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FINAL WORK PLAN FOR AREA OF CONCERN 1 GROUNDWATER REMEDIATION INVESTIGATION NAS FORT WORTH TX

6/1/2001

HYDROGEOLOGIC

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NAVAL AIR STATION FORT WORTH JRB CARSWELL FIELD TEXAS

ADMINISTRATIVE RECORD COVER SHEET

AR File Number 604

HYDRO GeoLogic INC.

FINAL
WORK PLAN
AREA OF CONCERN 1
GROUNDWATER REMEDIATION INVESTIGATION
NAS FORT WORTH JRB, TEXAS

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

Contract Number F41624-95-D-8005
Delivery Order 0016

June 2001

HydroGeoLogic, Inc
12343 Hymeadow Drive, Suite 3B
Austin, TX 78750
(512) 336-1170

HYDRO GeoLogic INC.

FEDERAL EXPRESS

June 22, 2001

Mr. Don Ficklen
HQ AFCEE/ERD
3207 North Road
Brooks AFB, Texas 78235-5363

Re: Final AOC 1 Work Plan Groundwater Remediation Investigation
NAS Fort Worth JRB, Texas
F41624-95-D-8005-0016

Dear Mr. Ficklen:

HydroGeoLogic, Inc. is pleased to submit the Final AOC 1 Work Plan for a Groundwater Remediation Investigation to be conducted at NAS Fort Worth JRB, Texas. This report discusses the additional data gap investigation and aquifer testing necessary to support the preparation of plans for an interim remedial system to prevent further off-site migration of petroleum hydrocarbon contamination emanating from AOC 1 (the Former Base Service and Gas Stations), at NAS Fort Worth JRB, Texas. All comments provided by AFCEE on the draft work plans have been responded to, and appropriate revisions made to the final work plan.

Please call me at (512) 336-1170 should you have any questions or comments concerning this document.

Sincerely,

Todd C. Harrah
Project Manager

Enclosure

cc: Mr. Michael Dodyk, P.E. (1 copy)
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RESPONSES TO COMMENTS:
DRAFT AOC 1 WORK PLAN
GROUNDWATER REMEDIATION INVESTIGATION,
NAS FORT WORTH JRB, TEXAS
JUNE 2001

Responses to UNITEC's General Comments

Comment 1 *A number of acronyms were used in the report without being defined initially and/or being included in the list of acronyms. For example, the acronym "BSS" was not defined the first time it was used on page 2-6 of the text. Additionally, this acronym was not included in the list of acronyms. It is recommended that he Contractor correct these discrepancies throughout the document.*

Response **HydroGeoLogic will review the report and include all acronyms in the List of Acronyms.**

Comment 2 *There are several typographical and grammatical errors throughout the document. It is recommended that the Contractor review the report and correct all typographical and grammatical errors as necessary.*

Response **HydroGeoLogic will review the report for grammatical errors.**

Responses to UNITEC's Specific Comments

Comment 1 *Page 1-1, Section 1.0 - Overview: Since another major objective of the Work Plan is to fill data gaps required for plume delineation, it is recommended that a discussion of the data gaps be included in this section of the Work Plan.*

Response **HydroGeoLogic will include data gaps as part of the objective of this investigation.**

Comment 2 *Page 1-1, Section 1.1, Paragraphs 2 and 3: The FSP and HSP are introduced in this section as if they have already been mentioned elsewhere in the document. To create a seamless introduction of these additional planning documents, it is recommended that they be introduced at the end of the first paragraph.*

Response **HydroGeoLogic will modify this paragraph accordingly.**

Comment 3 *Page 1-3, Section 1.2, Sentence 1: Insert "and corrective measure" after "satisfied when investigation".*

Response **HydroGeoLogic will modify the text accordingly.**

Comment 4 *Page 2-5, Section 2.2, Paragraph 1, Sentence 1: Please change the sentence to read: The focus of the study is to conduct an additional data gap investigation and to determine shallow aquifer characteristics...".*

Response **HydroGeoLogic will modify the text accordingly.**

Comment 5 *Page 2-5, Section 2.2, Paragraph 1, Sentences 2 and 3: Since Davison Drive and Military Parkway are not visible on Figure 1.1, it is recommended that the reference to Figure 2.7 in the second sentence be changed to Figure 1.1 and the reference to Figure 1.1 in the third sentence be changed to Figure 2.7.*

