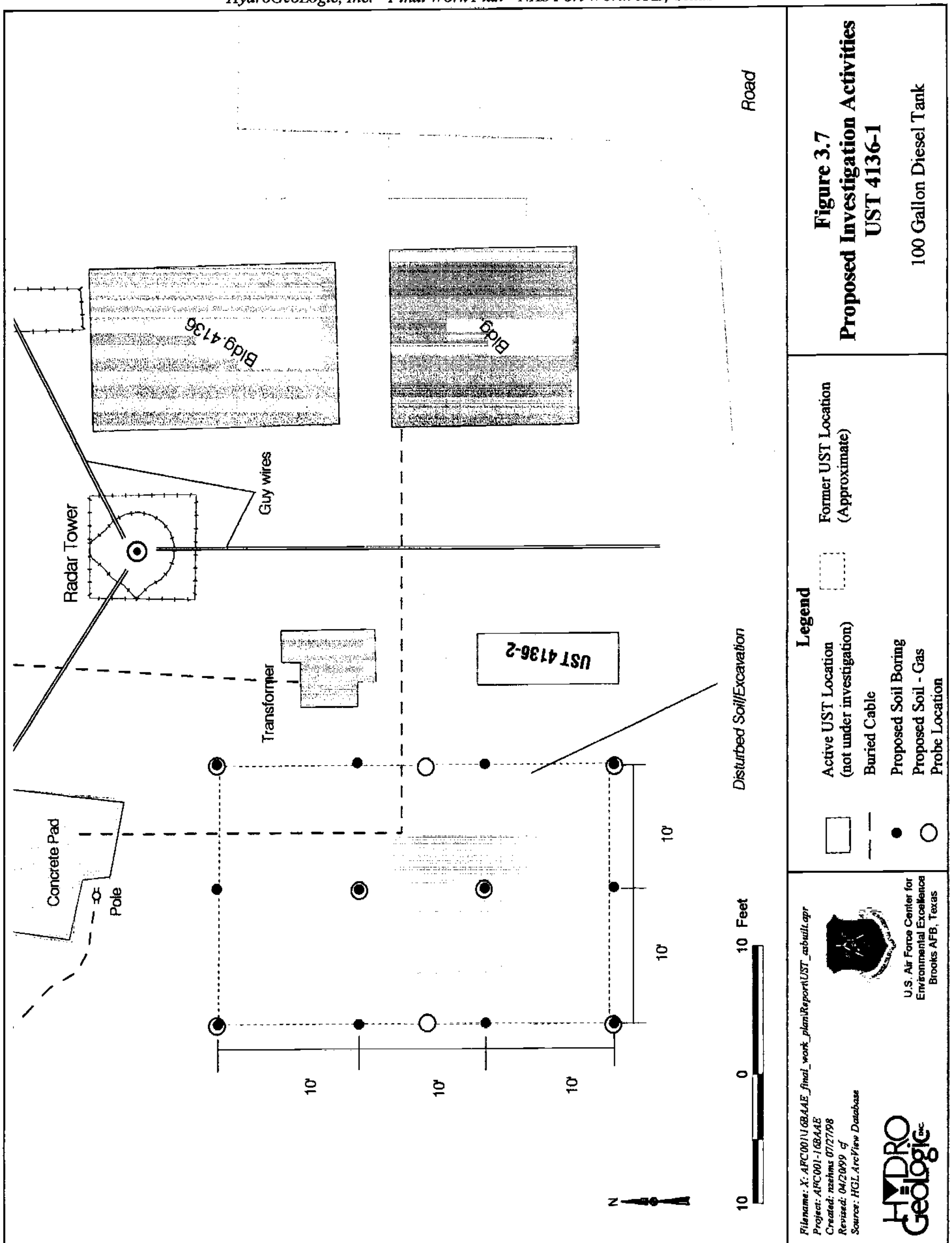

Figure 3.7
Proposed Investigation Activities
UST 4136-1
100 Gallon Diesel Tank

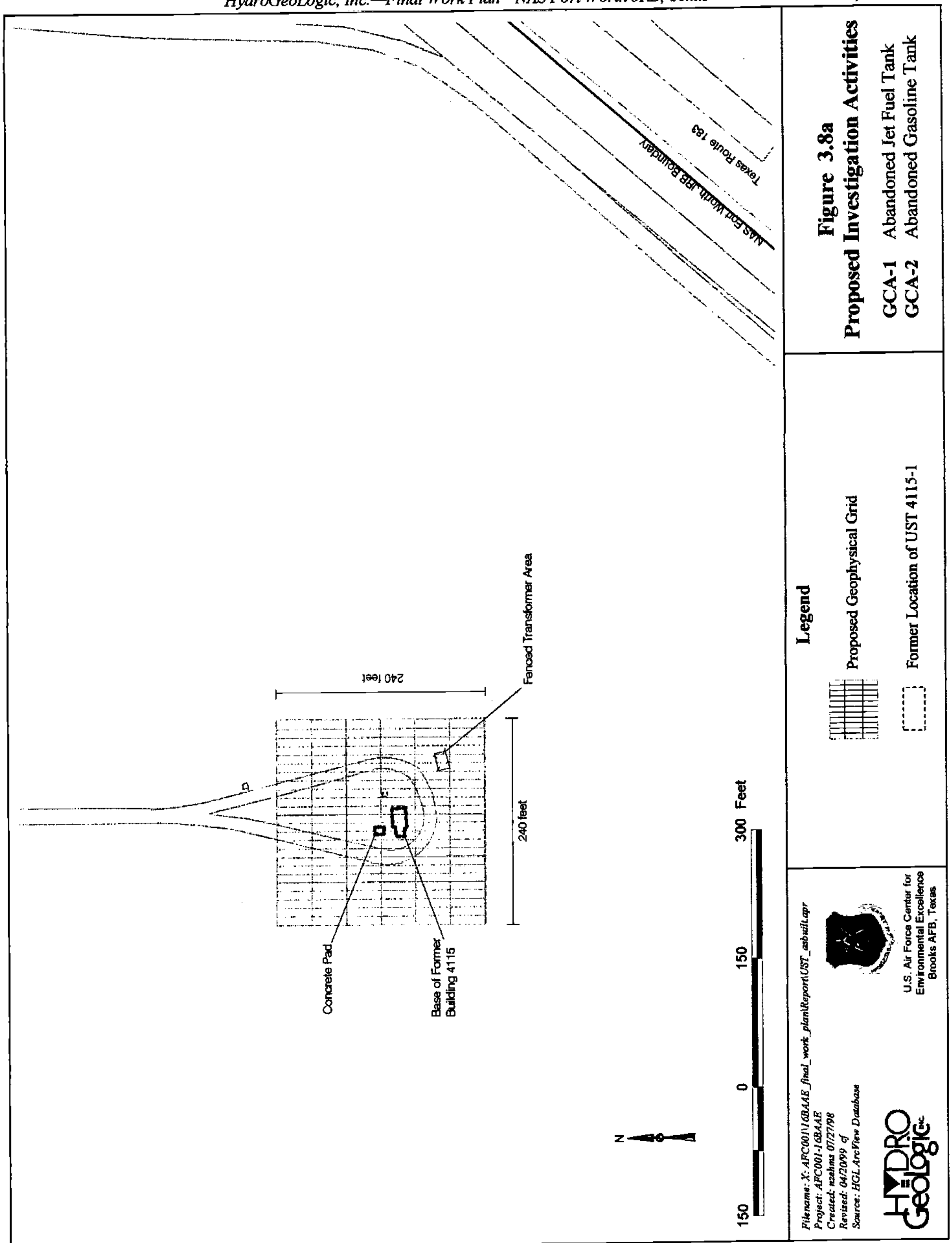
Figure 3.8a
Proposed Investigation Activities
GCA-1 Abandoned Jet Fuel Tank
GCA-2 Abandoned Gasoline Tank
Texas Route 183
NAS Fort Worth JRB Boundary
Legend
Proposed Geophysical Grid
Former Location of UST 4115-1
240 feet
240 feet
Fenced Transformer Area
Concrete Pad
Base of Former Building 4115
150
0
150
300 Feet
N
Filename: X:\AFC001\16BAAE_final_work_plan\Report\UST_asbuilt.apr
Project: AFC001-16BAAE
Created: nzehms 07/27/98
Revised: 04/20/99 cf
Source: HGL ArcView Database
HYDRO GEOLOGIC INC
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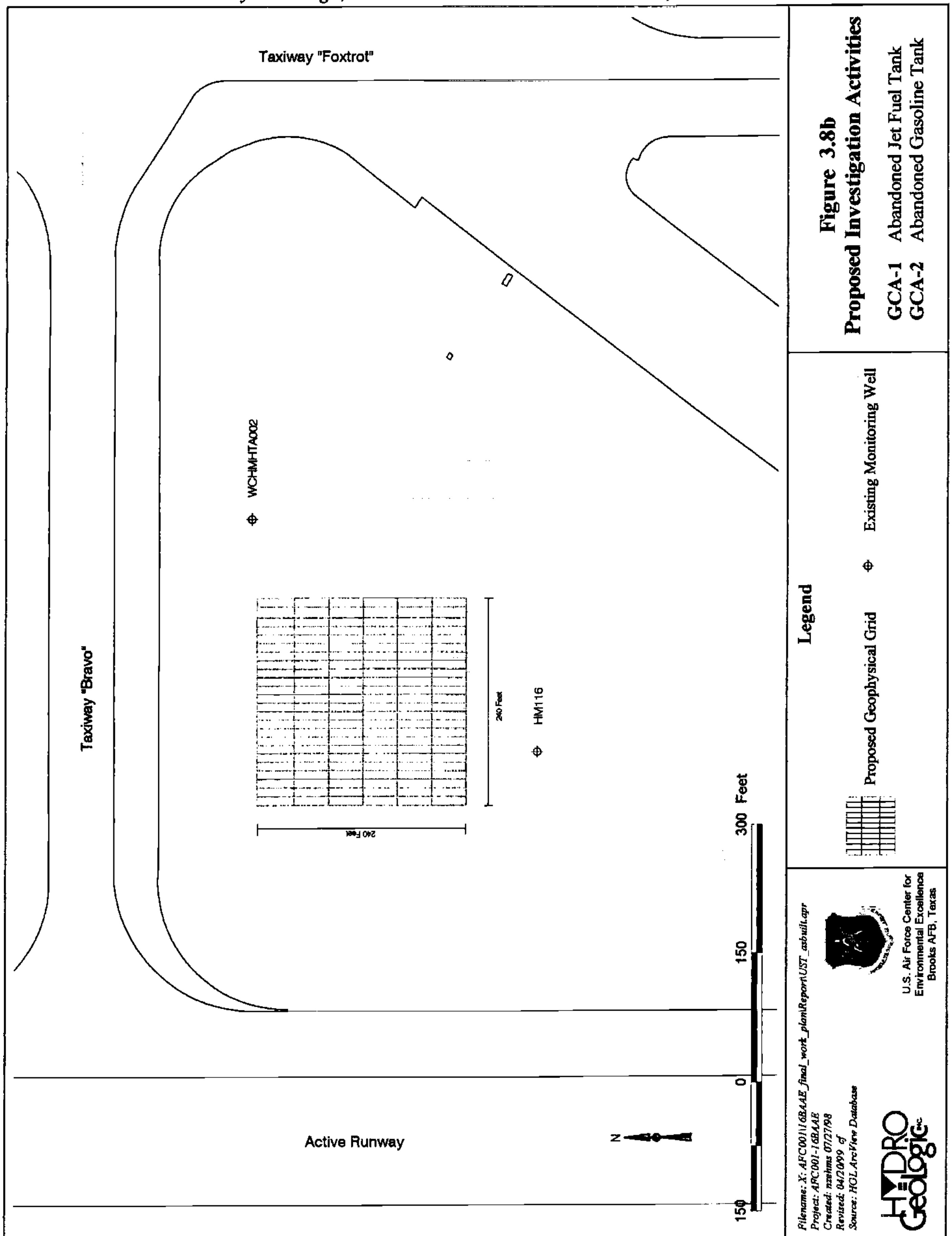
Figure 3.8b
Proposed Investigation Activities
GCA-1 Abandoned Jet Fuel Tank
GCA-2 Abandoned Gasoline Tank
Legend
Proposed Geophysical Grid
Existing Monitoring Well
Taxiway "Foxtrot"
Taxiway "Bravo"
Active Runway
WCHMHTA002
HM116
240 Feet
240 Feet
150 0 150 300 Feet
N
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Project: AFC001-16BAAE
Created: nzehms 07/27/98
Revised: 04/20/99 cf
Source: HGL ArcView Database
U.S. Air Force Center for Environmental Excellence Brooks AFB, Texas
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TAB

Section 4.0

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TAB

Field Sampling Plan

FINAL
FIELD SAMPLING PLAN
SITE INVESTIGATION
12 UNDERGROUND STORAGE TANKS
NAS FORT WORTH JRB, TEXAS

Prepared for

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

Contract Number F41624-95-D-8005

May 1999

480 119

FINAL
FIELD SAMPLING PLAN
SITE INVESTIGATION
12 UNDERGROUND STORAGE TANKS
NAS FORT WORTH JRB, TEXAS

Contract Number F41624-95-D-8005
Delivery Order No. 0016

Prepared for

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

Prepared by

HydroGeoLogic, Inc.
1155 Herndon Parkway, Suite 900
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May 1999

480 120

Final
Field Sampling Plan
Site Investigation
12 Underground Storage Tanks
NAS Fort Worth JRB, Texas
and the
Air Force Center
for
Environmental Excellence

Preparer:	______________________	Date: ________
Approved:	______________________ Prime Contractor QA/QC Manager	Date: ________
Approved:	______________________ Prime Contractor Project Manager	Date: ________
Approved:	______________________ Applicable Subcontractor(s)	Date: ________
Approved:	______________________ Applicable State and Federal Regulatory Agencies	Date: ________
Approved:	______________________ Applicable State and Federal Regulatory Agencies	Date: ________
Approved:	______________________ AFCEE Team Chief	Date: ________

Contract Number F41624-95-D-8005-0016

PREFACE

This Final Field Sampling Plan (FSP) is part of the Work Plan (WP) document for a site investigation (SI) intended to determine the impacts associated with the former and abandoned underground storage tanks (USTs) at Naval Air Station Fort Worth Joint Reserve Base (NAS Fort Worth JRB), Texas. The investigation is being conducted as part of the U.S. Air Force Installation Restoration Program (IRP). This work is authorized as Delivery Order No. 0016 under Air Force Center for Environmental Excellence (AFCEE) Contract No. F41624-95-D-8005. This WP document consists of a WP, a Sampling and Analysis Plan (SAP), and a Health and Safety Plan (HSP). The SAP consists of a FSP and a Quality Assurance Project Plan (QAPP). The FSP describes in detail the proposed sampling and analysis and the specific procedures, measurements, and record keeping requirements for the field effort.

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LIST OF ACRONYMS AND ABBREVIATIONS

3-D	three-dimensional
AFB	Air Force Base
AFBCA	Air Force Base Conversion Agency
AFCEE	U.S. Air Force Center for Environmental Excellence
ARAR	Applicable or Relevant and Appropriate Requirement
ASTM	American Society for Testing and Materials
BRAC	Base Realignment and Closure
BTEX	benzene, toluene, ethylbenzene, and xylenes
°C	degrees Celsius
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
DEQPPM	Defense Environmental Quality Program Policy Memorandum
DNAPL	dense non-aqueous phase liquid
DO	dissolved oxygen
DoD	Department of Defense
DPT	direct push technology
DQO	data quality objective
EC	electrical conductivity
EM	electromagnetic
EPA	U.S. Environmental Protection Agency
ERD	Environmental Restoration Division
Fe^{2+}	ferrous iron
FS	feasibility study
FSP	Field Sampling Plan
GCA	ground control approach
HSA	hollow stem auger
HSC	Health and Safety Coordinator
HSP	Health and Safety Plan
HydroGeoLogic	HydroGeoLogic, Inc.
IDW	investigative derived waste
IRP	Installation Restoration Program
IRPIMS	Installation Restoration Program Information Management System
LNAPL	light non-aqueous phase liquid
LPST	leaking petroleum storage tank
L/min	liters per minute

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

mg/L	milligrams per liter
MS	matrix spike
MSD	matrix spike duplicate
MTBE	methyl tert-butyl ether
NAS Fort Worth JRB	Naval Air Station Fort Worth Joint Reserve Base
NCP	National Contingency Plan
NTU	nephelometric turbidity unit
ORP	oxidation-reduction potential
OWS	oil/water separator
PAH	polynuclear aromatic hydrocarbon
PID	photoionization detector
POC	point of contact
QA	quality assurance
QC	quality control
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RG	regulatory guidance
RI	remedial investigation
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SI	site investigation
TAC	Texas Administrative Code
TBD	to be determined
TDS	total dissolved solids
TNRCC	Texas Natural Resource Conservation Commission
TOC	total organic carbon
TPH	total petroleum hydrocarbon
USCS	United Soil Classification System
UST	underground storage tank
VOC	volatile organic compound
WP	Work Plan

FINAL
FIELD SAMPLING PLAN
SITE INVESTIGATION
12 UNDERGROUND STORAGE TANKS
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: (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 Final Basewide QAPP (HydroGeoLogic, 1998) shall constitute, by definition, an AFCEE SAP.

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

Guidelines followed in the preparation of this plan are set out in the NAS Fort Worth JRB Resource Conservation Recovery Act (RCRA) Permit HW-50289, issued by the Texas Natural Resource Conservation Commission (TNRCC) on February 7, 1991. Additional reference documents followed in the preparation of this FSP include AFCEE's *Model Field Sampling Plan* (March, 1997) and the AFCEE *Handbook for the Installation Restoration Program (IRP) for Remedial Investigations and Feasibility Studies* (1993). All laboratory analyses performed as part of this FSP will follow the Final Basewide QAPP (HydroGeoLogic, 1998).

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

Controlled distribution of the FSP will 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 FSP. Controlled copies shall be provided to applicable Air Force managers, regulatory agencies, remedial project managers, project managers, and quality assurance (QA) coordinators. Whenever Air Force revisions are made or addenda added to the FSP, a document control system shall be put into place to ensure: (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 objective of the Air Force IRP at NAS Fort Worth JRB and the rationale for implementing this FSP.

2.1 THE U.S. AIR FORCE INSTALLATION RESTORATION PROGRAM

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

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

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

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

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

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

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

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

2.2 PROJECT PURPOSE AND SCOPE

The purpose of this field investigation is to gather sufficient data to support closure of 12 USTs at NAS Fort Worth JRB under the TNRCC Leaking Petroleum Storage Tank (LPST) program. Other information pertaining to the purpose and scope of this project has been discussed in Section 1.0 of the WP.

Field methods that will be used to characterize the UST sites include a geophysical survey using an electromagnetic (EM) system, soil sampling using soil gas probes, soil boring installation and sampling using direct push technology (DPT), and groundwater sampling from existing monitoring wells. Based on the results of the preliminary investigation, additional soil borings may be advanced and groundwater samples may be collected for contamination delineation. New monitoring wells will be installed and sampled if necessary.

The data collected as part of this FSP will be used to evaluate and determine if additional sampling data will be necessary to proceed to closure under the TNRCC regulatory guidance (RG) -17 and RG-36.

2.3 PROJECT SITE DESCRIPTION

Carswell Air Force Base (AFB) was officially closed on September 30, 1993, as part of the Base Realignment and Closure (BRAC) Act of 1990. As part of the BRAC transfer of property to the Navy, closure will be requested from the TNRCC for removed and abandoned UST sites.

A 2,555-acre parcel of the former Carswell AFB, which now is known as NAS Fort Worth JRB, is in the process of being transferred from Air Force to Navy management. However, before the property transfer can be completed, environmental investigations of potential contamination related to Air Force activities at the NAS Fort Worth JRB property are to be completed and contaminated sites remediated.

This document is part of the WP for a SI and characterization of 12 former and abandoned UST sites at NAS Fort Worth JRB. This investigation is managed by the Air Force under the Environmental Restoration Account. Other portions of the former Carswell AFB that are not being transferred to the Navy remain under BRAC funding and management.

The primary regulatory program that governs this SI and the closure of these sites is the TNRCC LPST Program. The TNRCC is the lead regulatory agency for activities to be conducted at the former and abandoned UST sites.

This SI has been designed to meet the requirements of guidance documents from the Air Force IRP, the EPA, TNRCC's RG-17 and RG-36, and RCRA. The WP for this project consists of the following documents:

> The Work Plan describes the work to be performed, explains project objectives, and presents the rationale for conducting specific project activities. This WP describes the site history and setting along with a summary of environmental investigations at the base. The site is described along with data needs and the proposed sampling program for the site. Technical reports and presentation formats are also discussed in this WP.
>
> The Sampling and Analysis Plan consists of a FSP and a QAPP.
>
> The Field Sampling Plan describes the planned field sampling procedures. Each method to be used is described in detail, including mobilization activities, environmental sampling procedures, record keeping procedures, and a field quality control program.
>
> The Quality Assurance Project Plan describes the field and analytical procedures that will be used to ensure quality control for the project. The QAPP provides the project organization responsibility and defines quality assurance objectives on a project-wide basis. Laboratory operating procedures are presented, including calibration, data management, validation, and reporting. Internal controls and procedures are also defined. This investigation will use the Final Basewide QAPP generated by HydroGeoLogic (1998).
>
> The Health and Safety Plan provides guidance and procedures to satisfy health and safety regulations. The HSP describes required monitoring, personal protection, and site safety protocols. Medical surveillance, site control, and emergency response procedures are also described. Potential health and safety risks for the investigation are identified.

2.4 PROJECT SITE CONTAMINATION HISTORY

Section 3.4 of the WP provides the history of environmental investigations conducted at each site and documents subsequent contamination.

3.0 PROJECT SCOPE AND OBJECTIVES

The following sections describe the objectives of the UST site investigation and the specific field activities that will be conducted to characterize each site.

3.1 OBJECTIVES

The data generated by this project must be of sufficient quality and quantity to support the overall project objective, which is closure of 12 USTs at various sites throughout the base. The objectives of this work are to better define the geologic and hydrogeologic regime beneath each site, and to determine if hazardous constituents have been released to the environment from the subject sites. If a release is confirmed, the investigation will continue in order to determine the nature and extent of the contamination.

Data from the following categories are required for this study:

- Site Characterization - Data will be used to evaluate physical and chemical properties of the soil and groundwater.

- Health and Safety - Data will be used to establish the level of protection needed for the work party and other site-related personnel. This data will be gathered by the use of organic vapor analyzers 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 Objective (DQO) Process for Superfund Interim Final Guidance (EPA/540/G-93/071, 1993) are described below:

- Screening Data with Definitive Confirmation - Screening data are generated by rapid, less precise methods of analysis with less rigorous sample preparation. Sample preparation steps may be restricted to simple procedures such as dilution with a solvent instead of elaborate extraction/digestion and cleanup. Screening data provides analyte identification and quantification. Although the quantification may be determined using analytical methods with QA and 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 analyses of samples must be sufficiently sensitive to allow comparison of the results to the TNRCC action levels listed in RG-17 and the TNRCC's Plan A Category I and II Target Concentrations listed in RG-36. These TNRCC action levels and Plan A target concentrations are presented in Tables 3.1 and 3.2 respectively. The Final Basewide QAPP (HydroGeoLogic, 1998) describes each analytical method that will be used as part of the investigation and outlines the QA measures that the contract laboratory must follow. The methods of analysis selected for samples collected from NAS Fort Worth JRB will produce screening as well as definitive data.

3.2 SAMPLE ANALYSIS SUMMARY

Samples collected as part of this FSP will be analyzed for volatile organic compounds (VOCs), total petroleum hydrocarbons (TPHs), and polynuclear aromatic hydrocarbons (PAHs). In accordance with the TNRCC RG-175, the following EPA methods will be used:

- SW8260B/5035 - VOCs
- 1005 - TPHs
- SW8310 - PAHs

All sites requiring benzene, toluene, ethylbenzene, and xylenes (BTEX) analyses by EPA Method 8020 in RG-175 will be analyzed for VOCs by EPA Method 8260B. For sites that dealt with waste oils, both VOC (Method 8240) and BTEX (Method 8020) analyses are required as per RG-175. Method 8240, which is now obsolete, provides only a total number for xylenes and does not differentiate between the various isomers of xylene, unlike Method 8260B, which quantifies each isomer of xylene. VOCs analysis by 8260B will also be substituted for BTEX at sites that dealt with fuels, such as diesel, gasoline, and jet fuel, because Method 8260B provides a lower detection limit for BTEX and methyl tert-butyl ether (MTBE), a common oxygenate of gasolines. These sites require BTEX analysis as per RG-175; however, VOC analysis by Method 8260B is more complete with lower detection limits.

According to TNRCC RG-175, total dissolved solids (TDS) are to be obtained during the sampling of each monitoring well to aide in determining which of the four beneficial use categories (RG-36) a site would fall into under a Plan A evaluation. HydroGeoLogic collected numerous TDS samples in May 1998, during field investigations of Area of Concern 4. These TDS concentrations ranged from 570 milligrams per liter (mg/L) to 910 mg/L, well below the Category I value of 3,000 mg/L stated in Table 1, Beneficial Groundwater Use Categories, RG-36. Given that TDS concentrations will be fairly constant throughout a site the size of NAS Fort Worth JRB, additional TDS samples are not warranted.

If Plan A target concentrations listed in RG-36 are exceeded, then the following analytical methods for soil will be analyzed for the purposes of monitoring the degradation rate of the fuel contamination by natural attenuation:

- Method SW9060A - total organic carbon (TOC) (soil only)
- Method SW-846 - Moisture

Tables 3.3 and 3.4 provide a summary of all soil and groundwater sample analyses proposed for this field investigation on a site by site basis. These tables also provide a breakout of the number and type of samples that are anticipated to be collected to ensure that proper QC is maintained.

3.3 FIELD ACTIVITIES

Field investigation activities will be conducted at each of the former/abandoned UST sites in order to achieve the project objectives presented in Section 1.5 of the WP. Table 3.5 provides a summary of the proposed field activities on a site by site basis. Details as to the justification for each sample to be collected are presented in Section 3.0 of the WP. Table 3.6 is a summary of the data quality levels and intended uses for data collected during the investigation.

3.3.1 Rationale

The majority of the USTs under investigation have been removed from the ground. The USTs were originally installed for several purposes, such as supplying diesel fuel for backup generators, providing temporary storage for liquid waste, and serving as storage tanks for jet fuel. The majority of the USTs have not been investigated since their removal, and the ones that were investigated were done so in an incomplete manner. The potential for human exposure in these areas is considered minimal due to their location and accessibility.

In order to delineate the extent of potential contamination, field investigations proposed for each site will vary in order to conform to the specific requirements of each former or abandoned UST. The field investigations for this project will include each of the following tasks:

- **UST 4136-1:** Conduct a soil gas survey, using carbonated soil gas samplers, in an effort to pinpoint the former UST excavation. Collect soil samples, using DPT, from the area surrounding the former UST excavation for comparison to the TNRCC action levels.

- **UST 1040-1 and UST 4115-1:** Collect soil samples, using DPT, from the area surrounding the former UST excavations from which no analytical data was found to be associated with the USTs for comparison to the TNRCC action levels.

- **UST 1191-1, UST 1427-1, UST 1750-1, and UST 1750-2:** Collect soil samples, using DPT, from the area surrounding the former UST excavations and abandoned UST to use in conjunction with the original analytical results for comparison to the TNRCC action levels.

- **UST 1411-1, UST 1411-2, and UST 1411-3:** Collect groundwater samples from the existing monitoring wells surrounding the former UST excavations to use in conjunction with the original analytical results for comparison to the TNRCC action levels.

- **UST GCA-1 and UST GCA-2:** Conduct a visual inspection to identify any surface features generally associated with a UST, such as depressions, stressed or dead vegetation, etc., and conduct a geophysical survey of the area using an EM system, in an effort to locate the abandoned USTs at the former ground control approach (GCA) sites. If the abandoned USTs are located, collect soil samples, using DPT, from the area surrounding the USTs for comparison to the TNRCC action levels.

If the analytical results of this investigation are below the TNRCC action levels for LPST sites, the former/abandoned UST sites will be recommended for closure without additional corrective action. In the event that the analytical results exceed the TNRCC action levels for LPST sites, a Plan A investigation will be proposed as outlined in Section 1.4.2 of the WP. The results of the entire investigation will be presented in an SI report with a discussion of any additional requirements for closure. Additional soil borings may be advanced, and additional or new monitoring wells may be installed and sampled to evaluate the extent of any contamination resulting from the USTs that exceeds the TNRCC action levels.

3.3.2 Soil Contamination Delineation

Soil samples will be collected using DPT methods with split spoon samplers. Three soil samples will be collected from each soil boring, a surface soil sample, a sample from the area above the water table that exhibits the greatest potential for contamination, and a sample from the unsaturated soil immediately above the water table. The location that exhibits the greatest potential for contamination is likely to be the depth corresponding to the bottom of the tank. Each soil boring will be sampled continuously and field screened with a photoionization detector (PID). Each interval will be logged according to American Society for Testing and Materials (ASTM) methods. Locations of the proposed investigations are illustrated in Figures 3.2 through 3.9b. Soil samples selected for chemical analysis will be analyzed for VOCs (8260B/5035), TPH (1005), and PAHs (8310) as stated in Section 3.2. All samples will be submitted to an analytical laboratory and analyzed in accordance with the Final Basewide QAPP (HydroGeoLogic, 1998).

The soil samples proposed for selected sites will be collected using DPT methods to either confirm or deny the presence of contamination. If contamination is present, DPT borings will be instrumental in delineating the vertical and aerial extent of contaminants that may have leaked or were the result of spills or overfills. At several of the sites, initial investigations have been conducted; however, these investigations either did not collect an adequate number of samples or did not delineate the extent of contamination. In these cases, additional borings will be installed to complement the initial investigation and to determine whether the site can be closed without further action. For sites that have not been investigated, DPT borings will be installed at the four sides and in the center of the former tank pit as accessibility permits.

3.3.3 Groundwater Contamination Delineation

Under this preliminary field effort, new monitoring wells will not be installed to investigate or delineate the extent of groundwater. However, existing monitoring wells at site 1411 will be sampled to complement the results of the initial soil investigation. In addition, existing monitoring wells may be sampled if soil contamination is detected above TNRCC action levels during the preliminary investigations of the other sites. During initial investigations, groundwater samples were collected from the base of the excavation during the removal of UST 1750-1, and from monitoring wells in the immediate areas of USTs 1191-1 and 1427-1. These wells, in addition to several others, may be re-sampled if contamination in the surrounding soils exceeds the TNRCC action levels shown in Table 3.1. If contamination in the soils surrounding the other UST sites exceeds TNRCC action levels, then existing monitoring wells may be sampled and new monitoring wells may be installed and sampled during a second field effort.

3.4 PROPOSED INVESTIGATION

The following sections describe the proposed field activities to be conducted at each site. Figure 3.1 illustrates the locations of each of the 12 USTs.

3.4.1 UST 1040-1

The proposed method of site characterization for UST 1040-1 includes the advancement of four soil borings, as accessibility permits, in and around the location of the former UST excavation. Locations of the proposed soil borings are illustrated in Figure 3.2. An initial soil boring will be advanced at the UST site in the approximate center of the former tank pit in order to determine the depth of the excavation. The additional three soil borings will be advanced along each exposed side of the former excavation. Each soil boring will be advanced to the water table for soil characterization and contaminant delineation.

Three soil samples will be collected from each soil boring. These samples include one sample at the surface, one sample in the area above the water table that exhibits the greatest potential for contamination, and one sample in the unsaturated soil immediately above the water table. Each soil boring will be sampled continuously and field screened with a PID. Each interval will be logged according to ASTM methods. Soil samples selected for chemical analysis will be analyzed for VOCs (8260B/5035), TPH (1005), and PAHs (8310) in accordance with TNRCC RG-175. All samples will be submitted to an analytical laboratory and analyzed in accordance with the Final Basewide QAPP requirements (HydroGeoLogic, 1998). If a particular analyte exceeds its TNRCC action level, the site will be investigated under a Plan A evaluation as per Section 1.4.2 of the WP.

The analytical results obtained from samples collected at the proposed soil borings are intended to determine whether any release from the subject UST has impacted the soil surrounding the site. A summary of proposed sampling and analysis activities is presented in Tables 3.3 and 3.4.

If necessary, additional soil borings may be installed to delineate the extent of any contamination originating from the UST if the proposed soil borings identify any contamination above TNRCC action levels. In addition, the existing monitoring well may be sampled and/or new monitoring wells may be installed and sampled if contamination levels warrant a Plan A investigation.

3.4.2 UST 1191-1

A preliminary site investigation will be conducted to determine what further action, if any, needs to be conducted at UST 1191-1 in order to obtain closure from the TNRCC. Four soil borings will be advanced around the former UST location in order to determine if a release has occurred. The initial soil boring will be advanced in the approximate center of the former tank pit in order to determine the depth of the excavation. The remaining three soil borings will be advanced on the north, east, and south sides of the former excavation. SB119104 will suffice as an existing soil boring along the western wall of the excavation since no organic compounds were detected in the initial sampling event. Each soil boring will be sampled continually to the water table and field screened with a PID. Each interval will be logged according to ASTM methods. Locations of the proposed soil borings are depicted in Figure 3.3.

Three soil samples will be collected from each soil boring. These samples include one sample at the surface, one sample in the area above the water table that exhibits the greatest potential for contamination, and one sample in the unsaturated soil immediately above the water table. Soil samples selected for chemical analysis will be analyzed for VOCs (8260B/5035), TPH (1005), and PAHs (8310) in accordance with TNRCC RG-175. All samples will be submitted to an analytical laboratory and analyzed in accordance with the Final Basewide QAPP (HydroGeoLogic, 1998). If a particular analyte exceeds its TNRCC action level, then the site will be investigated under a Plan A evaluation as per Section 1.4.2 of this WP.

The analytical results obtained from samples collected at the proposed soil borings are intended to determine whether the contamination identified in the investigation of the nearby oil/water separator (OWS) is associated with any release from the subject UST. Results of this investigation are discussed in detail in Section 3.4.2.1 of the WP. In addition, the analytical results obtained from samples collected from the proposed soil borings are intended to determine whether a release from UST 1191-1 has impacted the soil surrounding the site. A summary of proposed sampling and analysis activities is presented in Tables 3.3 and 3.4.

If necessary, additional soil borings may be installed to delineate the extent of contamination originating from the UST if the proposed soil borings identify any contamination above TNRCC action levels. In addition, the existing monitoring well may be sampled or additional monitoring wells may be installed and sampled if contamination levels warrant a Plan A investigation.

3.4.3 USTs 1411-1, 1411-2, and 1411-3

A preliminary site investigation will be conducted to determine what further action, if any, needs to be conducted at USTs 1411-1, 1411-2, and 1411-3 in order to obtain closure from the TNRCC. Groundwater samples will be collected from the five existing monitoring wells at the site, MW-38, MW-39, MW-40, MW-41, and MW-42. The monitoring well locations are presented in Figure 3.4.

Groundwater samples will be analyzed for VOCs (8260B/5035), TPH (1005), and PAHs (8310) in accordance with TNRCC RG-175. All samples will be submitted to an analytical laboratory and analyzed in accordance with the Final Basewide QAPP requirements (HydroGeoLogic, 1998).

If a particular analyte exceeds its TNRCC action level, then the site will be investigated under a Plan A evaluation as per Section 1.4.2 of the WP.

The analytical results obtained from samples collected at the existing monitoring wells are intended to determine whether the contamination found during the removal efforts of the USTs has had an impact on the groundwater beneath the site. Results of the removal investigation are discussed in detail in Section 3.4.3.1 of the WP. A summary of proposed sampling and analysis activities is presented in Tables 3.3 and 3.4.

If necessary, additional soil borings may be installed to delineate the extent of contamination originating from the USTs if the groundwater samples identify any contamination above TNRCC action levels, and additional monitoring wells may be installed and sampled if contamination levels warrant a Plan A investigation.

3.4.4 UST 1427-1

A preliminary site investigation will be conducted to determine what further action, if any, needs to be conducted at UST 1427-1 in order to seek closure with the TNRCC. In order to determine if there had been a release from the UST, one initial soil boring will be advanced at the UST site in the approximate center of the former tank pit in order to determine the depth of the original excavation. Four additional soil borings will be advanced, one along each of the four sides of the excavation. Each soil boring will be sampled continually for lithologic characterization according to ASTM methods. Each soil sample will also be field screened using a PID to determine the volatile organic concentration. Locations of the proposed soil borings are depicted in Figure 3.5.

Three soil samples will be collected from each soil boring. These samples include one sample at the surface, one sample in the area above the water table that exhibits the greatest potential for contamination, and one sample in the unsaturated soil immediately above the water table. Soil samples selected for chemical analysis will be analyzed for VOCs (8260B/5035), TPH (1005), and PAHs (8310) in accordance with TNRCC RG-175. All samples will be submitted to an analytical laboratory and analyzed in accordance with the Final Basewide QAPP requirements (HydroGeoLogic, 1998). If a particular analyte exceeds its TNRCC action level, then the site will be investigated under a Plan A evaluation as per Section 1.4.2 of the WP.

The analytical results obtained from samples collected at the proposed soil borings are intended to determine whether the contamination found during the removal efforts of the UST has had an impact on the soil surrounding the site. Results of the removal investigation are discussed in detail in Section 3.4.4.1 of the WP. A summary of proposed sampling and analysis activities is presented in Tables 3.3 and 3.4.

If necessary, additional soil borings may be installed to delineate the extent of any contamination originating from the UST if the proposed soil borings identify any contamination above TNRCC action levels. In addition, the existing monitoring well may be sampled or new monitoring wells may be installed and sampled if contamination levels warrant a Plan A investigation.

3.4.5 USTs 1750-1 and 1750-2

A preliminary site investigation will be conducted to determine what further action, if any, needs to be conducted at USTs 1750-1 and 1750-2 in order to obtain closure from the TNRCC. In order to determine if either UST has leaked in the past, a total of six soil borings will be installed around the tanks. One soil boring will be advanced in the center of the former UST 1750-1 excavation in order to supplement the results of the previous investigation and one soil boring will be advanced in the area of the former fuel and supply lines. The remaining four soil borings will be advanced along each side of the abandoned UST 1750-2. All soil borings will be advanced to the water table and sampled continually for lithologic characterization according to ASTM methods. Each soil sample will also be field screened using a PID to determine the volatile organic concentration. Locations of the proposed soil borings are depicted in Figure 3.6.

Three soil samples will be collected from each soil boring. These samples include one sample at the surface, one sample in the area above the water table that exhibits the greatest potential for contamination, and one sample in the unsaturated soil immediately above the water table. Soil samples selected for chemical analysis will be analyzed for VOCs (8260B/5035), TPH (1005), and PAHs (8310) in accordance with TNRCC RG-175. All samples will be submitted to an analytical laboratory and analyzed in accordance with the Final Basewide QAPP requirements (HydroGeoLogic, 1998). If a particular analyte exceeds its TNRCC action level, then the site will be investigated under a Plan A evaluation as per Section 1.4.2 of the WP.

The analytical results obtained from samples collected from the proposed soil borings are intended to determine whether the contamination found during the previous investigation of UST 1750-1 has had an impact on the soil surrounding the site. Results of the removal investigation are discussed in detail in Section 3.4.5.1 of the WP. A summary of proposed sampling and analysis activities is presented in Tables 3.3 and 3.4.

If necessary, additional soil borings may be installed to delineate the extent of any contamination from either UST if the proposed soil borings identify any contamination above TNRCC action levels. In addition, monitoring wells may be installed and sampled if contamination levels warrant a Plan A investigation.

3.4.6 UST 4115-1

A preliminary site investigation will be conducted to determine what action, if any, needs to be conducted at UST 4115-1 in order to obtain closure with TNRCC. An initial soil boring will be advanced in the approximate center of the former UST location in order to determine the depth of the original excavation. Four additional soil borings will be advanced adjacent to the four sides of the former tank pit. Each soil boring will be sampled continually for lithologic characterization according to ASTM methods. Each soil sample will also be field screened using a PID to determine the volatile organic concentration. Locations of the proposed soil borings are depicted in Figure 3.7.

Three soil samples will be collected from each soil boring. These samples include one sample at the surface, one sample in the area above the water table that exhibits the greatest potential for contamination, and one sample in the unsaturated soil immediately above the water table. Soil samples selected for chemical analysis will be analyzed for VOCs (8260B/5035), TPH (418.1/1005), and PAHs (8310) in accordance with TNRCC RG-175. All samples will be submitted to an analytical laboratory and analyzed in accordance with the Final Basewide QAPP requirements (HydroGeoLogic, 1998). If a particular analyte exceeds its TNRCC action level, then the site will be investigated under a Plan A evaluation as per Section 1.4.2 of the WP.

The analytical results obtained from samples collected at the proposed soil borings are intended to determine if any contamination found is associated with a release from the subject UST. A summary of proposed sampling and analysis activities is presented in Tables 3.3 and 3.4.

If necessary, additional soil borings may be installed to delineate the extent of any contamination from the UST if the proposed soil borings identify any contamination above TNRCC action levels. In addition, monitoring wells may be installed and sampled if contamination levels warrant a Plan A investigation.

3.4.7 UST 4136-1

A preliminary site investigation will be conducted to determine both the exact location of the former UST excavation, and what further action, if any, needs to be conducted at UST 4136-1 in order to obtain closure from the TNRCC. A soil gas survey will be used to determine the location of the former UST. A 30- by 20-foot grid will be marked at the site using a tape measure for distance and a transit for trueness. Survey lines will be placed every 10 feet; however, grid points will be marked with pin flags or fluorescent color paint at a spacing of 10 feet. Several wooden stakes will be placed as temporary markers to locate the grid for future reference. The location and elevation of the wooden stakes will be surveyed and correlated to existing coordinate systems. In addition, a detailed sketch of surface features will be drawn in the field to facilitate the soil gas survey interpretation.

A total of eight carbonated soil gas samplers will be inserted into the soil at locations both around the perimeter and in the center of the grid. These soil gas sample locations are presented in Figure 3.8. The soil gas samplers will be installed in shallow boreholes below the surface (i.e., to a measured depth of 6 inches or less, or deep enough to protect the sampler from being broken by surface activities), exposing the collector to the soil gas of the subsurface environment. Results from these soil-gas probes are intended to establish the location of the former UST excavation and pinpoint the placement of the soil boring locations during the UST investigation. If the results of the soil-gas probes determine the location of the former UST, a total of five soil borings will be advanced, one in the center and one along each side of the former UST excavation. If the results from the soil-gas probes do not determine the location of the UST excavation, the number of soil borings may increase to a total of 12 soil borings—1 soil boring every 10 feet within the

30- by 20-foot grid— in order to fully characterize the area in which the former UST was most likely to have been located[1].

Each soil boring will be advanced to the top of the water table, sampled continuously for lithologic characterization according to ASTM methods, and field screened using a PID to determine the volatile organic concentration. The proposed soil gas sampler and soil boring locations are depicted in Figure 3.8.

Three soil samples will be collected from each soil boring. These samples include one at the surface, one sample in the area above the water table that exhibits the greatest potential for contamination, and one sample in the unsaturated soil immediately above the water table. Soil samples selected for chemical analysis will be analyzed for VOCs (8260B/5035), TPH (1005), and PAHs (8310) in accordance with TNRCC RG-175. All samples will be submitted to an analytical laboratory in accordance with the Final Basewide QAPP requirements (HydroGeoLogic, 1998). If a particular analyte exceeds its TNRCC action level, then the site will be investigated under a Plan A evaluation as per Section 1.4.2 of the WP.

The analytical results obtained from samples collected at the proposed soil borings are intended to determine if any contamination found is associated with a release from the subject UST. A summary of proposed sampling and analysis activities is presented in Tables 3.3 and 3.4.

If necessary, additional soil borings may be installed to delineate the extent of any contamination from the UST if the proposed soil borings identify any contamination above TNRCC action levels. In addition, monitoring wells may be installed and sampled if contamination levels warrant a Plan A investigation.

3.4.8 USTs GCA-1 and GCA-2

A preliminary site investigation will be conducted to determine both the exact locations of the abandoned USTs, and what further action, if any, needs to be conducted at GCA-1 and GCA-2 in order to obtain closure from the TNRCC. A time domain metal detection survey utilizing a Geonics EM61 will be performed at both GCA sites in order to determine the possible locations of GCA-1 and GCA-2. Figures 3.9a and 3.9b illustrate the approximate locations and the spatial orientations of the grids to be surveyed. A 240-foot by 240-foot grid is proposed at each site with the intention of encompassing the suspected USTs. The grid locations are based on the existing structures at each site, and supported by a review of aerial photographs. However, each grids' location, orientation, spacing, and size may be modified based on field observations, such as surface depressions or variations in vegetation.

A systematic grid, typically oriented approximately north-south, will be established at each site using a tape measure for distance and a transit for trueness. Grid lines will be spaced every 10

[1] Due to the absence of installation/removal records, and the replacement of the former structures with new grading and new buildings, the exact location of the former UST was not determined. As a result, the 12 proposed soil borings have been proposed in a grid formation in order to adequately cover the area where the UST was most likely to have existed.

feet; however, grid points will be marked with pin flags or fluorescent paint at a spacing of 40 feet. Wooden stakes will be placed as temporary location markers to locate the grid for future reference. The location and elevation of the wooden stakes will be surveyed and correlated to existing coordinate systems. A sketch of surface features will be drawn in the field to facilitate the geophysical interpretation.

The survey procedure will consist of carrying the instrument along survey lines to effectively provide a 5-foot line spacing. Data will be digitally recorded approximately every foot along lines except were prevented by obstructions. The geophysical data will be downloaded and evaluated in the field for data quality, and to make preliminary interpretations. The results will be gridded and contoured, and displayed as contour maps and 3-dimensional mesh diagrams to identify anomalous areas. Descriptions of the instruments used, methods of data collection, and interpretation will be provided in a separate report discussing the geophysical survey.

If anomalies indicating USTs or associated piping are not located during the geophysical survey, they will be designated as non-existent tanks, and a letter will be submitted to the TNRCC outlining the steps taken to reach this determination. If the abandoned USTs are located at either GCA site, then a preliminary site investigation will be conducted to determine what further action, if any, needs to be taken at the abandoned USTs in order to obtain closure from the TNRCC. A total of eight soil borings will be advanced, one along each side of each abandoned UST. Each soil boring will be drilled to the top of the water table, sampled continuously for lithologic characterization according to ASTM methods, and field screened using a PID to determine the volatile organic concentration.

Three soil samples will be collected from each soil boring. These samples include one at the surface, one sample in the area above the water table that exhibits the greatest potential for contamination, and one sample in the unsaturated soil immediately above the water table. Soil samples selected for chemical analysis will be analyzed for VOCs (8260B/5035), TPH (1005), and PAHs (8310) in accordance with TNRCC RG-175. All samples will be submitted to an analytical laboratory in accordance with the Final Basewide QAPP requirements (HydroGeoLogic, 1998). If a particular analyte exceeds its TNRCC action level, then the site will be investigated under a Plan A evaluation as per Section 1.4.2 of the WP.

The analytical results obtained from samples collected at the proposed soil borings are intended to determine if any contamination found is associated with a release from the subject USTs. A summary of proposed sampling and analysis activities is presented in Tables 3.3 and 3.4.

If necessary, additional soil borings may be installed to delineate the extent of any contamination from the USTs if the proposed soil borings identify any contamination above TNRCC action levels. In addition, monitoring wells may be installed and sampled if contamination levels warrant a Plan A investigation.

4.0 PROJECT ORGANIZATION AND RESPONSIBILITY

Table 4.1 lists key project personnel and their respective telephone numbers. Figure 4.1 shows the project organization, reporting relationships, and line authority. 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 WP, QAPP, FSP, and HSP
- Providing sufficient resources to the project team so that it can respond fully to the requirements of the investigation
- Providing direction and guidance to the Project Manager
- Reviewing the final project report
- Providing other responsibilities as requested by the Project Manager

4.1.2 Project Manager

The Project Manager will be the prime point of contact (POC) with AFCEE and will have primary responsibility for technical, budget, and scheduling matters. The Project Manager's responsibilities include the following:

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

- Ensuring 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 the following:

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

4.2.2 Health and Safety Coordinator

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

- 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 Project Manager will report directly to HydroGeoLogic's Project Manager 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 Operation Manager will report to the Laboratory Project Manager and will be responsible for the following:

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

4.3.3 Laboratory QA Officer

The Laboratory QA Officer has the overall responsibility for data after it leaves the laboratory. The Laboratory QA Officer will be independent of the laboratory but will communicate data issues through the Laboratory Project Manager. In addition, the Laboratory 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 data review
- Determine whether to implement laboratory corrective actions, if required
- Define appropriate laboratory QA procedures

- Prepare laboratory standard operation procedures

4.3.4 Laboratory Sample Custodian

The Laboratory Sample Custodian will report to the Laboratory Operations Manager. Responsibilities of the Laboratory Sample Custodian will include the following:

- Receiving and inspecting the incoming sample containers
- Recording the condition of the incoming sample containers
- Signing appropriate documents
- Verifying chain of custody and its correctness
- Notifying the Laboratory Project Manager and the Laboratory Operations Manager 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 laboratory 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 the following:

- Providing orientation and any necessary training to field personnel (including subcontractors) on the requirements of the FSP, HSP, and QAPP before the start of work
- Providing direction and supervision to the sampling crews
- Monitoring sampling operations to ensure that the sampling team members adhere to the QAPP and FSP
- Ensuring the use of calibrated measurement and test equipment
- Maintaining a field records management system

- Coordinating activities with the Project Manager
- Supervising geological data interpretation activities
- Overseeing field data documentation and conducting quality checks on interpretive geologic work products
- Reviewing reports for compliance with state of Texas and EPA requirements
- Assuming the duties of the HSC at the direction of the HSC

4.5 SUBCONTRACTORS

Subcontractors will be used for the installation of the DPT of soil borings and monitoring well installation during the field investigation. In addition, laboratory analyses of all samples collected during the investigation will also be subcontracted to an analytical laboratory.

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

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 AFCEE POC at the base will be Mr. Michael Dodyk. HydroGeoLogic's Project Geologist/Field Coordinator will be determined prior to mobilization.

5.1 GEOLOGIC STANDARDS

The lithologic descriptions for consolidated materials, which include igneous, metamorphic, and sedimentary rocks, will follow the standard professional nomenclature (Tennissen, 1983), with special attention given to describing fractures, vugs, solution cavities and their fillings or coatings, and any other characteristics affecting permeability. Color descriptions will be designated in the soil boring logs (Appendix A) using the Munsell Color System.

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

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

The scales for maps, cross sections, or 3-D diagrams will be selected in accordance with the geologic and hydrologic complexity of the area and the purposes of the illustrations. If field activities reveal inconsistencies with current maps, the maps will be redrawn to show the inconsistencies using the current standards presented in the attached maps and figures.

Cross sections will depict north toward the viewer's right side. Thus, if the line of cross section is predominantly east-west, the eastern end will be on the right side. Maps shall be oriented with north toward the top, unless the shape of the area dictates otherwise.