Response **HydroGeoLogic will modify the figure references accordingly.**

Comment 6 *Page 2-5, Section 2.2, Paragraph 1, Sentence 6: It is recommended that he reader be referred to Figure 2.7 for the location of the Former Base Gas Station.*

Response **HydroGeoLogic will modify the text accordingly.**

Comment 7 *Page 2-5, Section 2.2.1, Paragraph 1, Sentence 2: Please insert a space between the words "in" and "grain".*

Response **HydroGeoLogic will modify the text accordingly.**

Comment 8 *Page 2-5, Section 2.2.1, Paragraph 2, Sentence 4: Please delete the word "Although" at the beginning of the sentence.*

Response **HydroGeoLogic will modify the text accordingly.**

Comment 9 *Page 2-5, Section 2.2.1, Paragraph 2, Sentence 5: Since the groundwater flow beneath the two stations is being described, it is recommended that the sentence be rewritten as "Groundwater flow in the Quaternary alluvium aquifer beneath the stations is...".*

Response **HydroGeoLogic will modify the text accordingly.**

Comment 10 *Page 2-6, Section 2.2.2, Paragraph 1, Sentence 1: Please include the title of the study or report where the site was originally identified.*

Response **HydroGeoLogic will reference this section.**

Comment 11 *Page 2-6, Section 2.2.2, Paragraph 1, Sentence 2: Please include the title of the study or report where the gasoline contamination has been verified. Also, it is recommended that the due date of IRP designation for ST16 be stated in the text.*

Response **HydroGeoLogic will reference this section. The date of the ST16 designation is unknown, and presumed to be assigned by the U.S. Air Force Installation Restoration Program soon after the confirmation of the petroleum contamination.**

Comment 12 *Page 2-6, Section 2.2.2, Paragraph 1, Sentence 2: Since the four former underground storage tanks are not visible on Figure 1.1, it is recommended that the reference to Figure 1.1 in the sentence be changed to Figure 2.7.*

Response **HydroGeoLogic will modify the text accordingly.**

Comment 13 *Page 2-6, Section 2.2.2, Paragraph 1, Sentence 3: Please indicated the date that the subsurface release was reported to the TWC. Also, please indicated the date and LPST number issued for the site by the TNRCC.*

Response **HydroGeoLogic will include the date (April 1992) and LPST number (104524).**

Comment 14 *Page 2-6, Section 2.2.2, Paragraph 1, Last Sentence: Please state the actions that were taken by the Air Force to address the NOV.*

Response **HydroGeoLogic will incorporate language indicating the actions taken following the NOV received by the TWC.**

Comment 15 *Page 2-6, Section 2.2.2, Paragraph 2, Sentence 1: It is recommended that the 600-gallon waste oil tank be shown on Figure 2.7.*

Response **HydroGeoLogic was unable to locate a figure referencing the location of the 600-gallon waste oil tank; however, WC Environmental Group sited the 600-gallon tank on the southeast side of Building 1518. HydroGeoLogic will incorporate this information into the Work Plan.**

Comment 16 *Page 2-6, Section 2.2.2, Paragraph 2, Sentence 4: Please include the amount of soil excavated. Also, please indicated if soil analysis was performed on the soil before placing the soil back into the excavation.*

Response **HydroGeoLogic will incorporate the necessary language in response to the above comment.**

Comment 17 *Page 2-6, Section 2.2.2, Paragraph 2, Sentence 5: It is recommended that the contractor mention whether the cap covers the side and bottom of the area.*

Response **HydroGeoLogic was unable to identify whether the liner covered the sides and bottom of the excavation, therefore no additional language was added.**

Comment 18 *Page 2-6, Section 2.2.2, Paragraph 2, Sentence 7: It is recommended that the three ASTs be shown on the map.*

Response **HydroGeoLogic will add the ASTs to Figure 1.4.**

Comment 19 *Page 2-6, Section 2.2.2, Paragraph 3, Sentence 2: Please indicate the number of USTs and ASTs that were removed.*

Response **HydroGeoLogic will include the number of USTs and ASTs at the former Base Gas Station.**

Comment 20 *Page 2-6, Section 2.2.2, Paragraph 3, Sentence 3: Please explain why the stained soils were not excavated.*

Response **During the AST and equipment removal, it was evident that the soil had been impacted with petroleum hydrocarbons and the Scope of Work had to be modified. The soil was sampled and returned to the excavation until additional characterization of the soil could be completed (IT Corporation, 1996).**