5.2 SITE RECONNAISSANCE, PREPARATION, AND RESTORATION PROCEDURES

Areas designated for intrusive sampling will be surveyed for the presence of underground utilities. Utility locations will be determined using existing utility maps and field verified using a hand-held magnetometer or utility probe. Prior to commencement of drilling activities, digging permits will be obtained through Mr. Dodyk of HQ AFCEE Environmental Restoration Division (ERD), currently located at 6560 White Settlement Road, NAS Fort Worth JRB. The base civil engineer will be contacted to verify that the selected locations are free of underground utilities. Those locations not clear of underground utilities will be relocated to achieve clearance, and then verified for clearance a second time. Vehicle access routes to sampling locations will be determined prior to commencing any field activity.

A centralized decontamination area will be provided for drilling rigs and equipment. The decontamination area will be large enough to allow storage of cleaned equipment and materials prior to use, as well as to stage drums containing decontamination waste. The decontamination area will be lined with a heavy-gauge plastic sheeting and designed with a collection system to capture decontamination waters. Solid wastes will be accumulated in United Nations-approved 55-gallon drums and subsequently transported to a waste storage area designated by the Air Force. Smaller decontamination areas for personnel and portable equipment will be provided as necessary. These locations will include basins or tubs to capture decontamination fluids, which will be transferred to a large accumulation tank as necessary. The designated decontamination areas will be determined during the pre-construction meeting. The field office and the primary staging area (Figure 3.1) for field equipment and supplies will be located in the building adjacent to the west side of the former Air Force Base Conversion Agency (AFBCA) office at 6560 White Settlement Road, NAS Fort Worth JRB, Texas.

Each work site or sampling location will be returned to its original condition when possible. Efforts will 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 will be removed. Decontamination and/or purge water and soil cuttings will be transported to the designated locations as described in Section 5.7. At the completion of field activities, all capital equipment and consumable materials will be removed or turned over to base personnel in accordance with AFCEE procedures. A final site walk will be conducted with the base representative, at his/her discretion, to ensure that all sampling locations have been restored satisfactorily before final demobilization from the site.

5.3 GEOPHYSICAL SURVEYS

5.3.1 General Requirements for Geophysical Surveys

A geophysical survey is proposed for this investigation to confirm the presence or absence of two abandoned steel USTs. The Geonics EM61 is a time domain metal detector that detects both ferrous and non-ferrous metals. The response to an isolated buried metal object is a quick, sharply-defined peak, facilitating quick and accurate location of the object. In addition, the EM61 is relatively insensitive to nearby cultural interferences such as fences, buildings, and power lines although if present, such objects could still obscure an UST. Consequently, the EM61 is ideal for confirming the presence or absence of the abandoned USTs.

5.3.2 Electromagnetic Methods

A systematic grid, 240-foot by 240-foot, typically oriented approximately north-south, will be established at each suspected UST site using a tape measure for distance and a transit for trueness.

The grid location is based on the location of existing structures, and will be supplemented by a review of available aerial photographs. The grid location, orientation, and size may be modified based on field observations, such as surface depressions or variations in vegetation. Grid lines will be spaced every 10 feet; however, grid points will be marked with pin flags or fluorescent paint at a spacing of 40 feet. Wooden stakes will be placed as temporary location markers to locate the grid for future reference. The location and elevation of the wooden stakes will be surveyed and correlated to existing coordinate systems, and a sketch of surface features will be drawn in the field to facilitate the geophysical interpretation.

The survey procedure will consist of carrying the instrument along lines to effectively provide a 5-foot line spacing. Data will be digitally recorded approximately every foot along lines except where prevented by obstructions. The geophysical data will be downloaded and evaluated in the field for data quality, and to make preliminary interpretations. The results will be gridded and contoured, and displayed as contour maps and 3-dimensional mesh diagrams to identify anomalous areas. Descriptions of the instruments used, methods of data collection, and interpretation will be provided in a separate report discussing the geophysical survey.

5.4 SOIL GAS SURVEYS

The primary function of soil gas surveys are to assist in identifying potential source areas for soil and groundwater contamination. Soil gas surveys will be used during this investigation to help target soil boring and possible monitoring well locations within a small source area. The proposed soil gas sampling network is designed to obtain preliminary information with minimal expenditure of time and resources. The development of the sampling network has been based on background information, leading to the approximate location of a former UST location.

The proposed soil gas sampling scheme is based on a grid consisting of sampling points placed at equal distances along perpendicular lines. The selection of the sampling scheme is presented in Section 3.4.7 of this FSP. This transect line sampling network will be used to find a source area of contamination. The sample points are selected at points both around the perimeter and within the center of the grid in order to adequately encompass the area where a former UST had been located. This system was proposed since little information regarding this site is available. Based on visual interpretation of the site, additional sampling points may be placed near a suspected source of contamination in order to locate "hot spots" and further delineate the source of the contamination.

5.4.1 Sampler Installation

The soil gas samplers will be installed in shallow boreholes below the surface (e.g., a measured depth of 6 inches or less, or deep enough to protect the sampler from being broken by surface activities), exposing the collector to the soil gas of the subsurface environment. To insert each sampler, a hole less than 4 cm in diameter is advanced to the required depth using a stainless steel scoop or trowel. The sampler cap is removed and the sampler is placed, open end down, at the bottom of the hole. Soil from the core or cuttings will be placed back into the hole on top of the sampler. If grass is present at the surface, the sod plug is first removed and then re-installed to hide the sampler. The sampler's location is then marked with a pin flag and noted in the field logbook. The samplers will be retrieved after an elapsed time period has allowed the soil gas to emanate from the subsurface environment of the survey area to equilibrate with the installed samplers. The time integration period is determined for each soil gas survey on a site specific basis, but is generally based on the type of site conditions and the nature of the target compounds.

5.4.2 Sampler Retrieval

Following a controlled period of time, each sampler will be retrieved from its borehole, resealed, and submitted to an analytical laboratory for analysis. Typical exposure conditions using soil gas samplers are as follows:

- USTs, surface contamination — 24 hours - 3 days
- Soil or shallow groundwater (≤ 10 m) — 3 - 7 days
- deep ground water (≥ 10 m) — 7 - 30 days

Samplers are retrieved in the same order in which they were installed to minimize any variation based upon sample exposure time. The soil gas samplers are retrieved by opening the top of the hole (either by removing the grass plug or the soil) and lifting the sampler just out of the hole. The lip of the vial will be cleaned using a soft cloth, and a cap, with the septum firmly in place, will be immediately sealed on the vial. The septum must be firmly placed in the cap before sealing. The sampler vial will be numbered in accordance with a sample location map, placed back into the packaging in which it was sent, and wrapped carefully for transfer to the laboratory for analysis. All samplers will be shipped via overnight courier to minimize exposure.

5.5 BOREHOLE DRILLING, LITHOLOGIC SAMPLING, LOGGING, AND ABANDONMENT

5.5.1 General Drilling Procedures

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

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

The drilling rig will be cleaned and decontaminated in accordance with the procedures outlined in Section 5.7. The drilling rig shall not leak any fluids that may enter the borehole or contaminate equipment placed in the hole. The use of rags or absorbent materials to absorb leaking fluids is unacceptable and will not be permitted.

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

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.

5.5.2 Sampling and Logging

The lithology in all boreholes will be logged. The boring log form (Appendix A) 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; and sample description.

Unconsolidated samples for lithologic description will be obtained continually using split spoon samplers and standard penetration test methods. Lithologic descriptions of unconsolidated materials encountered in the boreholes will generally be described in accordance with ASTM D-2488-90 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) (ASTM, 1990). Descriptive information to be recorded in the field will include: (1) identification of the predominant particle 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 will include: (1) color using the 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 generally will be described in accordance with Section 5.1. Consolidated samples for lithologic description will be obtained continuously at 2-foot intervals using split spoon samplers and standard penetration test methods. All samples will be monitored with an organic vapor monitor (e.g., PID). Samples will be handled in such a way as to minimize the loss of volatiles. These procedures are described in Section 6.0. Cuttings will be examined for hazardous characteristics. Materials suspected to be hazardous because of abnormal color, odor, or organic vapor monitor readings will be containerized in conformance with RCRA, state, and local requirements.

5.5.3 Abandonment

Boreholes will be abandoned in accordance with 30 Texas Administrative Code (TAC) Chapter 238, Water Well Driller Rules (TNRCC, 1997). Because the borings to be constructed will not exceed 100 feet, borings that are abandoned will be plugged to a depth not exceeding 2 feet below ground surface with a solid column of either cement or 3/8-inch or larger granular sodium bentonite. The granular bentonite will be hydrated at frequent intervals while strictly adhering to the manufacturer's specifications. The top 2 feet of each boring will be filled with cement as an atmospheric barrier (TNRCC, 1997).

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

5.6 SURVEYING

All surveying locations of field activities will be measured by a state of Texas-certified land surveyor as the distance in feet from a reference location that is tied to the state plane system. The surveys will be third order (Urquhart, 1962). An XY-coordinate system will be used to identify locations. The X-coordinate will be the east-west axis; the Y-coordinate will be the north-south axis; the reference location will be the origin. All surveyed locations will be reported using the state plane coordinate system. The surveyed control information for all data collection points will be recorded and displayed in a table. The table will give the X and Y coordinates in state plane coordinate values, the ground elevation, and the measuring point elevation if the location is a groundwater monitoring well. The elevation of all newly installed wells and piezometers will be surveyed at the water level measuring point (notch) on the riser pipe. The elevation of the ground surface at each water level measuring point will be included in the survey.

The X-Y coordinates for each sample location will be determined to within 0.1 feet and referenced to the state plane coordinate system. Vertical control will be to the National Geodetic Vertical Datum and will be within 0.01 feet for all sampling locations. All monitoring wells will be resurveyed at a minimum of every 5 years, with the approval of AFCEE.

5.7 EQUIPMENT DECONTAMINATION

All equipment that may directly or indirectly contact samples will be decontaminated in a designated decontamination area. This includes steel casings, drill points, the portions of drilling 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, pipes and rods, and those portions of the drilling rig that may stand directly over a boring or well location or that come into contact with casings, auger flights, pipes, or rods. The external surfaces of equipment will be washed with hot water under high pressure 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 casings, drill rods, and auger flights will also be washed as described.

The following procedure will be used to decontaminate sampling and drilling devices such as split spoons, bailers, and augers that can be hand manipulated. For sampling and smaller drilling devices, the equipment will be scrubbed with a solution of potable water and Alconox™, or equivalent laboratory-grade detergent. The equipment will then be rinsed with copious quantities of potable water followed by a rinse with ASTM Type II reagent-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 be air dried on a clean surface or rack, and, if the sampling device will not be used immediately after being decontaminated, it will be wrapped in oil-free aluminum foil, or placed in a closed stainless steel, glass, or Teflon® container.

Type II reagent-grade 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 ensure that these materials remain free of contaminants. If any question of purity exists, new materials will be used.

All fluids generated during decontamination activities will be placed in 55-gallon drums or a larger accumulation tank as specified. Each container will be properly labeled as to content and will be staged in a central location designated by the base representative for temporary storage pending removal and disposal.

5.8 WASTE HANDLING

Waste handling will be dealt with on a site by site basis. Waste will be classified as either non-investigative waste or investigative waste per the requirements of 30 TAC §335, Subchapter R and 40 CFR Part 261, Subpart C.

Non-investigative 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 containing investigative derived waste (IDW) 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 or not matrix is considered hazardous.

Characterization of IDW will be based on samples obtained during the field investigation and analyzed using EPA-approved methods. Hazardous waste classification will be determined as per 40 CFR §261.2, §261.3, or §261.4. Waste that is determined to be nonhazardous will then be classified as Class 1, Class 2, or Class 3 according to 30 TAC §§335.505 through 335.507. Once the IDW has been characterized, an eight-digit waste code number will be provided as required in 30 TAC §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 marking may be required. The number of containers will be estimated on an as-needed basis. The containers will be sealed and transported in such a manner to prevent spillage or particulate loss to the atmosphere.

Drums containing IDW will be segregated at the site according to matrix (solid or liquid) and according to the method by which it was obtained (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. Soil cuttings will be placed in 55-gallon steel open-top drums with lids. Development and purge waters evacuated from groundwater monitoring wells, and all fluids generated during decontamination activities will be placed in 55-gallon steel drums. Drums will be properly labeled with the appropriate boring or well number, and content, and will be staged in a central location designated by the base representative for temporary storage pending removal and disposal.

5.9 HYDROGEOLOGICAL CONCEPTUAL MODEL

The Project Geologist or engineer will develop a base and site geological and hydrological conceptual model from pre-existing U.S. Geological Survey, regional, state, and local studies and information developed during the project. Maps and cross sections will be used to depict the conceptual model. The model will be the basis for evaluating monitoring well and piezometer locations, and contaminant distribution (plume delineation).

The conceptual model will consider stratigraphy, geological structure, aquifer homogeneity or heterogeneity, hydraulic conductivity, transmissivity, storativity, and effective porosity. As applicable, the model will consider leakage, dispersivity, and attenuation. In addition, the Project Geologist will evaluate the reliability of predictions resulting from use of the model. Reliability will be based on sufficiency and representativeness of field data.

5.10 CORRECTIVE ACTION

The data gathered from the field investigations will be used to determine what corrective action will be required. This work is being done to satisfy state of Texas requirements for site characterization at former UST sites as set forth in TNRCC RG-17 and RG-36.

6.0 ENVIRONMENTAL SAMPLING

6.1 SAMPLING PROCEDURES

All purging and sampling equipment will be decontaminated according to the specifications in Section 5.7 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, polyvinyl chloride, metal) discussed below will be appropriate for the contaminant of concern and shall not interfere with the chemical analyses being performed.

6.1.1 Groundwater Sampling

The need for groundwater sampling will be determined on a site by site basis. A description of site-specific groundwater sampling requirements is included in Section 3.0 of the WP. A description of general field procedures for groundwater sampling is presented in the following sections.

6.1.1.1 Monitoring Well Sampling

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

Before groundwater sampling begins, wells will be inspected for signs of tampering or other damage. If tampering is suspected (i.e., casing is damaged, lock or cap is missing), this 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 of having been tampered with will not be sampled until the Project Geologist/field coordinator has discussed the matter with the Project Manager.

Before the start of sampling activities, any down-hole equipment (i.e., pumps, bailers, etc.) will be removed and placed on plastic sheeting on the ground around the well. The plastic sheeting will be used to provide a clean working area around the well head and prevent any soil contaminants from contacting sampling equipment. Water will be removed from the protective casing, or from the vaults around the well casing, prior to venting and purging. Every time a casing cap is removed to measure water level or collect a sample, the air in the breathing zone will be checked with an organic vapor meter. Procedures in the HSP will be followed when high concentrations of organic vapors are detected. Air monitoring data will be recorded on the Field Sampling Report Form.

Purge pump intakes will be equipped with a positive foot check valve to prevent purged water from flowing back into the well. Purging and sampling will be performed in a manner that minimizes aeration in the well bore and the agitation of sediments in the well and formation.

Equipment will not be allowed to free-fall into a well. In addition to the information required in Section 7.0, the following information will be recorded each time a well is purged and sampled: (1) depth to water before and after purging; (2) well bore volume calculation; (3) sounded total depth of the monitoring well; (4) the condition of each well, including visual (mirror) survey; (5) the thickness of any light non-aqueous phase liquid (LNAPL) or dense non-aqueous phase liquid (DNAPL) layer; and (6) field parameters, such as pH, temperature, electrical conductivity (EC), dissolved oxygen (DO), oxidation-reduction potential (ORP), ferrous iron (Fe^{2+}), and turbidity. This information will be encoded in IRP Information Management System (IRPIMS) files when required. In order to ensure that the most current techniques are employed for low flow purging and sampling, recommendations as outlined in the EPA (1996) research paper entitled "Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures" have been adapted where practical to augment current AFCEE procedures.

6.1.1.1.1 Water Level and LNAPL/DNAPL Thickness Measurement

An interface probe will be used to determine the presence or absence of a LNAPL layer in the well. The probe will then be slowly lowered to the free product groundwater interface in order to minimize disturbance to the water surface within the casing. The groundwater level will then be measured to the nearest 0.01. Water levels will be measured from the notch located at the top of each 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. For wells that are suspected of containing separate phase DNAPLs, the interface probe will be lowered to the bottom of the well before purging to gauge the elevation and thickness of potential DNAPL layers. The same procedures will be followed while measuring DNAPLs as were followed during LNAPL measurements.

Following water sample collection, the total depth of the well from the top of the casing will be determined using a weighted tape or electric sounder and then recorded on the well sampling form. The water level depth will be subtracted from the total depth of the well to determine the actual 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 that measurements are accurate.

6.1.1.1.2 Purging Prior to Sampling

Purging of monitoring wells is performed to evacuate water that may have become 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: (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 middle of the interval (i.e., a measured depth of 43 percent of the saturated screened interval below the top of the water table). This procedure minimizes the resuspension of solids that have collected at the bottom of the well and minimizes the potential mixing of stagnant water trapped in the casing above the screen. Every effort will be made 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 that minimizes stress to the system, 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, Fe^{2+}, and turbidity will also be measured during purging and recorded on the well sampling form. Fe^{2+} will only be measured once and is not considered a stabilization parameter. Measurements will be taken every 3 to 5 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 $\pm$ 1.0 degrees Celsius (°C) for temperature, $\pm$ 0.1 units for pH, $\pm$ 5 percent for EC, $\pm$ 0.1 mg/L or 10 percent (whichever is greater) for DO, $\pm$ 10 percent for ORP, and $\leq$ 10 percent for turbidity. In general, the order of stabilization is pH, temperature, and EC, followed by ORP, DO, and turbidity. Water samples will be collected immediately after parameter stabilization using the same pump that was used in purging. Field equipment will be calibrated in accordance with the Final Basewide QAPP (HydroGeoLogic, 1998).

In lieu of measuring all six parameters (temperature, pH, EC, turbidity, DO, and ORP), a minimum subset would include pH, EC, and turbidity or DO as critical stabilization parameters. If parameter stabilization criteria are too stringent, then minor oscillations in indicator parameters may cause purging operations to become unnecessarily protracted. Turbidity is a very conservative parameter in terms of stabilization and is always the last parameter to stabilize. Excessive purge times are invariably related to the establishment of too stringent turbidity stabilization criteria. It should be noted that natural turbidity levels in groundwater may exceed 10 nephelometric turbidity units (NTUs) (EPA, 1996).

For wells known to have a less than 0.1 L/min flow rate, a low flow ($<$0.1L/min) pump will be lowered into the well to mid-screen as described above and set in place a minimum of 48 hours prior to the initiation of purging procedures. This procedure will reduce the purge volume requirements. Water samples will be collected as soon as parameters have stabilized (EPA, 1996).

Alternately, if a well is known to have less than a 0.1 L/min flow rate, a passive sampling device could be lowered to mid-screen and set in place a minimum of 48 hour prior to retrieval. Regulatory approval for sample volumes, which are lower than required by individual EPA analytical methods, would have to be obtained prior to using this procedure (EPA, 1996).

During low flow purging, if the drawdown is greater than 0.33 feet, the micropurge technique is assumed to be invalid and will be discontinued because groundwater flow to the pump no longer is 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 (i.e., drawdown >0.33 feet at low flow rates), the pumping rate will be increased, and a minimum of three borehole volumes will be removed to ensure that all of the stagnant water has been removed from the borehole. 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 three well volumes have been removed and water quality parameters have stabilized for three consecutive readings, water samples will be collected. Water samples will be collected using the low flow pump.

If the parameters do not stabilize, five well volumes will be removed and water samples will be collected using a low flow pump.

If a well is purged dry, 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 5.8. A maximum of five well volumes may be removed from any well before it is sampled. The well bore volume is defined as the volume of submerged casing, screen, and filter pack. One well volume can be calculated using the following equation (Ohio EPA, 1993):

$$V = H \times F$$

where:

- V = one well volume
- H = the difference between the depth of well and depth to water (feet)
- F = factor for volume of one foot section of casing (gallons) from Table 6.1

F also can be calculated from the formula:

$$F = \pi (D/2)^2 \times 7.48 \text{ gallons per feet}$$

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

6.1.1.1.3 Sample Collection

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

Following the micropurge techniques outlined above, a small positive-displacement pump (e.g., bladder pump) may 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 micropurging (temperature, pH, EC, DO, ORP, Fe^{2+}, and turbidity).

Groundwater samples will be collected after the critical water quality indicators have stabilized for three consecutive readings. Stabilization will be defined as follows: temperature ± 1.0 °C, pH ±0.1 units, EC ±5 percent, DO ± 0.1 mg/L or 10 percent (whichever is greater), ORP ±10 percent, and turbidity ≤10 NTU change between three consecutive readings. Where possible, groundwater samples will be collected using the same pump employed 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 will be collected as described above in Section 6.1.1.1.2, and the anomalous parameters shall be brought to the field coordinator's attention (HydroGeoLogic, 1998). Field equipment will be calibrated in accordance with the Final Basewide QAPP (HydroGeoLogic, 1998) and Section 7.2 of this document.

The preservative hydrochloric acid will be added to VOC sample bottles before introducing the sample water. Samples will 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 will be filled until a meniscus is visible and sealed immediately. When the bottle is capped, it will be inverted and gently tapped to ensure them that no air bubbles are present in the vial. If bubbles are present, the vials will be discarded and the VOC sampling effort will be repeated. Refilling of vials will result in loss of preservatives. After the containers are sealed, sample degassing may cause bubbles to form. These bubbles will be left in the container. These samples will never be composited, homogenized, or filtered. Following collection of VOC samples, TPH, and PAH samples will be collected.

Required sample containers, preservation methods, volumes, and holding times are given in Section 6.2 and Table 6.2. Sampling equipment shall be decontaminated in accordance with Section 5.7 upon completion of sampling activities.

6.1.1.2 Direct Push Sampling

As part of the field investigation, DPT will be utilized to collect surface and subsurface soil samples in a timely and cost-effective manner, while at the same time minimizing IDW. During the installation of DPT soil borings, soil samples will be collected using a stainless steel-lined, continuous drive sampler. These samplers will retrieve a core sample 36 inches in length and 1.0625 inches in diameter to accommodate four 6-inch stainless steel/Teflon® sleeves. Soil samples collected during boring installation will be field screened for VOCs using a PID. In order to gather sufficient data for a Plan A risk evaluation, one surface soil sample and two subsurface samples will be collected from each boring location and submitted to the laboratory for analysis (TNRCC, 1995). At locations covered by the tarmac, no surface soil samples will be collected since the concrete will serve as an effective barrier for potential contaminants to impact the underlying soil and will prevent potential exposure to receptors.

When a sample is ready to be obtained, the piston tip is closed and the sampler assembly is driven to the top of the sample interval. When the top of the sampling interval is reached, the piston tip is freed to retract, and the sampler is hydraulically driven an additional 36 inches with one continuous motion into the undisturbed soil. Once the sample has been collected, the sampler is retrieved from the boring disconnected from the rig, the sample sleeve removed from the sampler, and the sleeve placed on a prepared surface. As soon as the sleeves are removed from the sampler, the open ends will be monitored for organic vapors using the PID. Air monitoring results will be recorded on the boring log and in the field log book.

Samples for VOC analysis will be collected as an entire 5g core using an EnCore™ core sampler. Three such cores will be collected from each VOC sampling location. Each core sampler will be completely filled to eliminate headspace; cores will not be collected from large gravel or debris. 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 by extruding the soil out of the stainless steel/Teflon® sleeves immediately adjacent to (above and below) the VOC sample interval. Soil chemistry samples not being analyzed for VOCs will be placed in 4-ounce, laboratory cleaned, EPA-approved glass containers with Teflon® lined lids. This will be done using clean stainless steel sampling tools. If soil from several stainless steel/Teflon® rings must be composited to provide sufficient sample volume for a particular analysis, the sample will be composited and homogenized in a stainless steel bowl using a stainless steel trowel or scoop. The sample will then be transferred into the appropriate sample container, sealed, labeled, and placed in an iced cooler held at a temperature below 4 °C.

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

6.1.2 Surface Soil Sampling

Surface soil samples shall be collected from the land surface to 2 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. Aboveground plant parts and debris will be excluded from the sample.

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

6.1.3 Subsurface Soil Sampling

Two subsurface soil samples will be collected at each boring. The first subsurface sample will be collected from an area below the surface sample which will be determined based on odors, discoloration, organic vapor meter readings, and any other field screening methods. The second subsurface sample will be collected from the unsaturated soil immediately above the water table. Both subsurface soil samples will be sent to the laboratory for analysis.

6.1.4 Soil Gas Sampling

Soil gas sampled during this investigation will use commercially available soil gas sampling equipment, such as sampling probes, gas tight syringes or bulbs, or sorbent tubes. The following paragraphs describe the various sampling procedures for each type of soil gas sampler. However, project specific sampling procedures will adhere to the manufacturer's specifications for the selected soil gas samples.

When soil gas samples are collected using commercially available soil gas sampling probes, the probes are connected to a steel drive shaft used to push the probe to the desired sampling depth. The sampling container shall be a glass or metal bulb equipped with an entrance and exit spigot. The Tygon® tubing from the sampling probe shall be attached to the entrance spigot, and a second length of tubing shall run from the exit spigot of the bulb to a portable vacuum pump.

At each sample location, the sampling probes shall be driven to a depth according to manufacturer's specifications, usually between 5 to 10 feet below ground surface.

When the probe is at the desired depth, the steel drive shaft shall be pulled back slightly, exposing the gas intakes on the sample probe. The vacuum pump shall then be switched on, drawing the gas contained in the interstitial spaces of the soil through the probe, tubing, and sample container. When 2 liters of gas have been drawn, the Tygon® tubing shall be clamped shut on the downstream side of the bulb (toward the pump) and then the upstream side of the bulb. The vacuum pump shall then be switched off. The volume of 2 liters shall ensure that the gas in the glass bulb originated from the soil interstitial space, rather than the tubing, so long as a reasonably short tubing length is used. Following sample collection, the sample container shall be labeled and the sample number recorded in the field log book along with the following information: soil gas sample or probe depth, apparent moisture content (dry, moist, saturated) of the sampled zone, if available, soil gas purge rate, sampling duration, sampling system leak rake, and pump vacuum, description of sample containers, location of sample analysis, location and grid layout of sampling stations.

Gas tight syringe or bulb samples are collected for on-site laboratory analyses. To collect a syringe sample, a fitting with a Teflon® septum shall be installed in the sampling line ahead of the purge pump. After purging the required volume, samples are collected. Bulb samples are collected using a manifold configuration.

Sorbent tubes may be used to collect samples for real-time field analysis (i.e., colorimetric tubes such as Draeger tubes) or for off-site laboratory analyses. The well or probe is purged, the sorbent tube is installed in the sampling line, and the required volume of soil gas is drawn through the tube. Colormetric tubes are read directly, while sorbent tubes are capped and stored on ice (dry ice may be required) until being shipped to the laboratory.

In addition to the information listed in Section 8.0, the soil gas sample or probe depth, and the location and grid layout of sampling stations shall be recorded.

6.2 SAMPLE HANDLING

6.2.1 Sample Containers

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

6.2.2 Sample Volumes, Container Types, and Preservation Requirements

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

6.2.3 Sample Identification

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

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

Each sample will be assigned a unique identification number that describes where the sample was collected. The number will consist of a maximum 15-digit alphanumeric code as follows:

XHGLaaaaaabbb-cc

where:

X represents where each sample is collected from (e.g., B for boring, W for well, T for trench, etc.)

HGL represents the contractor conducting the field sampling effort (e.g., HGL for HydroGeoLogic)

a represents the site identification

bb represents the boring number (e.g., 001, 002, 003)

cc represents the sampling number collected from a particular boring (e.g., 01 for the first sample--usually surface soil, 02 for the second sample)

For example, the second soil sample of soil boring 02 collected from UST site Building 1040-1 will be identified as "BHGL1040-1002-02." Duplicate samples will be assigned consecutive numbers (e.g., DUP01, DUP02, etc.) and parent locations before the sample event. Proper notes will be entered into the field sampling log book to track field duplicate samples and any location changes.

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

xxyyyyyyzz

where:

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

yyyyyy represents date (day, month, year)

zz represents sample number from 01 to 99

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

6.3 SAMPLE CUSTODY

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

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

The following minimum information concerning the sample will be documented on the chain of custody form (as illustrated in Appendix A):

- 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)
- Pertinent field data (pH, temperature, etc.)
- Serial numbers of custody seals and transportation cases (if used)
- Custody transfer signatures and dates and times of sample transfer from the field to transporters and to the laboratory or laboratories
- Bill of lading or transporter tracking number (if applicable)

All samples will be uniquely identified, labeled, and documented in the field at the time of collection 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.

Ambient blanks will be collected if the surrounding conditions pose a threat to the integrity of the sample to be analyzed.

6.4.2 Equipment Blank

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

6.4.3 Trip Blank

The trip blank consists of a VOC sample vial filled in the laboratory with ASTM Type II reagent-grade water, transported to the sampling site, handled like an environmental sample, and returned to the laboratory for analysis. Trip blanks are not opened in the field. Trip blanks are included when VOC samples are collected from the field and sent to a laboratory for analysis. Their purpose is to determine whether an introduction of contaminants from other sources during transportation and/or storage has occurred. One trip blank will accompany each cooler of samples sent to the laboratory for VOC analysis.

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 10 samples collected.

6.4.5 Field Replicates

A field replicate sample, also called a split, is a single sample divided into two equal parts for analysis. The sample containers are assigned an identification number in the field such that they cannot be identified as replicate samples by laboratory personnel performing the analysis. Specific locations are designated for collection of field replicate samples prior to the beginning of sample collection. Replicate sample results are used to assess precision. One replicate sample will be collected for every 10 soil and sediment samples collected.

6.4.6 Matrix Spikes and Matrix Spike Duplicates

MSs are environmental samples to which a known concentration of analyte is added. The MS is taken through the entire analytical procedure, and the recovery of the analyte is calculated. Results are expressed as percent recovered of the known spike. The MS is used to evaluate the effect of the sample matrix on the accuracy of the analysis. Matrix spike samples will be obtained and analyzed at a rate of one MS sample per every 20 environmental samples collected and will be designated on the chain of custody by sampling personnel. Additional sample volume will be provided for each MS analysis.

6.4.7 Matrix Spike Duplicates

MSDs are collected along with matric spikes. MSDs are environmental samples that are divided in two separate aliquots, which are then both spiked with the same known concentrations of analytes. The two spiked aliquots are processed separately and the results compared to evaluate the effects of the matrix on the precision and accuracy of the analysis. Results are expressed as relative percent differences between the duplicate samples analyzed and percent recovery. MSDs will be analyzed at the same frequency as MS and will be designated on the chain of custody by the sampling personnel. Additional sample volume will be provided for each MS analysis.

7.0 FIELD MEASUREMENTS

7.1 PARAMETERS

7.1.1 Field Screening of Soils

Field activities will utilize field screening of soil samples for VOCs to determine the depth from which the laboratory analytical samples will be collected. During hand auguring, hollow-stem auger drilling, and sediment sampling activities, head space readings will be recorded from collected soils. Headspace analysis will be performed on each lithologic and analytical soil sample collected. A portion of the recovered soil sample will be placed into a 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 a PID sampling tip. The PID 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 empty resealable plastic bags handled in a manner identical to the plastic bag containing the headspace sample. The headspace reading and the background reading will be compared and recorded on the soil boring log (Appendix A).

7.1.2 Field Parameters for Water Samples

Temperature, pH, EC, DO, Fe^{2+}, and turbidity will be measured during monitoring well development and purging. The temperature of each water sample will be measured by either a pH/temperature probe, conductivity/temperature probe, or a mercury thermometer. This measurement will also be used to calibrate the pH meter.

The pH of each water aliquot will be measured by a portable pH meter. The pH meter will be calibrated with two buffer solutions of the appropriate range for the expected values of pH. The meter will be recalibrated daily. The stability of the calibration will be verified through the analysis of one standard periodically throughout the day as deemed necessary by the field coordinator, but at least once every 5 hours.

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

The turbidity of each water aliquot will be measured using a portable nephelometric turbidity meter. Calibration of the instrument is periodically performed at the factory as part of routine maintenance. A standard 0.2 NTU solution will be used to verify the stability of the calibration on a daily basis. All measurements will be recorded on the well development record/monitoring well purging form (Appendix A).

7.2 EQUIPMENT CALIBRATION AND QUALITY CONTROL

Field equipment will be maintained and calibrated to the standards in their respective operations manuals. Equipment failures will be repaired in the field if possible; if not, the instrument will be tagged, removed from use, and returned for repair or replacement. Field equipment will be calibrated daily before the start of sampling activities. Calibration records will be maintained on the calibration log (Appendix A). The calibration record will include a unique instrument number (e.g., serial number), standards used, concentrations, and meter readings. Corrective action procedures, Table 7.1, will be taken to ensure proper quality control.

7.3 EQUIPMENT MAINTENANCE AND DECONTAMINATION

7.3.1 Equipment Maintenance

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

7.3.2 Decontamination of Field Instruments

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

7.4 FIELD MONITORING MEASUREMENTS

7.4.1 Groundwater Level Measurements

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

Water level measurements will be taken with electric water level indicators. Devices that may alter sample composition will not be used. Pressure gauges, manometers, or equivalent devices will be used for flowing wells to measure the elevation of the piezometric surface. All measuring equipment will be decontaminated according to the specifications in Sections 5.7 and 7.3. Groundwater level will be measured to the nearest 0.01 foot.

Static water levels will be measured each time a well is sampled and before any equipment enters the well. If the casing cap is airtight, the well will be allowed to equilibrate prior to measuring the groundwater. Measurements will be repeated until the water level stabilizes.

7.4.2 Floating Hydrocarbon Measurements

The thickness of hydrocarbons floating in monitoring wells will be measured with an electronic interface probe. Hydrocarbon detection paste, or any other method that may affect water chemistry, will not be used. When detected, the presence of floating hydrocarbons will be confirmed by withdrawing a sample with a clear, bottom-fill Teflon® bailer.

7.4.3 Groundwater Discharge Measurements

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

7.5 FIELD PERFORMANCE AND SYSTEM AUDITS

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

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

The first three items above will be checked for completeness. Sampling operations will be reviewed to determine if they are performed as stated in the WP 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, sampling facilities, and equipment calibration logs. A performance audit may be conducted by the Project Manager and Project Geologist if deemed necessary by the Project Manager, Project Geologist, Laboratory QA Officer, 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, by the Project Manger and Project Geologist will prepare a checklist that will serve as a guide for the performance audit.

The audit will verify whether or not (1) collection of samples follows the available written procedures, (2) chain of custody procedures are followed for traceability of each 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 corrective action procedures are followed. An audit report summarizing the results and corrections will be prepared and filed in the project files.

8.0 RECORD KEEPING

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

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

The following additional information will be recorded for all sampling activities: (1) sample type (i.e., environmental, duplicate, MS/MSD, etc.), (2) sampling method, (3) identification of sampling devices,(4) the identity of each sample, (5) depth(s) of samples, where applicable, (6) volume collected, (7) sample description (e.g., color, odor, clarity), (8) identification of conditions that might affect the representativeness of a sample (e.g., refueling operations, damaged casing), and (9) project number.

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

8.1 FIELD LOG BOOK

Log books 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. Copies of pages from each log book detailing the activities of the day will be faxed to the Herndon, Virginia, office at the conclusion of each work week. Information to be recorded in the logs includes, but is not limited to, the following:

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

- Accomplishment of decontamination of drilling rig, construction materials, and sampling equipment
- Accomplishment of required calibration checks
- Accomplishment of well point purging, with time and/or volume
- Disposition of purge water, decontamination fluids, and soil cuttings
- Well water levels and field measurements
- Variances from project plans and procedures (details will be recorded in the log book and presented in the report)
- 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

8.2.1 Sample Collection Log

A sample collection log form (i.e., field sampling report) will be completed for each sample collected during the investigation. An example of the field sampling report form is included in Appendix A. 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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TAB

Tables

Table 3.1
TNRCC Action Levels and Screening Levels for LPST Sites

Constituents	Soil Action Levels (Mg/kg)		Groundwater Action Levels (mg/L)
	Fine-Grained Soil*	Coarse-Grained Soil*	
Benzene	0.50	0.50	0.005
Ethylbenzene	70	10	0.70
Toluene	100	20	1.0
Total xylenes	560	70	10
Acenaphthene	314	314	0.010
Anthracene	13	13	0.010
Benzo(a)anthracene	0.877	0.877	0.010
Benzo(b)fluoranthene	0.877	0.877	0.010
Benzo(k)fluoranthene	8.77	8.77	0.010
Benzo(a)pyrene	0.0877	0.0877	0.010
Chrysene	7.2	7.2	0.010
Dibenz(a,h)anthracene	0.0877	0.0877	0.010
Fluoranthene	156	156	0.010
Fluorene	247	247	0.010
Indeno(1,2,3-cd)pyrene	0.877	0.877	0.010
Naphthalene	389	389	0.010
Pyrene	99	99	0.010
SCREENING LEVELS			
Total petroleum hydrocarbons (TPH) for middle distillate releases**	500	500	5
Total petroleum hydrocarbons (TPH) for gasolene releases**	100	100	5

* Apply the fine-grained soil standard to sites dominated with clays and silts. Apply the coarse-grained soil standards to sites dominated with sands, gravels, and rock units.

** Apply the middle distillate TPH standard to diesel, kerosene, jet fuel, hydraulic oil, and used oil releases. Apply the gasoline standard to gasoline and aviation gasoline releases. At sites where both gasoline and middle distillate releases have occurred in the same area or tank hold, the gasoline standard will apply.

mg/kg = milligrams per kilogram
mg/L = milligrams per liter
Source: Texas Natural Resource Conservation Commission, PST Division, 1996a, RG-17: Action Levels for LPST Sites (TNRCC, 1996a).

Table 3.2
Plan A Category I and II Target Concentrations

Parameter	Soil (mg/kg)		Groundwater (mg/L)	
	Category I	Category II	Category I	Category II
Acenaphthene	314	314	2.19	2.19
Acetone	22	22	3.650	3.65
Anthracene	13	13	11.000	11
Benzene	0.13	0.74	0.005	0.0294
Benzo(a)anthracene	3.2	32	0.000117	0.00117
Benzo(b)fluoranthene	13	129	0.000117	0.00117
Benzo(k)fluoranthene	47	47	0.00117	0.0117
Benzo(a)pyrene	220	129	0.0002	0.000117
Chrysene	7.2	7.2	0.0117	0.117
Dibenz (a,h)anthracene	7.7	33	0.0000117	0.000117
Dichlorobenzene (1,2)	208	1,140	0.6	3.29
Dichlorobenzene (1,3)	208	1,140	0.6	3.25
Dichlorobenzene (1,4)	26	123	0.075	0.355
Ethylbenzene	160	1,193	0.7	3.65
Fluoranthene	156	156	1.46	1.46
Fluorene	247	247	1.46	1.46
Formaldehyde	46	46	7.3	7.3
Indeno(1,2,3cd)pyrene	17	17	0.000117	0.00117
Methyl Ethyl Ketone	142	142	21.9	21.9
Naphthalene	389	389	1.46	1.46
Pyrene	99	99	1.1	1.1
Toluene	69	503	1	7.3
Xylenes	568	968	10	73

Source: TNRCC, 1994 (RG-36).

Table 3.3
Soil Sampling Analysis Summary
NAS Fort Worth JRB, Texas

UST Site	Analytical Parameter			DPT Soil Borings	Equipment Blanks[1]	Ambient Blanks[2]	Trip Blanks[3]	Field Duplicates[4]	MS/MSD[5]	Total Samples
	VOC	PAH	TPH							
1040-1	12	12	12	4	1	1	1	1	1	41
1191-1	12	12	12	4	1	0	1	1	1	40
1411-1, 1411-2, 1411-3	0	0	0	0	0	0	0	0	0	0
1427-1	15	15	15	5	1	0	1	1	1	49
1750-1,1750-2	18	18	18	6	1	0	1	2	1	59
4115-1	15	15	15	5	1	0	1	2	1	50
4136-1	15	15	15	5[6]	1	0	1	2	1	50
GCA-1, GCA-2	24	24	24	8[6]	1	0	1	2	1	77
Total	111	111	111	37	7	1	7	11	7	366

1 A maximum of one equipment blank will be taken per day.
2 Ambient blanks will only be collected if VOCs are detected by a PID during the acquisition of a sample.
3 One trip blank will accompany each cooler that contains samples to be analyzed for VOCs.
4 Field duplicates will be collected on a 10 percent basis.
5 Matrix spike/matric spike duplicates (MS/MSDs) will be collected on a 5 percent basis.
6 The exact number of proposed soil borings may increase based on the results of the preliminary investigation.

Equipment Blanks = A maximum of one equipment blank will be taken per day, per analysis, regardless of media sampled.
Field Duplicates = Collected on a 10 percent basis of investigation samples.
Trip Blanks = One trip blank will be included per cooler when at least one sample is analyzed for VOCs from that cooler.
Ambient Blanks = One ambient blank will be collected at the beginning of the field investigation for soil and groundwater.

Table 3.4
Groundwater Sampling Analysis Summary
NAS Fort Worth JRB, Texas

UST Site	Analytical Parameters			Monitoring Wells	Equipment Blanks[2]	Ambient Blanks[3]	Trip Blanks[4]	Field Duplicates[5]	MS/ MSD[6]	Total Samples[7]
	VOC	PAH	TPH							
1040-1	1	1	1	1[1]	1	1	1	1	1	8
1191-1	1	1	1	1[1]	0	0	0	0	0	3
1411-1, 1411-2, 1411-3	5	5	5	5	2	0	2	2	1	22
1427-1	1	1	1	1[1]	1	0	1	1	0	6
Total	8	8	8	8	4	1	4	4	2	39

1 Monitoring wells will be sampled only if soil samples exceed TNRCC action levels.
2 A maximum of one equipment blank will be taken per day.
3 Ambient blanks will only be collected if VOCs are detected by a PID during the acquisition of a sample.
4 One trip blank will accompany each cooler that contains samples to be analyzed for VOCs.
5 Field duplicates will be collected on a 10 percent basis.
6 Matrix spike/matric spike duplicates (MS/MSDs) will be collected on a 5 percent basis.
7 Total number of samples includes samples obtained from existing monitoring wells that may not be sampled due to their proximity to the former UST.

Equipment Blanks = A maximum of one equipment blank will be taken per day, per analysis, regardless of media sampled.
Field Duplicates = Collected on a 10 percent basis of investigation samples.
Trip Blanks = One trip blank will be included per cooler when at least one sample is analyzed for VOCs from that cooler.
Ambient Blanks = One ambient blank will be collected at the beginning of the field investigation for soil and groundwater.

Table 3.5
Field Activities Summary
NAS Fort Worth JRB, Texas

UST Site	Activity	Number
1040-1	Soil borings using DPT	4
	Sample existing monitoring well	1[1]
1191-1	Soil borings using DPT	4
	Sample existing monitoring well	1[1]
1411-1, 1411-2, 1411-3	Soil borings using DPT	0
	Sample existing monitoring wells	5
1427-1	Soil borings using DPT	5
	Sample existing monitoring well	1[1]
1750-1, 1750-2	Soil borings using DPT	6
4115-1	Soil borings using DPT	5
4136-1	Soil borings using DPT	5[2]
GCA-1, GCA-2	Soil borings using DPT	8[3]

1 Monitoring well(s) are located in the area of the former UST excavation and may be utilized as part of this investigation.
2 The exact number of proposed soil borings may increase based on the results of the soil gas survey.
3 The exact number of proposed soil borings may increase based on the results of the geophysical survey.
DPT = Direct-Push Technology

Table 3.6
Data Quality Levels and Intended Use for Field and Laboratory Data
NAS Fort Worth JRB, Texas

Sampling Matrix/ Location[1]	Parameters[2]	Analytical Method	Field/Lab Analysis	Data Quality Level	Intended Use
Soil at all locations	VOCs	PID	Field	Screening	Field screening for selecting samples for lab analysis
		Boring Logs	Field	Screening	To differentiate the stratigraphy and to potentially identify contamination
Groundwater[3] all locations	Temperature pH EC DO ORP Fe^{2+} Turbidity	E170.1 150.1 120.1 E360.1 D1498 Hach 8146 E180.1	Field Field Field Field Field Field Field	Screening Screening Screening Screening Screening Screening Screening	Field screening to determine sufficient purging/development of monitoring well
Groundwater[3]	VOCs TPH PAHs	8260B/5035 T1005 SW8310	Lab Lab Lab	Definitive Definitive Definitive	Nature/extent of contaminants, risk assessment, corrective measures study
Soil	VOCs TPH PAHs	8260B/5035 T1005 SW8310	Lab Lab Lab	Definitive Definitive Definitive	Nature/extent of contaminants, risk assessment, corrective measures study

[1] Each location will be sampled for the same analytes per matrix as stated in Section 3.2.
[2] Parameters are in accordance with TNRCC RG-175
[3] Groundwater may be sampled if soils sampled exceed their respective action level.
ORP = oxidation-reduction potential
NA = Not Applicable

Table 4.1
Key Project Personnel
NAS Fort Worth JRB, Texas

Name	Title	Organization	Telephone
Joseph Dunkle	Team Chief	AFCEE/ERD	(210) 536-5214
Michael Dodyk	Point of Contact	AFCEE/ERD	(817) 732-9734
John Robertson, P.G.	Program Manager	HydroGeoLogic	(703) 478-5186
James Costello, P.G.	Project Manager	HydroGeoLogic	(703) 478-5186
Gary Mayer	QA Manager	HydroGeoLogic	(703) 478-5186
Ken Rapuano	Health and Safety Officer	HydroGeoLogic	(703) 478-5186
TBD	Lab Project Manager	TBD	TBD
TBD	Lab Operations Manager	TBD	TBD
TBD	Lab QA Officer	TBD	TBD
TBD	Lab Sample Custodian	TBD	TBD
TBD	Project Geologist	HydroGeoLogic	(703) 478-5186
Omar Abdi	Data Mgmt. Supervisor	HydroGeoLogic	(703) 478-5186
Bruce Rappaport, Ph.D.	Senior Reviewer	HydroGeoLogic	(703) 478-5186

TBD = To Be Determined

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

Diameter of Borehole (inches)	F Factor (gallons)
1.5	0.09
2	0.16
3	0.37
4	0.65
6	1.47
8	2.60
10	4.04
12	5.81

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

Name	Analytical Methods	Container[a]	Preservation[b,c]	Minimum Sample Volume or Weight	Maximum Holding Time
VOCs (water)	SW8260B	G, Teflon-lined septum, T	4 °C, 0.008% $Na_2S_2O_3$ (HCl to pH < 2 for volatile aromatics by SW8260)[b]	3 x 40 mL	14 days; 7 days if unpreserved by acid
VOCs (soil)	SW8260B/ SW5035	EnCore™ Sampler	4 °C, frozen at -12 °C within 2 days of collection	3 x 5 gram cores	14 days
TPH	E418.1	G, Teflon-lined septum, T	4 °C, HCl to pH < 2	2 x 40 mL or 4 ounces	14 days (water and soil); 7 days if unpreserved by acid
PAHs	SW8310	G, Teflon-lined cap, T	4 °C, store in dark, 0.008% $Na_2S_2O_3$	1 liter or 4 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)

[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.

Table 7.1
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	- Calibrated to ±20% of known calibration gas	- Daily		- Correct problem, recalibrate - Repair or replace malfunctioning parts
pH	- Calibrated with two buffer solutions that bracket expected sample pH	- Daily		
EC	- 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		
Turbidity	- Calibrate within expected range of sample turbidity	- Daily		- 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 - Document to Project Geologist, Project Manager, and Quality Assurance Manager
Insufficient sample volume collection	NA	NA	Sufficient sample volume is provided to maintain sample integrity 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 - 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 - Document to Project Geologist, Project Manager, and Quality Assurance Manager

NA = Not Applicable

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TAB

Figures

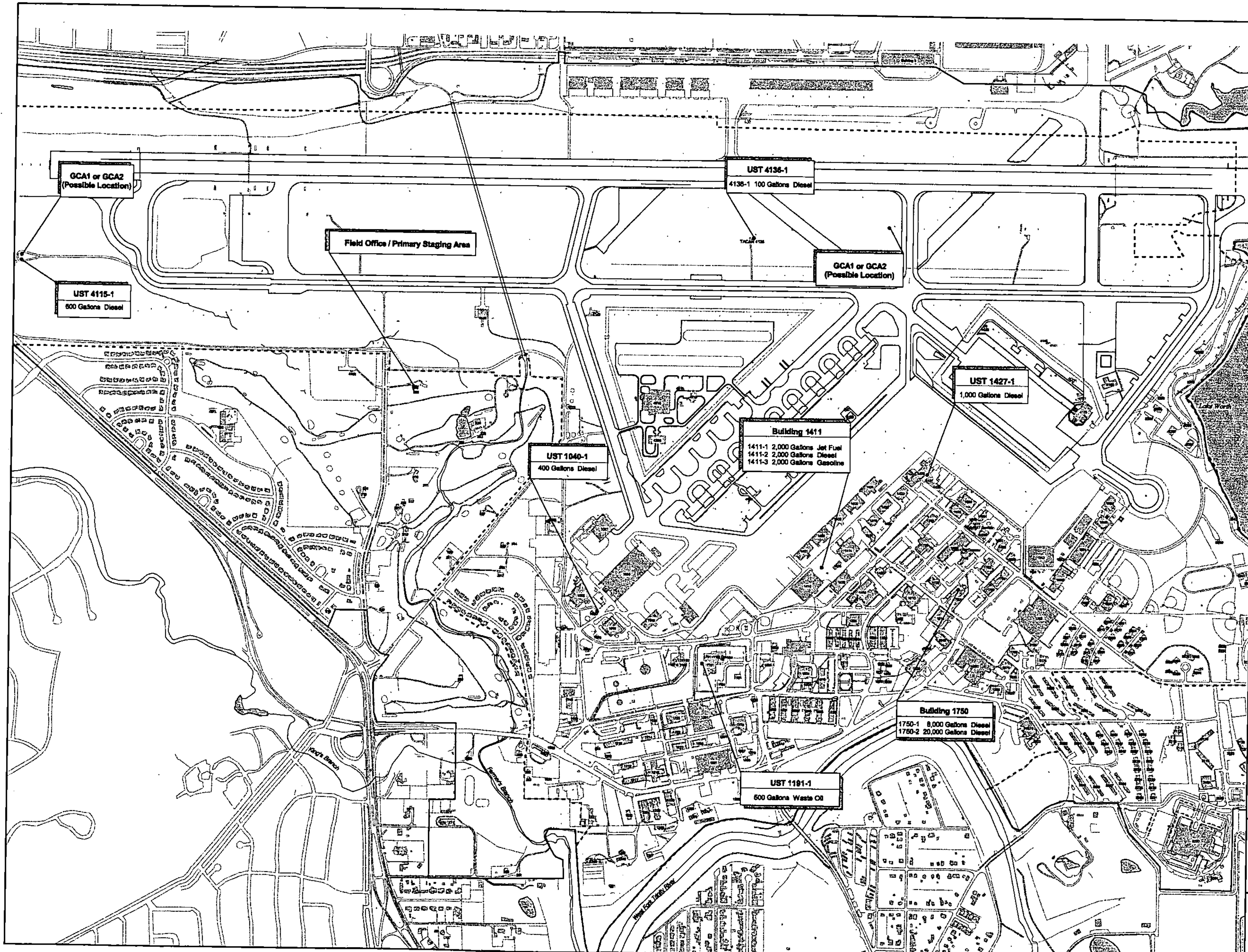

Figure 3.1

UST Locations
NAS Fort Worth JRB, Texas

Air Force Center for Environmental Excellence

Legend

- Former Underground Storage Tank (UST) (Approximate Location)
- NAS Fort Worth JRB (Carswell Field)
- Former Carswell Air Force Base
- Building/Facility
- Field Office / Primary Staging Area

N

0 500 1000
Scale in Feet

HYDRO GeoLogic Inc.

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Project No.: AFC001-16BAAE
Revised: 04/22/99 cf

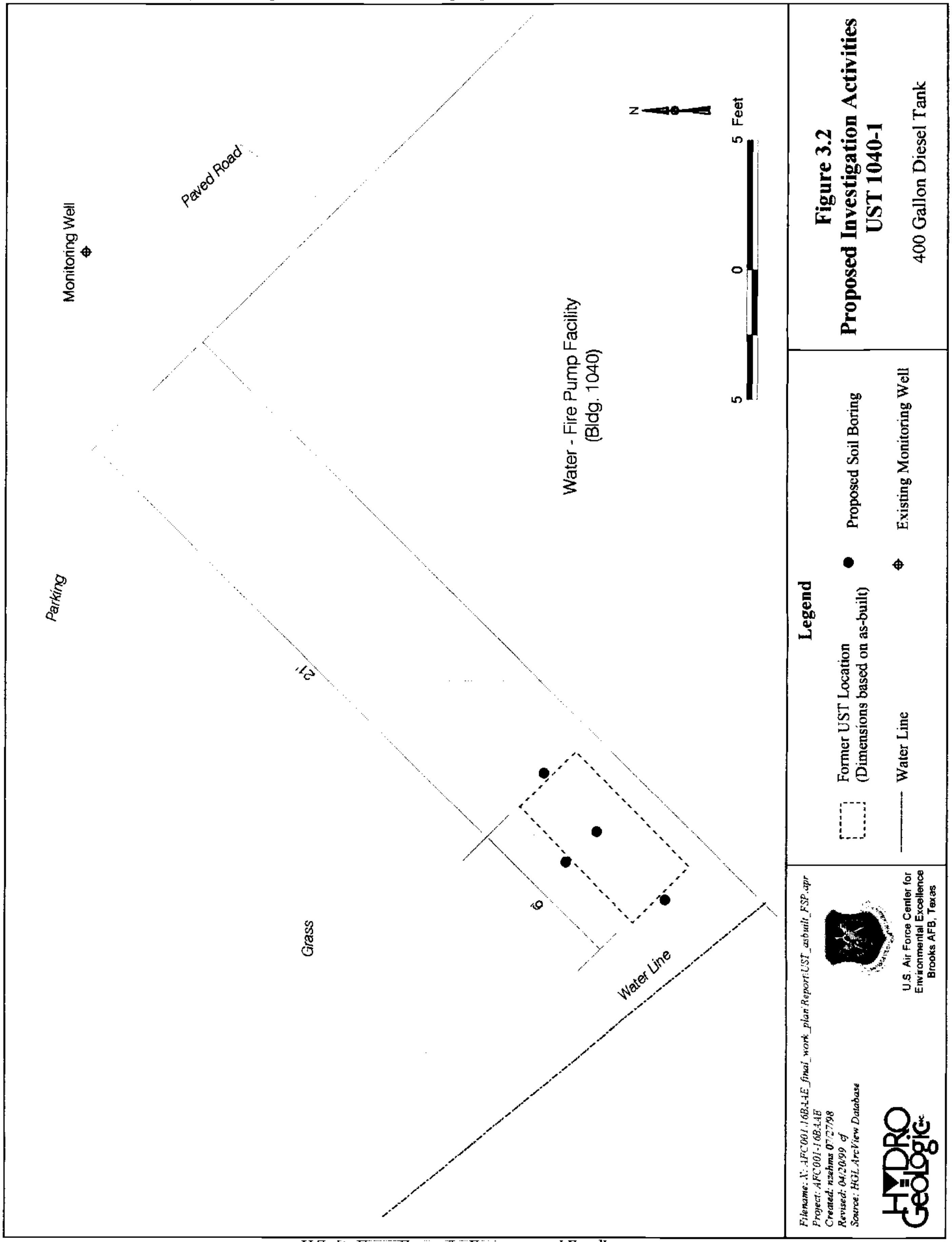


Figure 3.2
Proposed Investigation Activities
UST 1040-1
400 Gallon Diesel Tank

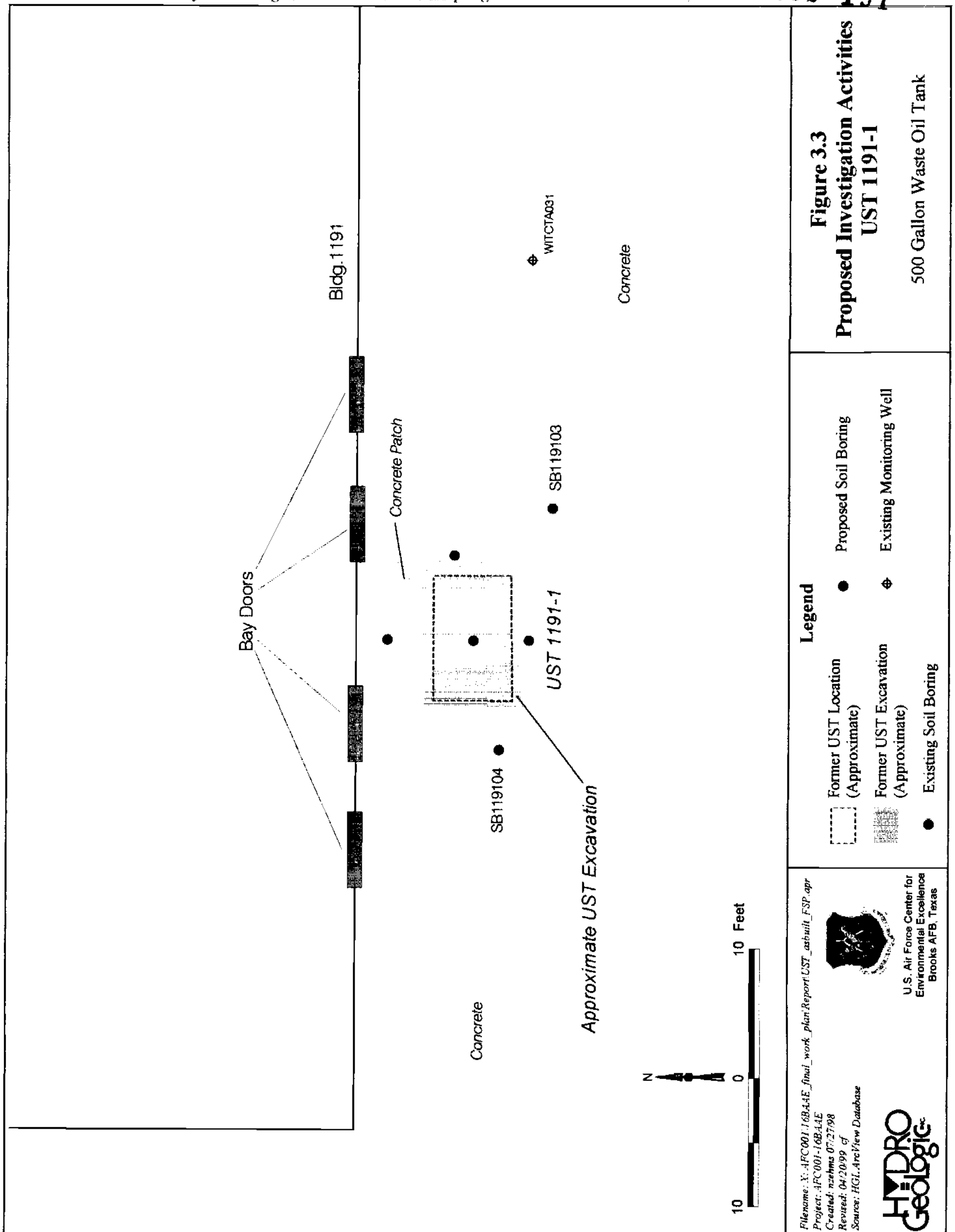
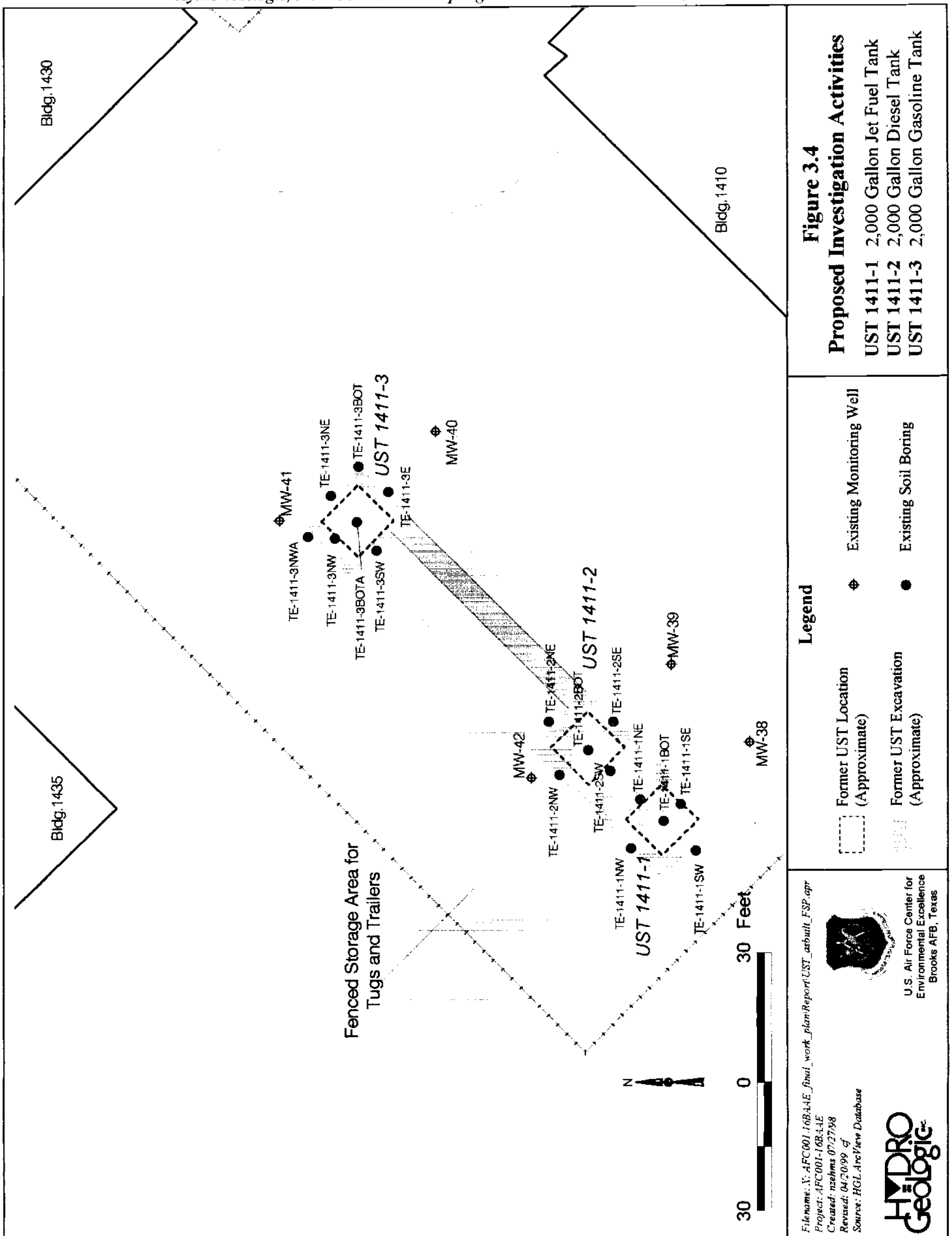


Figure 3.3
Proposed Investigation Activities
UST 1191-1

500 Gallon Waste Oil Tank


Bldg.1430
Bldg.1410
Bldg.1435
Fenced Storage Area for Tugs and Trailers
UST 1411-1
UST 1411-2
UST 1411-3
TE-1411-1NW
TE-1411-1SW
TE-1411-1NE
TE-1411-1BOT
TE-1411-1SE
TE-1411-2NW
TE-1411-2SW
TE-1411-2NE
TE-1411-2BOT
TE-1411-2SE
TE-1411-3NWA
TE-1411-3NW
TE-1411-3BOTA
TE-1411-3SW
TE-1411-3NE
TE-1411-3BOT
TE-1411-3E
MW-38
MW-39
MW-40
MW-41
MW-42
30 0 30 Feet
N
Legend
Former UST Location (Approximate)
Former UST Excavation (Approximate)
Existing Monitoring Well
Existing Soil Boring
Figure 3.4
Proposed Investigation Activities
UST 1411-1 2,000 Gallon Jet Fuel Tank
UST 1411-2 2,000 Gallon Diesel Tank
UST 1411-3 2,000 Gallon Gasoline Tank
U.S. Air Force Center for Environmental Excellence Brooks AFB, Texas
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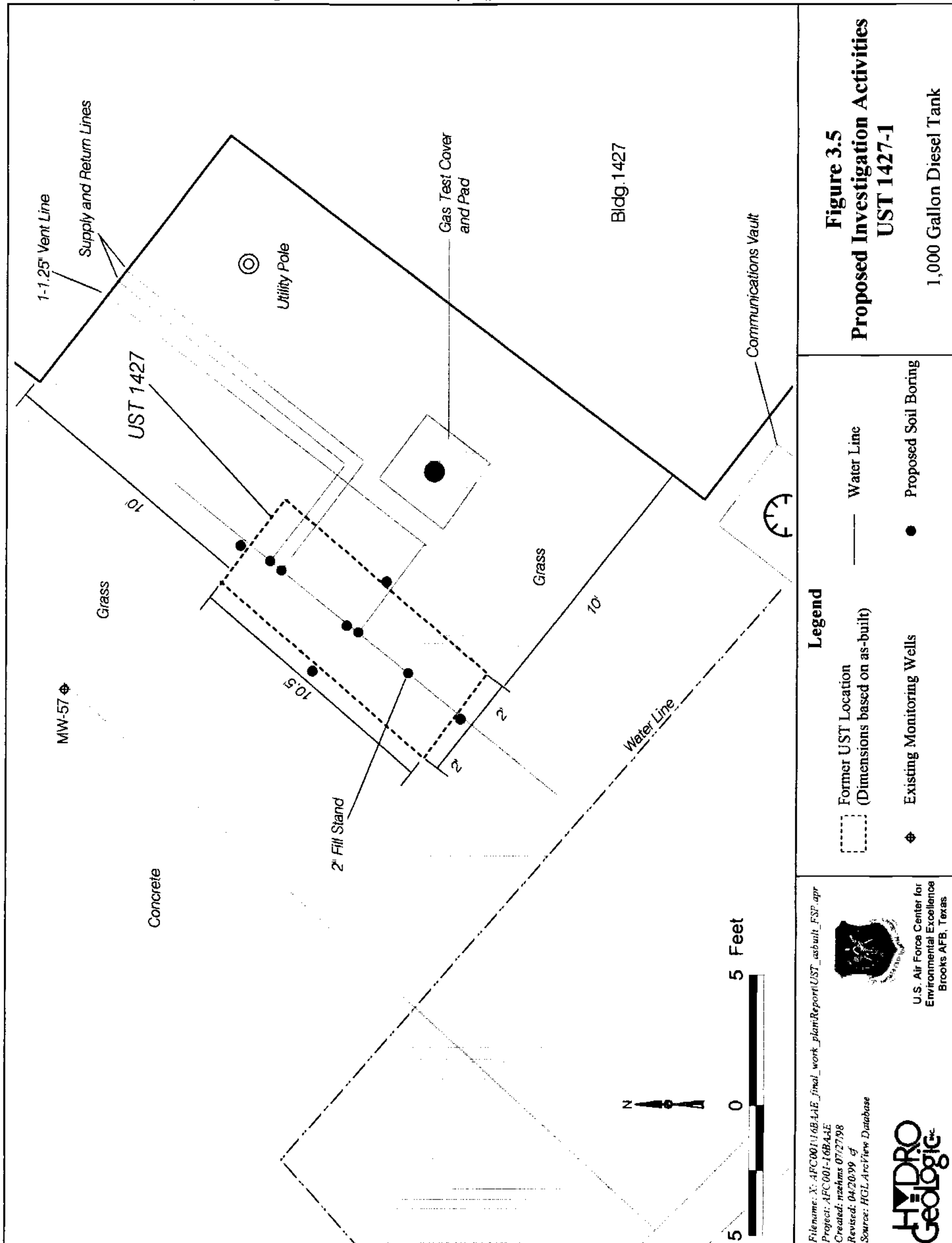
1-1.25" Vent Line
Supply and Return Lines
Utility Pole
Gas Test Cover and Pad
Bldg.1427
Communications Vault
UST 1427
10'
10.5'
2'
2'
10'
Grass
Grass
MW-57
2" Fill Stand
Water Line
Concrete
5 0 5 Feet
N
Figure 3.5
Proposed Investigation Activities
UST 1427-1
1,000 Gallon Diesel Tank
Legend
Former UST Location (Dimensions based on as-built)
Water Line
Existing Monitoring Wells
Proposed Soil Boring
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HYDRO GEOLOGIC INC
U.S. Air Force Center for Environmental Excellence Brooks AFB, Texas

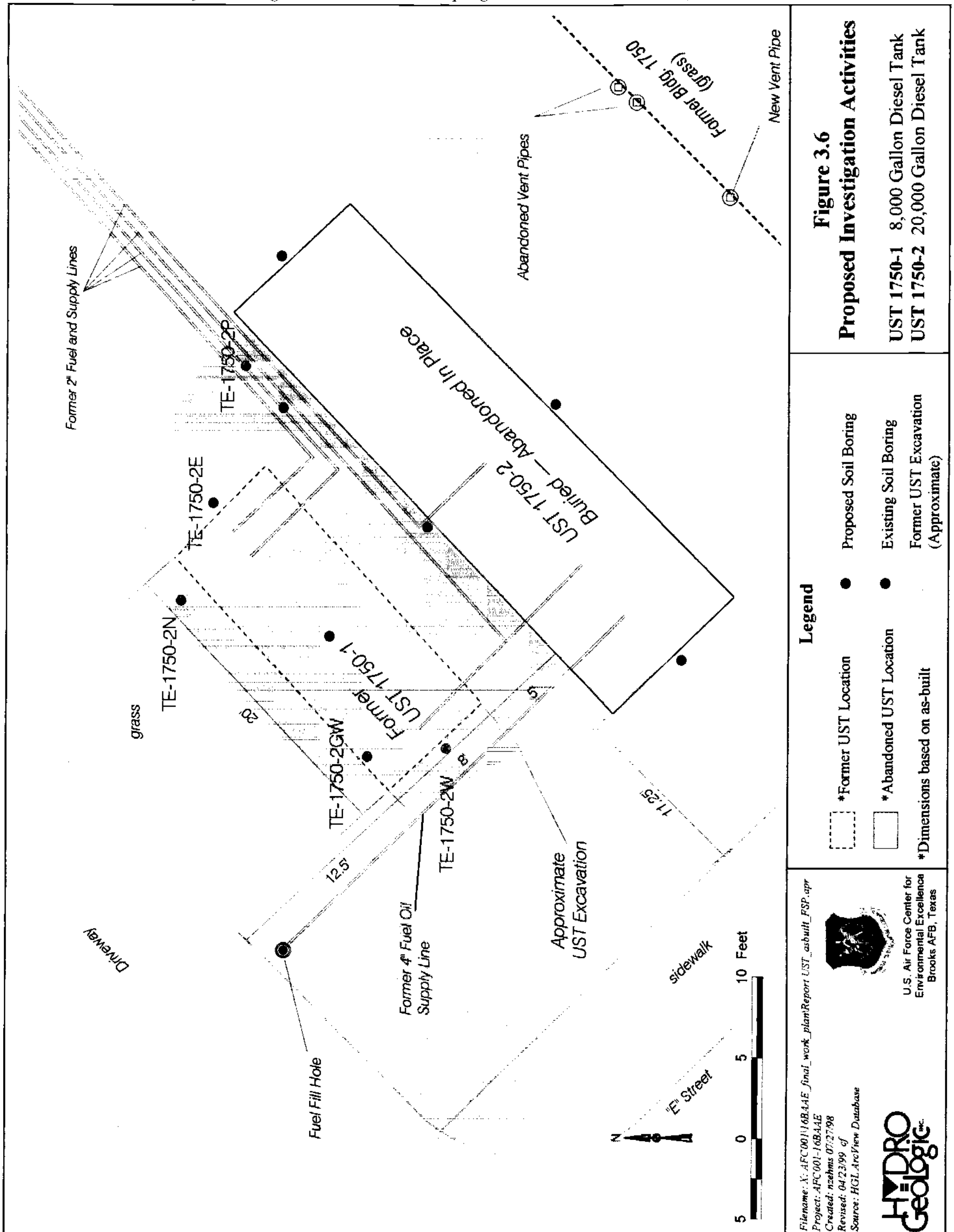

Figure 3.6
Proposed Investigation Activities

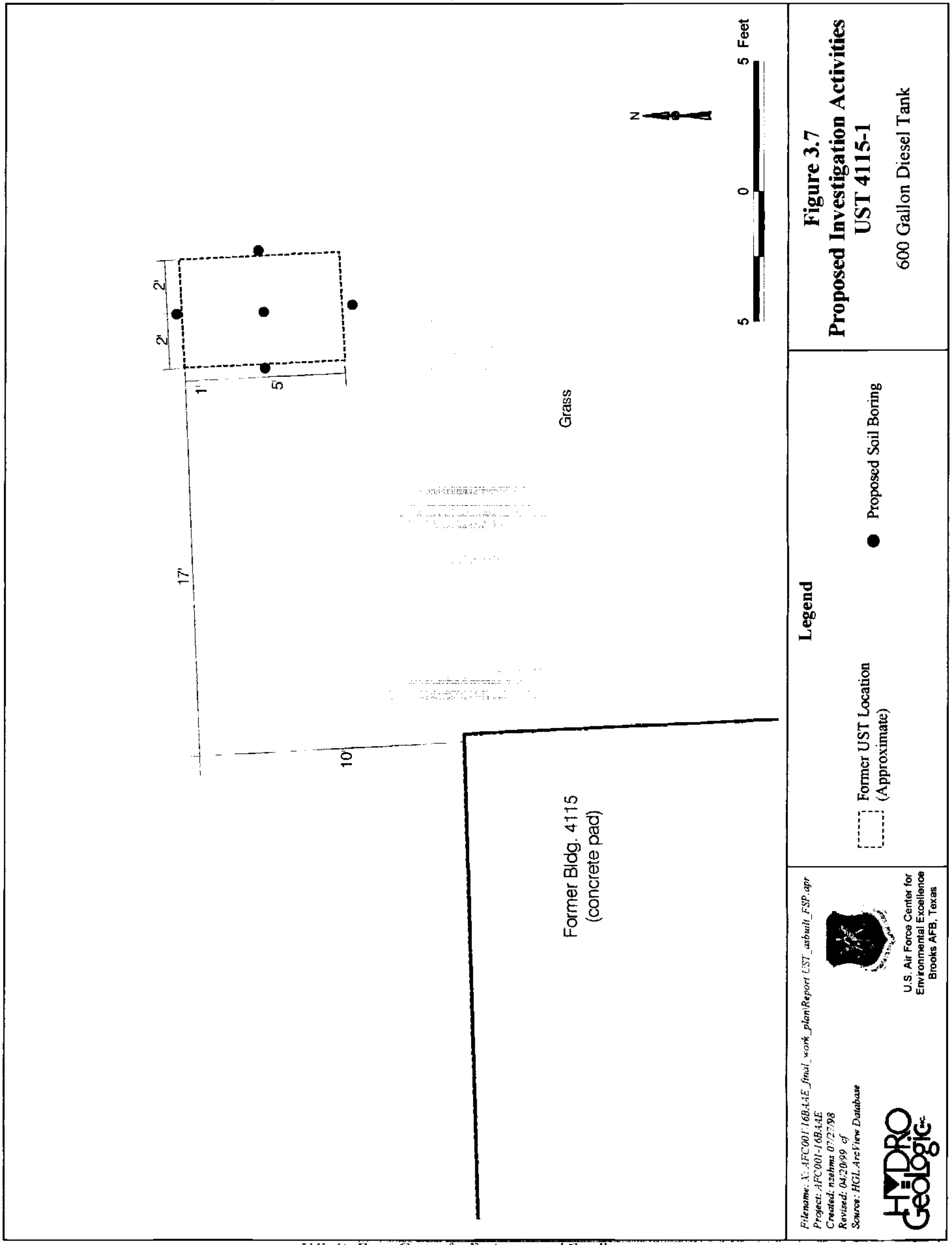
Figure 3.7
Proposed Investigation Activities
UST 4115-1
600 Gallon Diesel Tank
Legend
Former UST Location (Approximate)
Proposed Soil Boring
Grass
Former Bldg. 4115 (concrete pad)
2'
2'
1'
5'
17'
10'
N
5
0
5 Feet
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U.S. Air Force Center for Environmental Excellence Brooks AFB, Texas
HYDRO GEOLOGIC

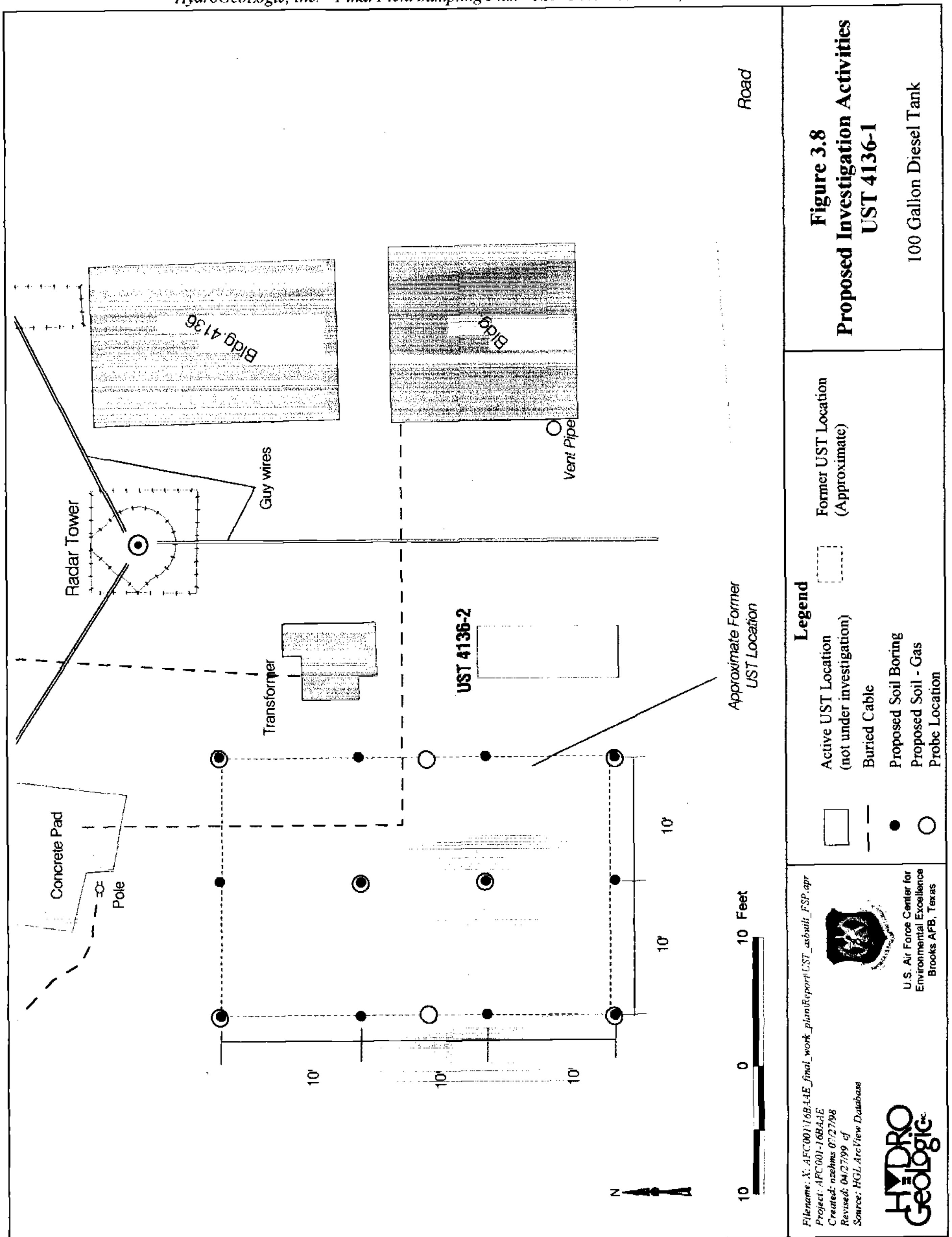
Figure 3.8
Proposed Investigation Activities
UST 4136-1
100 Gallon Diesel Tank
Legend
Active UST Location (not under investigation)
Buried Cable
Proposed Soil Boring
Proposed Soil - Gas Probe Location
Former UST Location (Approximate)
Road
Bldg. 4136
Bldg.
Vent Pipe
Guy wires
Radar Tower
Transformer
UST 4136-2
Approximate Former UST Location
Concrete Pad
Pole
10'
10 Feet
0
10
N
U.S. Air Force Center for Environmental Excellence Brooks AFB, Texas
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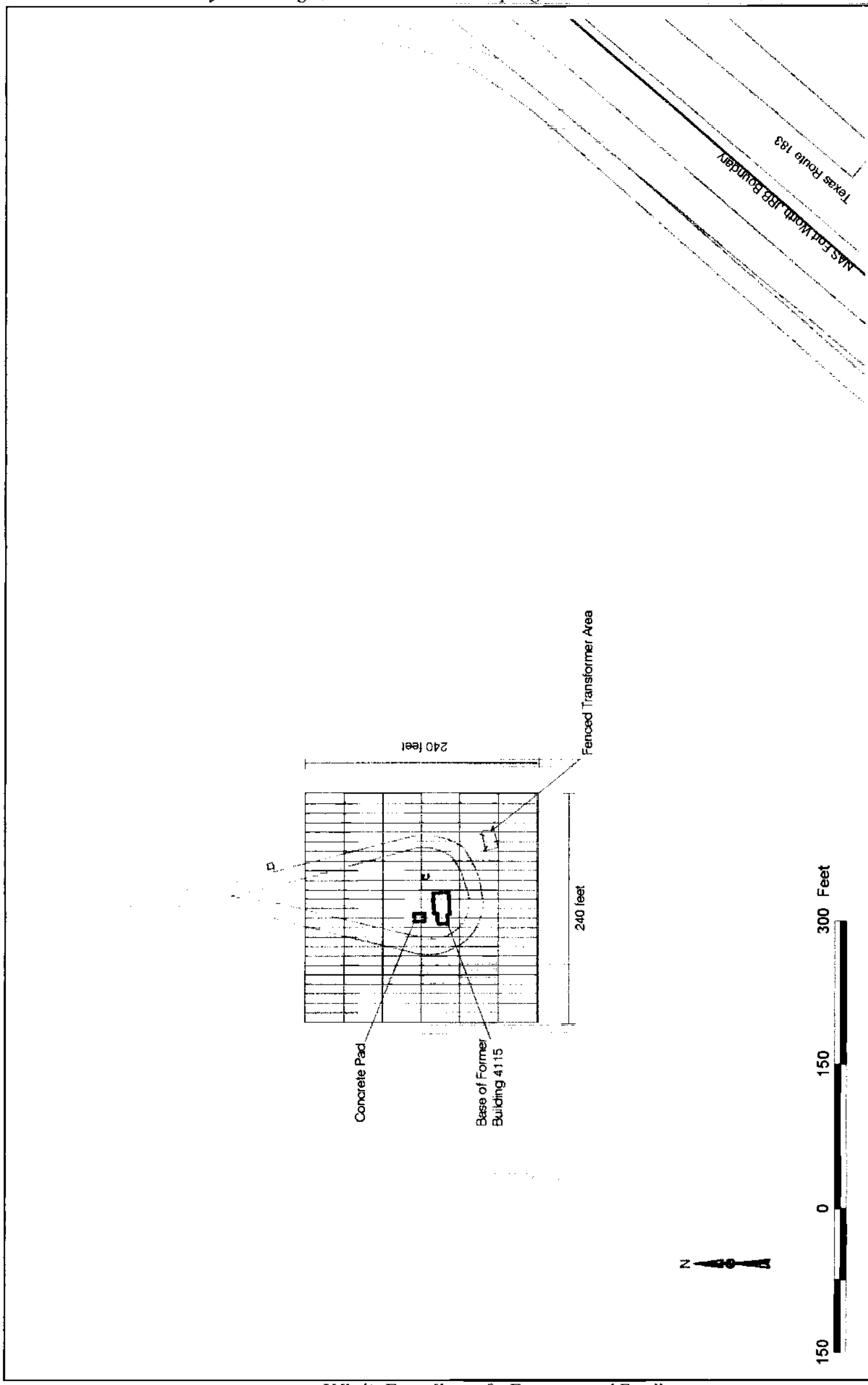

Figure 3.9a
Proposed Investigation Activities

GCA-1 Abandoned Jet Fuel Tank
GCA-2 Abandoned Gasoline Tank

Legend

Proposed Geophysical Grid

Former Location of UST 4115-1

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

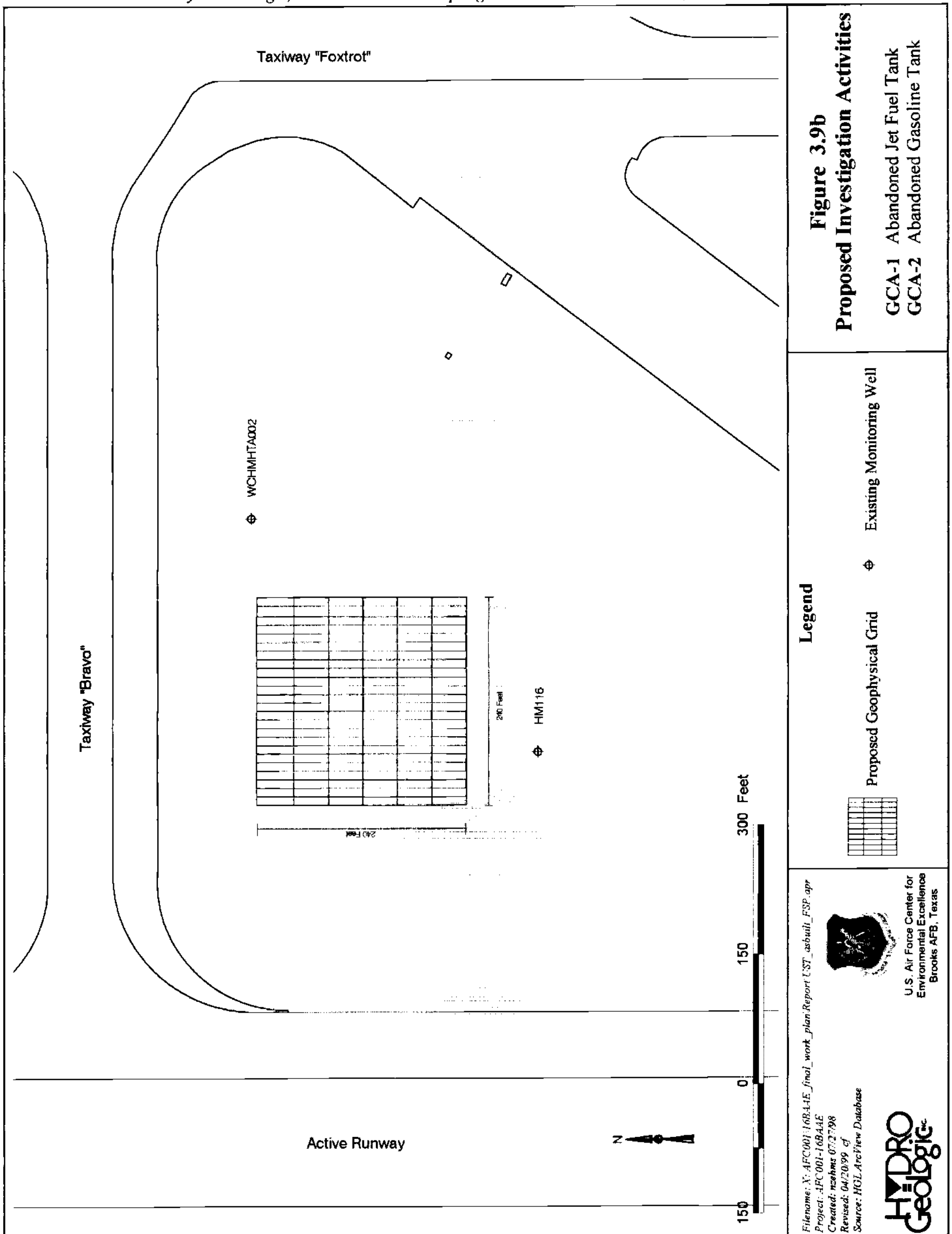

Figure 3.9b
Proposed Investigation Activities
GCA-1 Abandoned Jet Fuel Tank
GCA-2 Abandoned Gasoline Tank

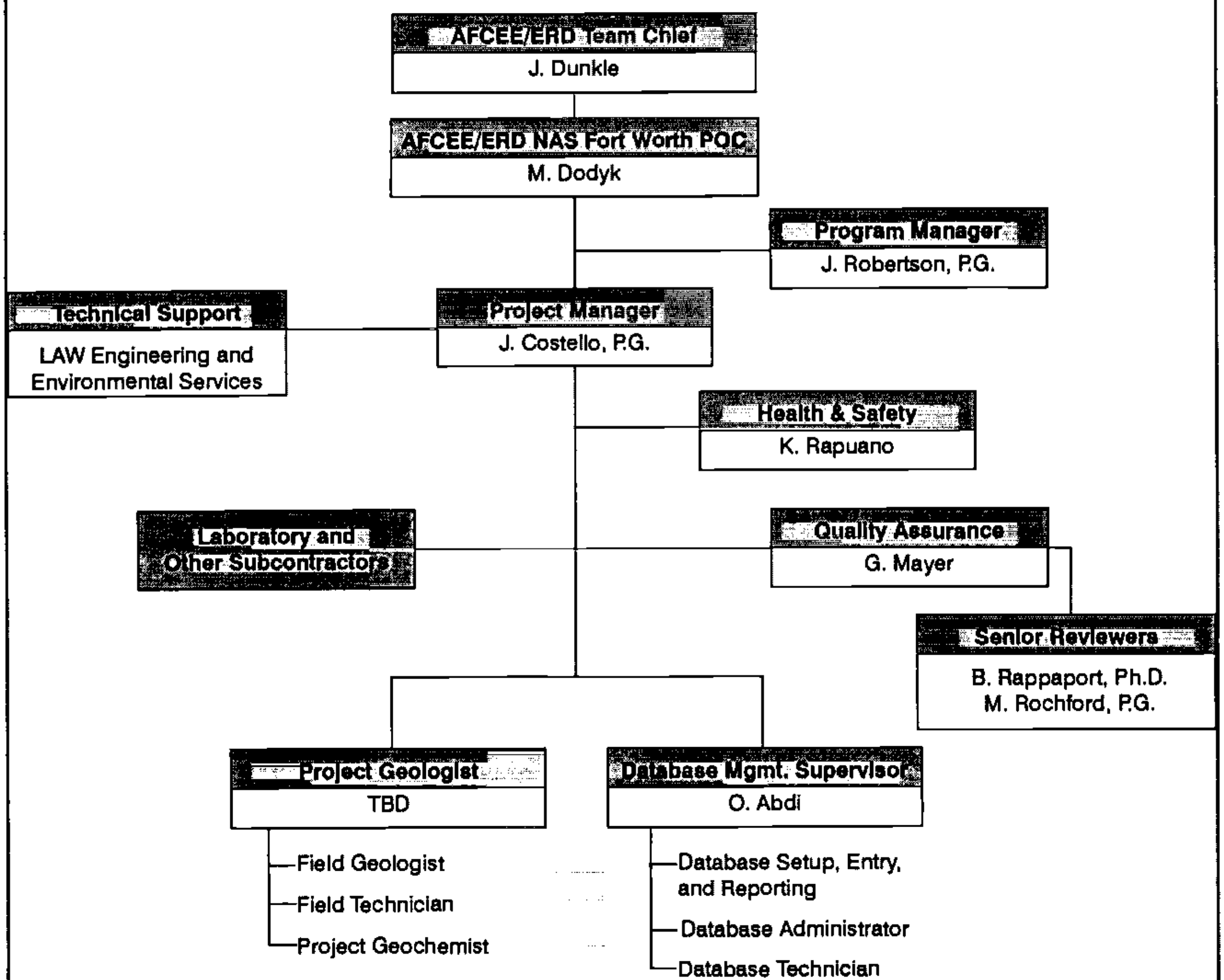

Figure 4.1 Project Organization Chart, NAS Fort Worth JRB, Texas

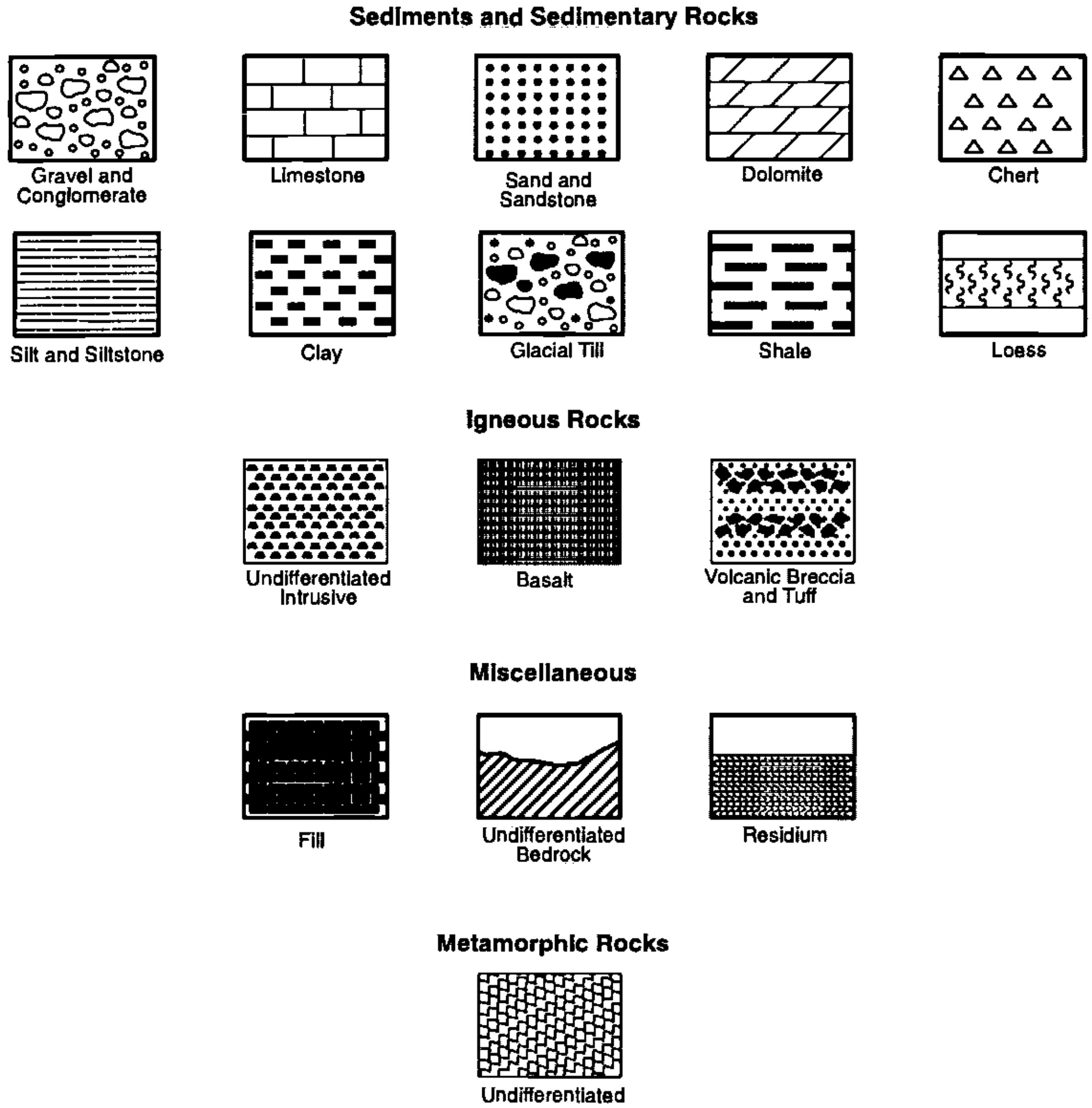

Figure 5.1 Lithologic Patterns for Illustration

TAB

Health and Safety Plan

FINAL
HEALTH AND SAFETY PLAN
SITE INVESTIGATION
12 UNDERGROUND STORAGE TANKS
NAS FORT WORTH JRB, TEXAS

Prepared for

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

Contract Number F41624-95-D-8005

May 1999

480 233

FINAL
HEALTH AND SAFETY PLAN
SITE INVESTIGATION
12 UNDERGROUND STORAGE TANKS
NAS FORT WORTH JRB, TEXAS

Contract Number F41624-95-D-8005
Delivery Order No. 0016

Prepared for

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

Prepared by

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

May 1999

FINAL
HEALTH AND SAFETY PLAN
SITE INVESTIGATION OF 12 UNDERGROUND STORAGE TANKS
AT 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
PROJECT SITE LOCATION:	NAS Fort Worth JRB, Texas
PROJECT MANAGER:	James Costello, P.G.
HEALTH AND SAFETY OFFICER:	Kenneth F. Rapuano
SITE SAFETY OFFICER:	TBA
PLAN PREPARERS:	Miquette Rochford, P.G.
PREPARATION DATE:	May 1999
APPROVED BY:	

Ken Rapuano   Date
HydroGeoLogic, Inc.
Health and Safety Officer

James P. Costello, P.G.   Date
HydroGeoLogic, Inc.
Project Manager

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LIST OF FIGURES

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LIST OF ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
AGE	aerospace ground equipment
ANSI	American National Standards Institute
°C	degrees Celsius
CFR	Code of Federal Regulations
COR	contracting officer's representative
CPC	chemical protective clothing
CPR	cardiopulmonary resuscitation
dB	decibel
EM	electromagnetic
EPA	U.S. Environmental Protection Agency
°F	degrees Fahrenheit
FAR	Federal Acquisition Regulations
FSP	Field Sampling Plan
GCA	ground control approach
HAZWOPER	Hazardous Waste Site Operations and Emergency Response
HCS	hazard communication standard
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
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

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

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
RAPCON	radar approach control
RCO	Responsible Corporate Officer
SAP	Sampling and Analysis Plan
SSO	Site Safety Officer
T	ambient air temperature
T_{aj}	adjusted air temperature
TACAN	tactical air navigation
TLV	Threshold Limit Value
UEL	upper explosive limit
USCG	U.S. Coast Guard
UST	underground storage tank
WP	Work Plan

FINAL
HEALTH AND SAFETY PLAN
SITE INVESTIGATION
12 UNDERGROUND STORAGE TANKS
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 site investigation activities at 12 underground storage tank (UST) sites at the former Carswell Air Force Base, now referred to as the Naval Air Station Fort Worth Joint Reserve Base (NAS Fort Worth JRB), located in Fort Worth, Texas. The request for these activities was identified in the statement of work dated January 21, 1997, under the authorization of the Air Force Center for Environmental Excellence (AFCEE) Contract Number F41624-95-D-8005, Delivery Order Number 0016. This HSP conforms to the requirements of the 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 (HAZWOPER)." Additional guidance for hazardous waste operations may be found in the U.S. Environmental Protection Agency (EPA) publication "Standard Operating Safety Guides" (November 1987), the National Institute of Occupational Safety and Health (NIOSH)/OSHA/U.S. Coast Guard (USCG)/EPA publication "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities" (October 1985), and the Federal Acquisition Regulations (FAR) clause 52.236-13, Accident Prevention.

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

1.2 APPLICABILITY

The provisions of the HSP are mandatory for all official visitors, HydroGeoLogic employees, and subcontractors while investigations are being conducted at NAS Fort Worth JRB. Field activities conducted during this investigation will include a geophysical survey using an electromagnetic (EM) system, soil sampling using soil gas probes, soil boring installation and sampling using direct-push technology, and groundwater sampling from existing monitoring wells. Depending on the results of the preliminary soil analysis, additional groundwater samples may be collected from existing monitoring wells and new monitoring wells may be installed and sampled.

Inadequate health and safety precautions on the part of visitors or subcontractors, or the belief that personnel on the site are or may be exposed to an immediate health hazard, can be cause for HydroGeoLogic to suspend on-site activities and require all personnel to evacuate the area of concern.

1.3 PROJECT ORGANIZATION, PERSONNEL, AND RESPONSIBILITIES

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

1.3.1 Responsible Corporate Officer (RCO)

The RCO for this project will be John Robertson, P.G. (Executive Vice President). The RCO has authority to direct changes to the corporate health and safety program and determines and implements personnel disciplinary actions, as required. The RCO's responsibilities for this project will be to:

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

1.3.2 Health and Safety Officer (HSO)

The HSO for this project will be Kenneth F. Rapuano. The HSO has the authority to do the following:

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

The HSO for this project will perform the following activities:

- Interface with the Project Manager (PM) in matters of health and safety.
- Keep the RCO and PM informed on the status of the site health and safety plan.
- Develop or review and approve project health and safety plans prior to submittal.
- Conduct staff training and orientation on health and safety related activities.
- Appoint or approve a Site Safety Officer (SSO).
- Monitor compliance with health and safety plans and conduct site audits.
- Assist in obtaining required health and safety equipment.
- Approve personnel to work on hazardous waste management projects with regard to medical examinations and health and safety training.
- Maintain records pertaining to medical surveillance, training, fit testing, chemical exposure, and accidents/incidents.
- Provide industrial hygiene/chemical safety guidance.

1.3.3 Project Manager (PM)

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

- 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 the 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 for this project will perform the following activities:

- Ensure that the project is performed in a manner consistent with the health and safety program.

- Ensure that the project health and safety plan is prepared, approved, and properly implemented.

- Provide the HSO with the information needed to develop health and safety plans.

- Ensure that adequate funds are allocated to implement project health and safety plans fully.

1.3.4 Site Safety Officer (SSO)

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

The SSO will report any problems or concern to the HydroGeoLogic HSO 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 principal person responsible for on-site safety. At the facilities, the SSO has primary responsibility for the following activities:

- Directing health and safety activities on a 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 (i.e., 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 preformed 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 document.

- Verifying OSHA 40-hour health and safety training before admitting official site visitors (e.g., Air Force and regulatory representatives) into any work exclusion zone.

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 the following:

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

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

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

1.3.6 Subcontractor Responsibilities

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

2.0 SITE DESCRIPTION INFORMATION

A description of the NAS Fort Worth JRB sites under investigation is presented in Section 1.0 of the Work Plan (WP). Please refer to this section for site description information. The areas of interest for this HSP are 12 USTs located throughout the NAS Fort Worth JRB installation. These USTs are described as follows:

- **UST 1040-1:** UST 1040-1 was installed in 1955 and removed in June 1994. According to as-built drawings, the former UST was located on the northwest side of Building 1040, the water-fire pump facility, and was described as a 400-gallon steel UST used for the storage of diesel fuel. A site visit by HydroGeoLogic and Navy personnel identified hardware on Building 1040 generally associated with a UST vent pipe. A nearby monitoring well was also located.

- **UST 1191-1:** UST 1191-1 was a 500-gallon steel waste oil tank along the south side of Building 1191, the vehicle maintenance shop. As-built drawings did not show the exact location of the tank, but a site visit identified an area of patched concrete that indicates the former UST excavation. The UST was installed in 1983 and was removed in October 1993.

- **USTs 1411-1, 1411-2, and 1411-3:** Building 1411, the aerospace ground equipment (AGE) refueling facility, had three 2,000-gallon steel USTs. UST 1411-1 stored jet fuel, UST 1411-2 stored diesel fuel, and UST 1411-3 stored gasoline. All three USTs were installed in 1963 and were removed in April 1996. The area is currently covered with an 8-inch layer of concrete.

- **UST 1427-1:** UST 1427-1 was a 1,000-gallon steel UST used for storing diesel fuel. As-built drawings accurately located the former UST on the northwest side of Building 1427, the radar approach control (RAPCON) support facility. UST 1427-1 was installed in 1976 and was removed in November 1990.

- **USTs 1750-1 and 1750-2:** Building 1750, the communication relay station, had an 8,000-gallon fiberglass UST (1750-1) and a 20,000-gallon steel UST (1750-2).[1] Both USTs were located near the southwest corner of Building 1750 and were used for the storage of diesel fuel. UST 1750-2 was installed in 1957 and was permanently abandoned in-place in September 1992. UST 1750-1 was installed in 1986 and was removed in May 1996. During the removal of 1750-1, the abandoned tank 1750-2 was observed in the wall of the excavation. Building 1750 and its associated structures no longer exist.

- **UST 4115-1:** UST 4115-1 was a 600-gallon steel diesel tank near Building 4115, the former ground control approach (GCA) site. UST 4115-1 was installed in

[1] The 20,000-gallon steel UST was identified in the Jacobs report as Tank 1750-1. However, the Texas Natural Resource Conservation Commission identified this UST as 1750-2. This document will refer to the 20,000-gallon UST as 1750-2.

1968 and was removed in January 1991. Although the exact location of the former UST was not identified, review of as-built drawings and a site visit to the remaining foundation with Navy personnel identified an approximate area where the UST was located.

- **UST 4136-1:** UST 4136-1 was a 100-gallon steel diesel tank located outside Building 4136, the tactical air navigation (TACAN) station. This tank was installed in 1980 and was removed in January 1991. As-built drawings show the location of the former UST in relation to the former TACAN site. A site visit to the current TACAN area, which was built over the former location, identified an approximate area where the UST may have been located. An existing tank, UST 4136-2, is a 300-gallon fiberglass tank, which is used for storing diesel fuel. UST 45136-2 does not require an investigation.

- **USTs GCA-1 and GCA-2:** Two USTs were identified by the TNRCC Petroleum Storage Tanks Summary Listing as GCA-1 and GCA-2. There was no information on the TNRCC list regarding the tanks except that they may have contained jet fuel (GCA-1) and gasoline (GCA-2), and that they were abandoned on an unknown date. Interviews with Navy personnel indicated that any USTs associated with the GCA site would be small and near a backup generator located at either end of the runway. Navy personnel questioned the existence of these two USTs, stating that it would not by typical to abandon a small UST that could be easily removed. In addition, Navy personnel explained that all USTs on a military base are identified with the number of the building they serve and that the existence of these tanks is questionable due to the lack of a building number and any additional information. A search of Air Force and Navy records in conjunction with additional personal interviews did not reveal any additional information concerning these two tanks.

3.0 SITE INVESTIGATION ACTIVITIES

The site investigation activities to be conducted at the NAS Fort Worth JRB will include the following:

- Completion of a metal detection survey utilizing an EM system in order to confirm the existence of USTs in question.

- Installation of carbonated soil gas samplers to establish the location of a former UST location.

- Installation of direct-push soil borings site-wide requiring a field geologist, field technician, and drilling subcontractor to characterize the soil associated with the subject USTs. Each soil boring will be advanced to the top of the water table for soil characterization and contaminant delineation.

- Groundwater sampling of pre-existing well sites using a submersible pump.

- Installation of monitoring wells at selected sites requiring a field geologist, field technician, and drilling subcontractor for additional delineation if the contaminant levels warrant a Plan A investigation.

4.0 HAZARD ASSESSMENT

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

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

4.1 CHEMICAL HAZARDS

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

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

4.2 DECONTAMINATION SOLUTIONS AND PRESERVATIVES

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

- Nitric acid
- Hydrochloric acid
- Methanol
- Hexane

Although overexposure to these chemicals is unlikely, they are included in Tables 4.1 and 4.2.

In order to communicate the hazards of these chemicals to site personnel, a Material Safety Data Sheet (MSDS) 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, the following:

- 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. See Section 11.0, Standard Work Practices, for safety hazards associated with drilling rigs and support vehicles.

4.3.1 Heat Stress

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

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

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

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

- Heat stroke is the most serious form of heat stress. Temperature regulation fails, and the body temperature rises to critical levels. Immediate action must be taken to cool the body before serious injury or death occurs. When heat stroke is suspected, professional medical assistance 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).

The initial 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.

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

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

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

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

- Encourage workers to maintain an optimal level of physical fitness. Where indicated, acclimatize workers to site work conditions.

- Train workers to recognize, identify, and treat heat stress.

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

- Get the victim out of the heat.

- Loosen tight clothing.

- Remove perspiration-soaked clothing.

- Apply cool, wet cloths to the skin.

- Fan the victim.

- If the victim is conscious, give cool water to drink. Do not give electrolyte solutions (i.e., those containing salt) to victims of heat stress because it can cause nausea and vomiting. Only small sips of cool water should be administered to heat stress victims.

- Call for an ambulance if the victim refuses water, vomits, starts to lose consciousness, or shows symptoms of heat stroke.

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. This is especially true with regard to the wearing of Tyvek® suits. Because such disposable clothing does not "breathe," perspiration does not evaporate, and the suits can become wet. Wet clothes combined with cold temperatures can lead to hypothermia. If the air temperature is less than 40 °F and an employee perspires, the employee must change to dry clothes at regular intervals.

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 warm the body. Immediate first aid and medical treatment are required.

- Third-degree frostbite will appear as blue, blotchy skin. The tissue is cold, pale, and solid. Immediate medical attention is required.

- Hypothermia develops when body temperature falls below a critical level. In extreme cases, cardiac failure and death may occur. Immediate medical attention is warranted when the following symptoms are observed: involuntary shivering; irrational behavior; slurred speech; and sluggishness.

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

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

4.3.3 Noise Hazards

The SSO, or designee, will monitor high noise levels when equipment or machinery (e.g. backhoe, drill rig, etc.) is being used on-site. Field personnel working in areas where noise levels can be expected to reach or exceed 85 decibels (dB) will be issued hearing protection to reduce the level below the 85 dB threshold. Compliance standards for occupational noise exposure are found in 29 CFR 1910.95.

4.3.4 Materials Handling

The most common type of materials handling accident involves fingers or toes of field personnel becoming caught between two objects. Special precautions must be implemented during the moving, shifting, or rolling of materials. These activities should never be attempted by a single individual.

4.3.5 Utility Hazards

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

4.4 BIOLOGICAL HAZARDS

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

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

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

4.4.1 Poisonous Snakes and Spiders

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

Spiders in the United States are generally harmless, with two notable exceptions: the black widow spider (*Latrodectus mactans*) and the brown recluse or violin spider (*Lox osceles reclusa*). The symptoms of a black widow spider bite are slight local reaction, severe pain produced by nerve toxin, profuse sweating, nausea, painful cramps in abdominal muscles, and difficulty in breathing and speaking. 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 logs, rocks, covers to manholes, sumps, etc.

4.4.1.1 First Aid Procedures (Snakebite)

The objective of first aid is to reduce the circulation of blood through the bite area, to delay absorption of venom, to prevent aggravation of the local wound, and to sustain respiration. Several steps are listed to properly care for a snakebite victim. The most important step is to transport the snakebite victim to the hospital quickly. All investigation activities will be performed at NAS Fort Worth JRB, and a local hospital (Harris Methodist Hospital) is within reasonable travel time. Meanwhile, take the following first aid measures:

- Keep the victim from moving around.
- Keep the victim as calm as possible and preferably in a lying down 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 three-quarters to one and one-half 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 ensure that the blood flow has not stopped.

Several other factors must be considered in cases of snakebite:

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

4.4.1.2 General First Aid for Poisonous Insect Bites

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

- Apply a constricting band above the injection site on the victim's arm or leg (between the site and the heart). Do not apply tightly. You should be able to slip your index finger under the band when it is in place. Give artificial respiration, if necessary;
- Keep the affected part below the level of the victim's heart.
- If medical care is readily available, leave the band in place; otherwise, remove it after 30 minutes.
- Apply ice contained in a towel or plastic bag, or cold cloths, to the site of the sting or bite.
- Give home medicine, such as aspirin, for pain.

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

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

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

4.4.2 Ticks and Chiggers

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

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

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.
- Remove any attached ticks by tugging with tweezers where the tick's mouth parts enter the skin. Do not squeeze or crush it.

4.4.2.1 Lyme Disease

Lyme disease is an illness caused by a bacterium that may be transmitted by the bite of the 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; however, 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.

4.4.2.2 Rocky Mountain Spotted Fever

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

4.4.2.3 Other Diseases

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

4.4.3 Poisonous Plants

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

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

4.4.3.1 First Aid Procedure

- Remove contaminated clothing.
- Wash all exposed areas thoroughly with soap and water, followed by rubbing alcohol.

- Seek medical advice if a severe reaction occurs, or if there is a known history of previous sensitivity.

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

In order to comply with the HCS, HydroGeoLogic has determined that:

- All containers of hazardous chemicals must be appropriately labeled or tagged to identify the hazard and provide information on effects and appropriate protective measures.

- Labels, tags, or signs must be properly affixed and visible at all times while a hazard is present and removed promptly when the hazard no longer exists.

- Written information (i.e., MSDSs) on hazardous chemicals in the workplace must be available to employees working with the substances.

- Appropriate MSDSs will be available to any contractor or subcontractor employee working on projects under HydroGeoLogic'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 which they are to be used, techniques for their use, action levels for upgrading/downgrading levels of protection, and methods for instrument maintenance and calibration.

6.1 INSTRUMENTS AND USE

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

A PID and Draeger pump, if necessary, will be used throughout the execution of the following activities:

- Soil boring installation
- Monitoring well installation
- Soil sampling during drilling activities
- Well development
- Groundwater sampling
- Sampling equipment decontamination/equipment (heavy) decontamination
- Waste characterization and disposal

LEL/O_2 and methane detectors will be used throughout the execution of soil boring/monitoring well installation if flammable contaminants are anticipated.

6.2 AIR MONITORING REQUIREMENTS

6.2.1 Photoionization Detector

Air monitoring with a PID will be initiated at potential sources of vapor emissions (source monitoring) at specified frequencies. The following potential sources and monitoring frequencies are anticipated:

- Boreholes - Every 5 feet
- Open well heads - Upon initial opening
- Environmental sampling - Every sample set
- Surface/subsurface soil sampling - Every 5 feet
- Investigative derived waste characterization - Every container to be sampled

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

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

6.2.2 Draeger Pump and Tubes

A hand operated Draeger pump with colorimetric tubes will be used to confirm the results of PID testing. If the results of the PID tests show concentrations greater than 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, and/or trichloroethene in accordance with Table 6.1. The colormetric tube utilized will depend on the chemical(s) anticipated to be present at the site.

6.2.3 LEL/O_2 and Methane Detectors

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

6.2.4 Visual Observations

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

6.3 MODIFICATION OF AIR MONITORING REQUIREMENTS

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

6.4 INSTRUMENT MAINTENANCE AND CALIBRATION

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

6.5 RECORDKEEPING

Instrument calibrations and readings will be recorded on the air monitoring log sheet provided in Section 14.1 of this HSP. Copies of these log sheets will be maintained on-site until field activities covered by this HSP have been completed. Afterwards the log sheets will be transmitted to the HydroGeoLogic HSO and to the project file.

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

The LEL/O_2, methane detector, and PID will undergo daily operational checks. These checks will be recorded in the field log book and the 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

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

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

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 of field personnel prior to using respiratory protection include:

- All field personnel will be medically certified to wear a full face respirator and have the proper fit test documentation within the past 12 months prior to assignment.

- Only NIOSH-approved respirators are to be used on-site. The respirators are to be properly cleaned, inspected, and maintained prior to and at the conclusion of the work day.

- Used cartridges for 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-toed work boots were selected 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 were selected to minimize contamination of work clothes and to prevent direct skin contact with low-level contamination. Nitrile gloves of 11-mil thickness or greater were selected 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 were selected to prevent saturation of work clothes during activities involving large volumes of liquids and/or saturated soils/equipment.

7.3 PPE MODIFICATION CRITERIA

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

7.3.1 CPC Modification Criteria

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

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

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

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

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

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

Gloves and other PPE should be inspected frequently for integrity, and 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 WP. 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 WP. Decontamination and rinse solution will be contained on-site prior to disposal. Reusable rubber clothing will be cleaned, dried, and prepared for future use. If contamination of reusable 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 kept at the field office. On 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 for disposal after the analyses of the samples have been obtained.

8.2 EQUIPMENT DECONTAMINATION

All sampling equipment will be decontaminated prior to use, between sampling locations, and at the end of sampling activities to avoid cross-contamination. Furthermore, this approach will decrease the amount of contact of personnel with contaminated materials and reduce the probability of removing contamination from the site. The procedures for decontaminating equipment are presented in Section 5.5 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 ensure that the employee is 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 who 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 HAZWOPER course including 24 hours of actual field experience under the direction of a trained supervisor, and any subsequent annual 8-hour refresher courses. In addition, the on-site field leader will have completed an 8-hour supervisory course. In addition, a majority of HydroGeoLogic field investigation personnel are also current in first aid/CPR training requirements. HydroGeoLogic employee records are on file in the 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 have equivalent work experience as defined in OSHA Standard 29 CFR 1910.120(e) prior to performing work at the site. In addition, subcontractor personnel must also have successfully completed any subsequent annual 8-hour refresher training.

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

10.1.3 Requirements for Site Visitors

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

10.2 SITE-SPECIFIC TRAINING

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

- The contents of the HSP
- Names of personnel and alternates responsible for site health and safety

- Safety, health, and other hazards present on the site
- Use of personal protective equipment
- Work practices by which the employees can minimize risks from hazards
- Safe use of engineering controls and equipment on the site
- Medical surveillance requirements, including recognition of symptoms and signs 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.
- Eating, drinking, chewing gum or tobacco, taking medication, applying cosmetics, and/or smoking are prohibited in the exclusion and decontamination zones, or any location where a possibility for contact with site contaminants exists.
- The required level of PPE must be worn by all on-site personnel to include at a minimum steel-toed safety boots, safety glasses, and hard hat, if necessary.
- Upon leaving the exclusion zone, hands and face must be thoroughly washed. Any protective outer clothing is to be decontaminated and removed as specified in this HSP, and left at a designated area prior to entering the clean area.
- Contact with potentially contaminated substances must be avoided. Contact with the ground or with contaminated equipment must also be avoided. Air monitoring equipment must not be placed on potentially contaminated surfaces.
- No facial hair that interferes with a satisfactory fit of the mask-to-face seal is permitted on personnel required to wear respiratory protective equipment.
- All personnel must satisfy medical monitoring procedures.
- No flames or open fires will be permitted on-site.
- All personnel must be aware of and follow the action levels presented in this HSP for upgrading respiratory protection.
- Any new analytical data must be promptly conveyed via telephone to the project HSO by the laboratory technician or field leader.
- Personnel must develop hand signals with operators of heavy equipment (i.e., drillers, geoprobe operators, etc.). Standard hand signals to be used by personnel for nonverbal communication include the following:

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 hand giving the motion signal.
Emergency Stop	With arm extended to the side and palm down, move hand rapidly right and left.

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

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

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

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

- No person will enter an 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 the following:

    - Size up the load before trying to lift it, test the weight, and get help if needed.
    - Bend the knees.
    - 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 (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 OSHA standards.

- The SSO must make an entry into the site field log book, 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) and 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 and specifically to attach sections of drilling tools together. Pins that protrude from augers shall not be allowed.

A variety of additional work practices (i.e., hoisting, cat line, pipe and auger handling, etc.) are to be adhered to by the drilling crew. These practices 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 understanding 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 (i.e., methane). Heavier than air gases and vapors tend to stay close to the ground and may migrate to low-lying areas (i.e., hydrogen sulfide). In general, the only containment that can be done for a release to the air is termination of the release at the source by plugging 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 levels (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 time, and spills will be cleaned up immediately. Housekeeping will be the responsibility of all employees.

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

- Daily policing of the area for 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

Site personnel are not to undertake any activity in an area that could be considered to have a confined-space entry.

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 the appropriate Department of Transportation, OSHA, and EPA regulations for the waste that they will contain.

- Drums and containers will be inspected and their integrity verified 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 drum or container movement.

- Employees involved in drum or container operations will be warned of the hazards associated with the containers.

- Where spills, leaks, or ruptures may occur, adequate quantities of spill containment equipment (absorbent, pillows, etc.) will be stationed in the immediate area. The spill containment program must be sufficient to contain and isolate the entire volume of hazardous substances being transferred.

- Drums or containers that cannot be moved without failure will be emptied into a sound container.

- Fire extinguishing equipment meeting 29 CFR Part 1910.Subpart 1 shall be on hand and ready for use to control fires.

12.0 SITE CONTROL

12.1 WORK ZONES

Each investigation location will be physically barricaded with rope flagging or caution tape to control entry and exit into and from the area. These barricaded areas will be referred to as the exclusion zones. The exclusion zone will be identified by the site supervisor and consist of a 20-foot radius surrounding the drilling or test pit location. Each person leaving an exclusion zone will proceed directly to the decontamination zone, which will be located adjacent to the exclusion zone and also identified by physical barriers. The decontamination zone will consist of a low-lying area covered with a plastic sheeting. At the completion of decontamination procedures at each location, the debris will be enclosed in the plastic sheeting and deposited into 55-gallon type 17 E/H drums for later disposal as identified in the WP 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 develop 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 NAS Fort Worth JRB'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.

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 POC for outside emergency personnel and on-site personnel.

- The site supervisor will advise emergency response and emergency room personnel to the types of contamination potentially contacted by injured workers receiving emergency care.

- The site supervisor will ensure that the SSO promptly notifies the HydroGeoLogic PM and HSO of the incident.

13.2.1 Chemical Inhalation

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

13.2.2 Eye and Skin Contact

Field personnel who have come into contact with contaminants while in the exclusion zone will immediately proceed to the decontamination zone, where an eyewash station will be located. Do not decontaminate prior to using the eyewash. Remove necessary PPE to perform the eyewash procedures. Flush the eye with clean water for at least 15 minutes and arrange for prompt transport to the designated medical facility.

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

13.3 PROCEDURES FOR PERSONNEL REMAINING ON SITE

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

13.4 PROCEDURES TO ACCOUNT FOR SITE PERSONNEL

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

13.5 RESCUE AND MEDICAL DUTIES

Only those persons who have been trained by the American Red Cross, or equivalent, will be permitted to perform 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 of symptoms of overexposure must immediately be examined by a licensed physician. Subcontractor personnel who show signs or symptoms of overexposure will be encouraged to visit a licensed physician as well. Table 13.1 gives 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

On receiving a report of accident/incident (or near-incident) occurrence the SSO shall immediately investigate the circumstances and shall make appropriate recommendations to prevent recurrence. The HSO shall also be immediately notified by telephone of any serious accident or incident. At his discretion, he may also participate in the investigation.

Details of the incident shall be documented on an accident/incident report 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 the site support facilities.

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 that all of the necessary resources are available to carry out the requirements of the HSP.

14.1 DOCUMENTATION AND FORMS

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

- Site safety briefing forms
- HSP compliance agreement forms
- HSP amendments forms
- Accident/incident report forms
- Personnel medical data sheets
- Equipment calibration logs
- Air monitoring logs

In addition, the following documentation will be present on-site during 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
- Ear defenders/plugs
- Eye wash
- Inner latex or vinyl gloves
- Outer nitrile gloves (disposable and 11-mil thickness)
- Boot covers
- Hard hats and safety glasses
- Tyvek® coveralls
- PVC and/or Saranex® coveralls (with hoods)
- Decontamination kit
- Fire extinguisher
- Fall protection devices (body harness and lanyard)
- Duct tape
- LEL/O_2 meter
- Methane detector
- 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

Dräger Corporation (Kurt Leichnitz, compiler), "Detector Tube Handbook", 7th Edition, July 1989.

Federal Acquisition Regulation, FAR Clause 52.236-13: Accident Prevention.

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

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

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

TAB

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				
Organic Analytes									
Anthracene	see coal tar pitch volatiles								
Benzene	1 ppm	500 ppm (Ca[e])	Colorless	Aromatic	Liquid (freezes at 42°F)	1.5-5	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	5000 mg/m^3 (Ca[e])	Colorless	Slight	Oily liquid	ND	0.3% (at 474°F)	ND	ND
n-Butylbenzene	NA	ND	Clear	Aromatic	Liquid	ND	ND (combustible)	ND (combustible)	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				
sec-Butylbenzene	NA	ND	Clear	Aromatic	Liquid	ND	ND (combustible)	ND (combustible)	ND
Chlordane (alpha and gamma isomers)	0.5 mg/m^3	100 mg/m^3 (Ca[e])	Amber	Chlorine	Viscous liquid	ND	NA	NA	ND
Chrysene	see coal tar pitch volatiles								
Coal tar pitch volatiles	0.2 mg/m^3	80 mg/m^3 (Ca[e])	Black or brown	None	Solid	NA	NA	NA	NA
1,2-Dichloroethene (total)	200 ppm	1,000 ppm	Colorless	Acrid, chloroform-like	Liquid	ND	5.6	12.8	9.65
Dieldrin	0.25 mg/m^3	50 mg/m^3 (Ca[e])	Colorless to light tan	Mild, chemical	Crystals	ND	NA	NA	NA
Ethylbenzene	100 ppm	2,000 ppm	Colorless	Aromatic	Liquid	4.7-50	1.00	6.70	8.76
Fluoranthene	see coal tar pitch volatiles								
Gasoline	ND	ND (Ca[e])	Clear	Gasoline	Liquid	ND	1.4	7.6	ND
Hexane	500 ppm	1,100 ppm	Colorless	Gasoline	Liquid	ND	1.1	7.5	10.18
Indeno[1,2,3-*cd*]pyrene	see coal tar pitch volatiles								
Isopropylbenzene	50 ppm	900 ppm	Colorless	Sharp, aromatic	Liquid	ND	0.9	6.5	8.75
Methanol	200 ppm	6,000 ppm	Colorless	Pungent	Liquid	5	6.0	36.0	10.84

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				
Methylene chloride	25 ppm	2,300 ppm (Ca[e])	Colorless	Chloroform-like	Liquid	100 ppm	13	23	11.32
Naphthalene	10 ppm	250 ppm	Colorless to brown	Mothballs	Solid	ND	0.9	5.9	8.12
Phenanthrene	see coal tar pitch volatiles								...
Pyrene	see coal tar pitch volatiles								
1,1,2,2-Tetrachloroethane	5 ppm	100 ppm (Ca[e])	Colorless to pale yellow	Pungent, chloroform-like	Liquid	ND	NA	NA	11.10
Tetrachloroethene	100 ppm	150 ppm	Colorless	Chloroform-like	Liquid	ND	NA	NA	9.32
Toluene	200 ppm	500 ppm	Colorless	Aromatic	Liquid	0.17-40	1.1	7.1	8.82
1,1,2-Trichloroethane	10 ppm	100 ppm (Ca[e])	Colorless	Sweet, chloroform	Liquid	ND	6	15.5	11.00
Trichloroethene	100 ppm	1,000 ppm	Colorless	Chloroform-like	Liquid	20	8.0	10.5	9.45
Trichlorofluoromethane	1,000 ppm	2,000 ppm	Colorless	Nearly odorless	Liquid (gas >75°F)	ND	NA	NA	11.77
Vinyl chloride	1 ppm	ND (Ca[e])	Colorless	Pleasant	Gas (liquid < 7°F)		3.6	33.0	9.99
Xylenes (total)	100 ppm	900 ppm	Colorless	Aromatic	Liquid	1-1.5	1.1	7.0	8.50

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				
Inorganic Analytes									
Antimony	0.5 mg/m³	50 mg/m³	a) Silver-white b) Lustrous gray	NA	a) Solid or scales b) Powder	NA	NA	NA	NA
Arsenic	0.05 mg/m³	5 mg/m³ (Ca[e])	Silver-gray	NA	Metal	NA	NA	NA	NA
Barium (as barium compounds)	0.5 mg/m³	50 mg/m³	White	NA	Solid	NA	NA	NA	NA
Beryllium	0.002 mg/m³	4 mg/m³ (Ca[e])	Gray-white	NA	Metal	NA	NA	NA	NA
Cadmium	0.005 mg/m³	9 mg/m³ (Ca[e])	Bluish-silver	NA	Metal	NA	NA	NA	NA
Chromium (as chromic compounds)	0.5 mg/m³	25 mg/m³	Bright orange, yellow, or red	NA	Powder or crystal	NA	NA	NA	NA
Cobalt	0.1 mg/m³	20 mg/m³	Silver to black	NA	Solid	NA	NA	NA	NA
Copper	1 mg/m³	100 mg/m³	Reddish	NA	Metal	NA	NA	NA	NA
Hydrochloric acid	5 ppm (ceiling)	50 ppm	Clear to yellowish	Pungent	Solution	<5	NA	NA	12.74
Lead	0.05 mg/m³	100 mg/m³	Gray	NA	Solid	NA	NA	NA	NA
Manganese	5 mg/m³ (ceiling)	500 mg/m³	Silvery	NA	Solid	NA	NA	NA	NA
Mercury	0.1 mg/m³	10 mg/m³	Silver-white	Odorless	Liquid	NA	NA	NA	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				
Nickel	1 mg/m³	10 mg/m³ (Ca[e])	Silvery	NA	Solid	NA	NA	NA	NA
Nitric acid	2 ppm	25 ppm	Colorless, yellow, or red	Acrid, suffocating	Solution	0.5 (as nitrogen dioxide)	NA	NA	11.95
Selenium	0.2 mg/m³	1 mg/m³	Red to gray	NA	Solid	NA	NA	NA	NA
Silver	0.01 mg/m³	10 mg/m³	Silvery	NA	Solid	NA	NA	NA	NA
Sodium hydroxide	2 mg/m³	10 mg/m³	a) White b) Colorless	NA	a) Crystals b) Solution	NA	NA	NA	NA
Sulfuric acid	1 mg/m³	15 mg/m³	Colorless, yellow, or brown	Odorless	Solution	NA	NA	NA	ND

[a] OSHA Permissible Exposure Limit (PEL) or American Conference of Governmental Industrial Hygienists Threshold Limit Value - Time Weighted Average (TWA); those values in parentheses are PEL values that were vacated in 1993 by an appeals courts decision
[b] Immediately Dangerous to Life or Health (IDLH)
[c] Lower Explosive Limit (LEL)
[d] Upper Explosive Limit (UEL)
[e] To be treated as a carcinogen
[f] This class of compounds comprises the benzene-soluble fraction of coal tar.

NA = Not applicable
ND = Not determined
Ca = Carcinogen
ppm = parts per million
Source: N10SH, 1997
Dräger, 1989

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

Compound	Symptoms of Overexposure	First Aid Treatment
Organic analytes		
Anthracene	See coal tar pitch volatiles	
Benzene	Irritation to eyes, nose; respiratory systems; giddiness; headache, nausea; staggered gait; fatigue; anorexia; lassitude; dermatitis; bone marrow depressant/depression; abdominal pain; (carcinogenic)	Eye: Irrigate immediately Skin: Soap wash immediately Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
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 to eyes and mucous membranes; carcinogenic	Eye: Irrigate immediately Skin: Soap wash immediately Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
n-Butylbenzene	Toxic by ingestion; see gasoline	
sec-Butylbenzene	Toxic by ingestion; see gasoline	
Chlordane (alpha and gamma isomers)	Blurred vision; confusion; ataxia, delirium; coughing; abdominal pain, nausea, vomiting, diarrhea; irritability, tremors, convulsions; anuria; carcinogenic	Eye: Irrigate immediately Skin: Soap wash immediately Inhalation: Move to fresh air; 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

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

Compound	Symptoms of Overexposure	First Aid Treatment
1,2-Dichloroethene (total)	Irritation to eyes and respiratory system; central nervous system depression	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Dieldrin	Headache, dizziness; nausea, vomiting, malaise, sweating; myoclonic limb jerks; clonic, tonic convulsions; coma; carcinogenic	Eye: Irrigate immediately Skin: Soap wash immediately Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Ethylbenzene	Irritation to eyes, mucous membranes; headache; dermatitis; narcosis; coma	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Fluoranthene	See coal tar pitch volatiles	
Gasoline	Irritation to eyes, skin, and mucous membranes; dermatitis; headaches, fatigue, blurred vision, slurred speech, confusion, convulsions; chemical pneumonia; possible liver and kidney damage; carcinogenic	Eye: Irrigate immediately Skin: Soap wash immediately Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Hexane	Irritation to eyes and nose; light-headedness, headache; numb extremities; muscle weakness; dermatitis; giddiness; chemical pneumonia	Eye: Irrigate immediately Skin: Soap wash immediately Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Indeno(1,2,3-cd)pyrene	See coal tar pitch volatiles	
Isopropylbenzene	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
Methanol	Irritation to eyes, skin, and upper respiratory system; headache, drowsiness, dizziness, vertigo, light-headedness, nausea, and vomiting; visual disturbance, optic nerve damage (blindness); dermatitis	Eye: Irrigate immediately Skin: Water flush promptly 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
Methylene chloride	Irritation to eyes and skin; fatigue, weakness, sleepiness, light-headedness; numb tingling limbs; nausea; carcinogenic	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Naphthalene	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
Phenanthrene	See coal tar pitch volatiles	
Pyrene	See coal tar pitch volatiles	
1,1,2,2-Tetrachloroethane	Irritation to eyes and skin; weakness, restlessness, irregular respiration, muscular incoordination	Eye: Irrigate immediately Skin: Soap wash immediately Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Toluene	Fatigue; weakness; confusion; euphoria; dizziness; headache; dilated pupils; lacrimation; nervousness; muscle fatigue; insomnia; paresis; dermatitis; photophobia	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
1,1,2-Trichloroethane	Irritation to eyes and nose; central nervous system depression; liver and kidney damage; dermatitis; carcinogenic	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Trichloroethene	Headache, vertigo; visual disturbance, tremors, somnolence, nausea, vomiting; irritation of the eyes; dermatitis; cardiac arrhythmias, paresthesia; carcinogen	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Trichlorofluoromethane	Incoherence, tremors; dermatitis; cardiac arrhythmia, cardiac arrest; asphyxia; contact with liquid may cause frostbite	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
Vinyl chloride	Weakness; abdominal pain, gastrointestinal bleeding; enlarged liver; pallor or cyanosis of extremities; contact with liquid may cause frostbite; carcinogenic	Eye: Treat for frostbite Skin: Treat for frostbite Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Xylenes (total)	Dizziness; excitement; drowsiness; incoordination; staggering gait; irritation of eyes, nose, throat; corneal vacuolization; anorexia; nausea; vomiting; abdominal pain; dermatitis	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Inorganic Analytes		
Antimony	Irritation to eyes, nose, throat, and mouth; coughing; dizziness; headache; nausea, vomiting, diarrhea, stomach cramps; insomnia; anorexia; sleep disorders	Eye: Irrigate immediately Skin: Soap wash immediately Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Arsenic	Ulceration of nasal septum; dermatitis; gastrointestinal disturbances; peripheral neuropathy; respiratory irritation; hyperpigmentation of the skin; carcinogenic	Eye: Irrigate immediately Skin: Soap wash immediately Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Barium	Irritation of the eyes, skin, and upper respiratory system; skin burns; gastroenteritis; muscle spasms; slow pulse; extrasystoles; hypokalemia	Eye: Irrigate immediately Skin: Water flush immediately Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Beryllium	Irritation to eyes; dermatitis, carcinogenic; berylliosis (chronic exposure): anorexia, low-weight, weakness, chest pains, coughing, clubbing of fingers, cyanosis, pulmonary insufficiency	Eye: Irrigate immediately Skin: Soap 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
Chromium (as chromic compounds)	Irritation to eyes; sensitization dermatitis; note that chromium (VI) compounds are potent carcinogens and are mildly corrosive	Eye: Irrigate immediately Skin: Water flush promptly Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Cobalt	Coughing, dyspnea, wheezing, decreased pulmonary functioning; low weight; dermatitis; diffuse nodular fibrosis; respiratory hypersensitivity; asthma	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Copper	Irritation to eyes, nose, and pharynx; nasal perforation; metallic taste; dermatitis;	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Hydrochloric acid	Irritation to nose, throat, and larynx; coughing, choking; dermatitis; eye and skin burns	Eye: Irrigate immediately Skin: Water flush immediately 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 leadline; tremor; paralysis of wrist and ankles; encephala opathy; nephropathy; irritation to eyes; hypertension	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Manganese	Parkinsonism; asthenia, insomnia, mental confusion; low back pain; vomiting; malaise; fatigue; kidney damage; metal fume fever: dry throat, cough, chest tightness, dyspnea, rales, flu-like fever	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Mercury	Cough, chest pain, dyspnea, bronchitis pneumonitis; tremor, 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: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Nickel	Sensitization dermatitis; allergic asthma; pneuitis; carcinogenic	Eye: Irrigate immediately Skin: Water flush 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
Nitric acid	Irritation to eyes, skin, mucous membranes; delayed pulmonary edema, pneuitis, bronchitis; dental erosion; skin and eye burns	Eye: Irrigate immediately Skin: Water flush immediately Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Selenium	Irritation to eyes, skin, nose, and throat; visual disturbances; headache; chills, fever, dyspnea, bronchitis, metallic taste; garlic breath; gastrointestinal disturbances; eye and skin burns	Eye: Irrigate immediately Skin: Soap wash immediately Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Silver	Blue-gray eyes, nasal septum, throat, skin; irritation or ulceration of the skin; gastrointestinal disturbances	Eye: Irrigate immediately Skin: Water flush promptly Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Sodium hydroxide	Irritation to eyes, skin, and mucous membrane; pneuitis; eye and skin burns; temporary loss of hair	Eye: Irrigate immediately Skin: Water flush immediately Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
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

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 - 90 °F	After each 60 minutes of work	After each 30 minutes of work
82.5 - 87.5 °F	After each 90 minutes of work	After each 60 minutes of work
77.5 - 82.5 °F	After each 120 minutes of work	After each 90 minutes of work
72.5 - 77.5 °F	After each 150 minutes of work	After each 120 minutes of work

[1] Calculate the adjusted air temperature (T_{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 tetrachloroethylene and TCE colorimetric tubes -if confirmed as tetrachloroethene and/or TCE, then see specific hazard identified below -if denied as tetrachloroethylene 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 tetrachloroethylene)	Level C (see Table 7.1)	-continue with regular monitoring of breathing zone - contact HSO and Project Manager - continue use of tubes, attempt to identify unknown air contaminants
Vinyl Chloride	Colorimetric Tubes	confirmed 1.0 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 to 5 ppm or greater above background based on judgment of SSO	Level C (See Table 7.1)	-continue regular monitoring of breathing zone
Tetrachloroethene	Colorimetric Tubes	confirmed 25 to 50 ppm above background based on judgment of SSO	Level C (See Table 7.1)	-continue regular monitoring of breathing zone
Trichloroethylene	Colorimetric Tubes	confirmed 50 to 500 ppm above background based on judgment of SSO	Level C (See Table 7.1)	-continue regular monitoring of breathing zone

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

Hazard	Monitoring Method	Action Level	Protective Measures	Monitoring Schedule
Flammable/Explosive Gases and/or Vapors	LEL/O_2 and Methane Detector	0.0 to 5.0 percent LEL	-notify sampling team of readings	-prior to and during sampling activities, monitor all areas suspected of containing flammable/explosive gases and/or vapors -continue with regular monitoring of breathing zone
Flammable/explosive bases and vapors	LEL/O_2 and Methane Detector	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
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
Tetrachloroethylene	Colorimetric Tubes	confirmed 250 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
Trichloroethylene	Colorimetric Tubes	confirmed 500 ppm or greater above background based on judgment of SSO	STOP WORK, EVACUATE AREA, NOTIFY PROJECT MANAGER	- requires HSP amendments

Source: NIOSH/OSHA/USCG/EPA, 1985

Table 7.1
Protective Equipment for On-Site Activities

Activity	Level	Protective Equipment
MW Installation Groundwater Sampling Surface Soil Sampling Subsurface Soil 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) • Uncoated 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)

Source: NIOSH/OSHA/USCG/EPA, 1985

Table 8.1
Six Stages for Decontamination for Modified Level D Protection

Stage		Procedure
Stage 1:	Segregated Equipment Drop	Deposit equipment used on site on plastic drop cloths or in assigned containers with plastic liners.
Stage 2:	Boot Cover and Glove Wash	Scrub outer boot covers and gloves with decontamination solution, and rinse with water.
Stage 3:	Tape Removal	Remove tape around boots and gloves and deposit in container with plastic liner.
Stage 4:	Boots, Gloves, and Disposable Clothing Removed	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.

Source: NIOSH/OSHA/USCG/EPA, 1985

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 wear before and after each use.

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

Stage		Procedure
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.
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.

Source: NIOSH/OSHA/USCG/EPA, 1985

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

Key Personnel	Number
James Costello - Project Manager	(703) 736-4507
Kenneth F. Rapuano - Health and Safety Officer	(703) 736-4546
John Robertson - Executive Vice President	(703) 736-4560
Mike Dodyk - Base Point of Contact (AFBCA)	(817) 732-9734
Joseph Dunkle - AFCEE/ERD Contracting Officer's Representative	(210) 536-5290
Emergency Phones Numbers	
Ambulance -	911 or (817) 922-3150
Fire Department -	911 or (817) 246-1741
Poison Control	911 or (800) 441-0040
Hospital - Harris Methodist - Fort Worth 1301 Pennsylvania Avenue	911 or (817) 882-2000
Directions to Nearest Medical Facility (Figure 13.1)	
Exit NAS Fort Worth JRB south on Roaring Springs Road heading southeast for 2 miles, continue (as it changes to Horne 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.	

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: ______________________

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HEALTH AND SAFETY PLAN

COMPLIANCE AGREEMENT FORM

PROJECT: Site Investigation of 12 Underground Storage Tanks

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

LOCATION: NAS Fort Worth JRB, Carswell Field, Texas

PROJECT NO: AFC001-0016

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 AMENDMENT FORM

Change in field activities or hazards: ____________________

____

____

____

____

____

____

Proposed amendments: ____________________

____

____

____

____

____

____

Proposed by: ____________________ Date: ____________

Approved by: ____________________

Accented: ________ Declined: ________ Date: ____________

Amendment Number: ____________

Amendment Effective Date: ____________

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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 and 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 on-site 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

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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)

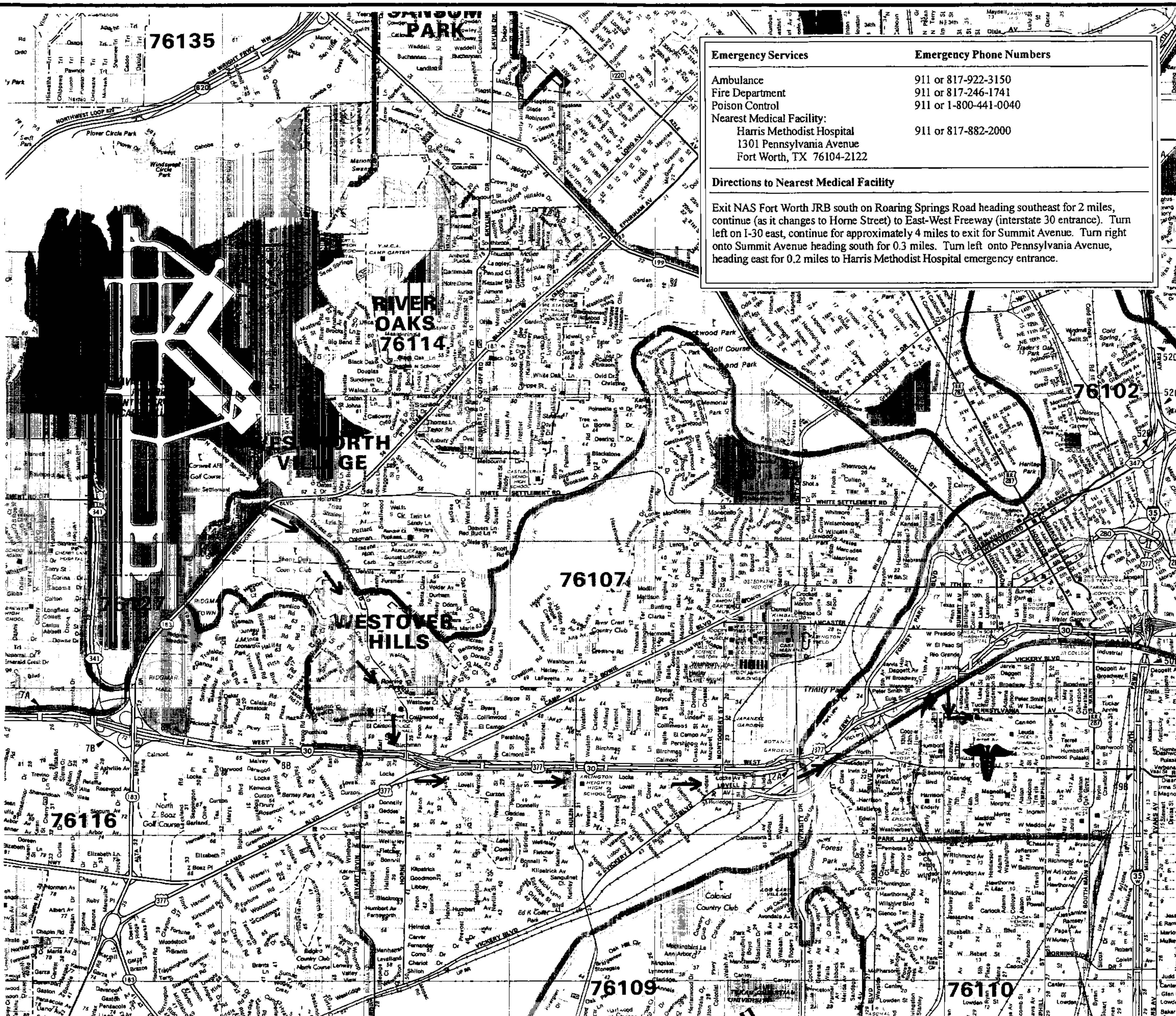
TAB

Figure

Figure 13.1

Nearest Medical Facility to NAS Fort Worth JRB, Texas

Air Force Center For Environmental Excellence Brooks AFB, Texas



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 Horne 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.

Legend

- Harris Methodist Hospital
- → Route to Hospital

N

Filename: X:\AFC001\16BAAE_final_work_plan\Report\Fig_13-1.cdr
Project: AFC001-16BAAE
Revised: 05/26/99 cf
Source: Rand McNally, 1996

HYDRO GeoLogic INC

480 282A

TAB

Appendix A

HYDRO GeoLogic INC.

BORING LOG

Borehole ID: ________
Sheet _____ of ____

			Location	
Project Name	Project Number	LTCCODE (IRPIMS)	Site ID	LPRCODE (IRPIMS)
Drilling Company	Driller	Ground Elevation	Total Drilled Depth	
Drilling Equipment / Drilling Method / Borehole Diameter		Date/Time Drilling Started	Date/Time Total Depth Reached	
Type of Sampling Device		Water Level (bgs) First	Final	
Sample Hammer Type / Driving Wt. / Drop		Hydrogeologist	Checked by/Date	
Location Description (include sketch in field logbook)				

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.)

AFCEE FORM BL.0

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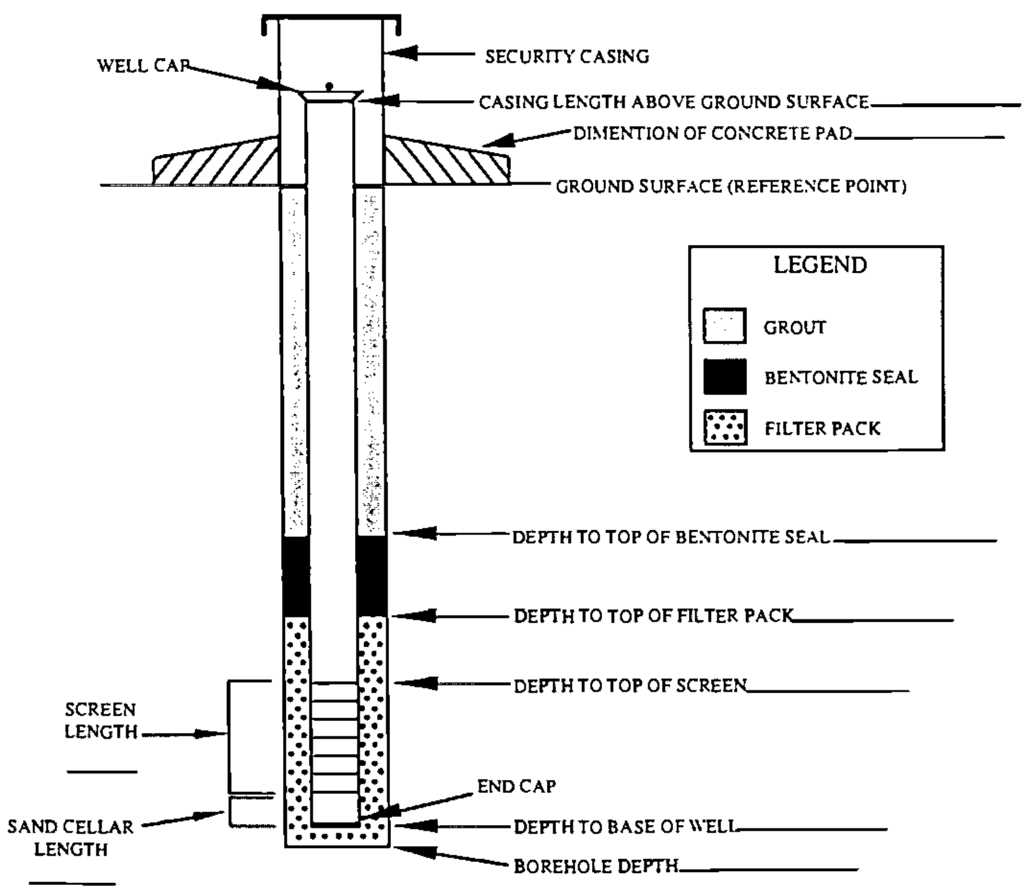
WELL CONSTRUCTION DETAILS AND ABANDONMENT FORM

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: ____________________

AFCEE FORM WAA.0

HYDRO GeoLogic INC.

WELL DEVELOPMENT RECORD

WELL/PIEZOMETER ID ______
SHEET ______ of ______

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

LOCATION: ________________ DATE INSTALLED: ________________

TOTAL DEPTH (FTOC) ____________ CASING DIAMETER ________________

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:

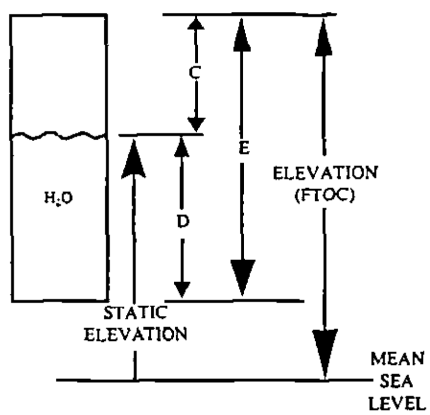
Measured Well Depth (B) ________________ft.

Measured Water Level Depth (C) ________________ft.

Length of Static Water Column (D) ______ - ______ = ________ ft.
(B) (C)

Casing Water Volume (E) + ______ x ______ = ________ gal
(A) (D)

Total Purge Volume = ________ (gal)



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

AFCEE FORM WD.0

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: ______________________________

MONITOR WELL STATIC WATER LEVEL FORM

PROJECT NAME: ______________________ DATE: ______________

WATER LEVEL INDICATOR ID # __________ FIELD BOOK # __________

LOCATION: __________________________ PAGE # ______________

Monitor Well Number	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 ______________________

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MONITOR WELL PURGING FORM

PROJECT : ______________________ DATE: ______________

LOCATION: ______________________ EXPLOSIMETER BOREHOLE READING ________

WELL ID: ______________________ PURGE VOLUME
(3 WELLBORE VOLUMES): ______________ (gal)

WELL DEPTH: ______________________

Time	Depth to Water (ft)	Flow Meter Reading	Volume Purged (gal)	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 INC.

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

NOTABLE OBSERVATIONS

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

GENERAL INFORMATION

WEATHER: SUN/CLEAR ____ OVERCAST/RAIN ____ WIND DIRECTION ____ AMBIENT TEMP ____

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

SHIPPED TO: ____________________

COMMENTS: ____________________

SAMPLER: ____________________ OBSERVER: ____________________

MATRIX TYPE CODES		SAMPLING METHOD CODES	
DC=DRILL CUTTINGS	SL=SLUDGE	B=BAILER	G=GRAB
WG=GROUND WATER	SO=SOIL	BR=BRASS RING	HA=HAND AUGER
LH=HAZARDOUS LIQUID WASTE	GS=SOIL GAS	CS=COMPOSITE SAMPLE	H=HOLLOW STEM AUGER
SH=HAZARDOUS SOLID WASTE	WS=SURFACE WATER	C=CONTINUOUS FLIGHT AUGER	HP=HYDRO PUNCH
SE=SEDIMENT	SW=SWAP\WIPE	DT=DRIVEN TUBE	SS=SPLIT SPOON
		W=SWAB\WIPE	SP=SUBMERSIBLE PUMP

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HYDRO GeoLogic INC.

CALIBRATION LOG

Project Name: ______________________ By: ______________________

Project No.: ______________________ Page ______ of ______

Date/Time	Instrument	STD	STD CONC ppm	Meter Reading	Comments

CHAIN OF CUSTODY RECORD

HYDRO GeoLogic INC.
1155 Hernd[illegible] 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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HYDRO GeoLogic INC.

LOG OF DAILY TIME AND MATERIALS

Project Name: ____________________
Project Number: ____________________
Subcontractor: ____________________
Boring or Well No: ____________________
Date: ____________________

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

Other____

____

HydroGeoLogic Site Representative: ____________________

Subcontractor Site Representative: ____________________

FINAL PAGE

ADMINISTRATIVE RECORD

FINAL PAGE