Comment 21 *Page 2-6, Section 2.2.2, Paragraph 4, Sentence 1: It is recommended that a list of the investigations referred to in this sentence be shown in the reference section.*

Response **HydroGeoLogic will incorporate a reference to the previous investigations conducted at AOC 1 and include them in the reference section.**

Comment 22 *Page 2-7, Section 2.2.2, Paragraph 5, Sentence 1: Please indicate the concentration level of benzene in the soil and groundwater that exceeded the TNRCC Plan A criteria.*

Response **HydroGeoLogic will incorporate the levels of benzene exceeding the TNRCC Plan A criteria.**

Comment 23 *Page 2-7, Section 2.2.2, Paragraph 5, Last Sentence: Please state the date that the TNRCC concurred in writing.*

Response **HydroGeoLogic will include the date of the letter concurring with the Plan B Risk Assessment.**

Comment 24 *Page 2-7, Section 2.2.2, Paragraph 6, Sentence 2: Please insert "following a meeting with the TNRCC PST Coordinator" after "In 2000,". Also please reference Figure 2.9 in each sentence that refers to a site or location.*

Response **HydroGeoLogic will modify the language and reference Figure 2.9 accordingly.**

Comment 25 *Page 2-7, Section 2.2.2, Paragraph 6, Sentence 4: Please add the range and locations of BTEX concentrations in the groundwater. Also, please provide an explanation why the reduction is occurring.*

Response **HydroGeoLogic will include Figure 1.3 which contains contours of the Total BTEX concentrations from October 1997 through July 1998 and Figure 1.4 which contains the BTEX concentrations from May and October 2000. Limited reduction can be observed and is presumed to be due to a combination of migration and natural attenuation. A formal natural attenuation study of the BTEX plume has not been performed at this site.**

Comment 26 *Page 2-7, Section 2.2.2, Paragraph 6, Sentence 4: It is recommended that the reason for drawing the conclusion about the plume extent and stability be stated. If the reason for this deduction is the detection of light non-aqueous phase liquids in the off-site monitoring well, as stated in the cover letter accompanying the Work Plan, then please state so.*

Response **The conclusion of plume stability results from previous investigations. It is apparent by recent TNRCC requests for additional groundwater investigations, that questions exist related to the complete delineation of the Petroleum Hydrocarbon groundwater plume emanating from AOC 1. It is also reasonable to state that conclusions of stability have to be based on complete plume delineation knowledge. HydroGeoLogic through the implementation of the TNRCC requested additional groundwater investigations, in combination with data gap investigations presented in this work plan, will develop a better understanding of the true extent and stability of the plume. Following this field work, HydroGeoLogic will prepare a**

revised Plan B Site Evaluation for AOC 1. This report will contain a summary of historical soil and groundwater investigation results, as well as currently collected data.

The primary purpose of this work plan is to support the performance of aquifer testing for upcoming interim remedial actions and to complete the data gaps in the complete understanding of the extend of the plume. Language in the work plan will be revised so as not to imply assumptions of plume stability.

Comment 27 *Page 2-7, Section 2.2.2, Paragraph 6: It is recommended that a figure of the plume with Benzene, Toluene, Ethylbenzene, and Xylene (BTEX) concentration contours be included and referenced in this paragraph. Such a figure would also be helpful to the reader in Section 3.2 (regarding additional plume delineation).*

Response HydroGeoLogic will include Figure 1.3 which contains contours of the Total BTEX concentrations from October 1997 through July 1998. This figure was included in the Work Plan to provide a general view of the two plumes existing at AOC 1. Monitoring well BSS-B located on the northern side of the Base Service Station has had significant influence on the definition of the Base Service Station plume. In 1999, the Base Service Station reopened and monitoring wells BSS-B and MW-4 were abandoned for the placement of the new three ASTs. In an attempt to reproduce the BTEX results produced by monitoring well BSS-B, HydroGeoLogic sampled monitoring well MW-5 as part of the April and October 2000 AOC 1 groundwater monitoring program. Monitoring well MW-5 (ND) was unsuccessful in producing similar BTEX values from BSS-B (20,000 μg/L), so MW-6 replaced MW-5 during the April 2001 groundwater sampling event. Preliminary unvalidated results for monitoring well MW-6 indicate BTEX levels are 15 μg/L, which are significantly lower than the 20,000 μg/L detected in July 1998 at BSS-B. In order to delineate the northern lobe of BTEX plume at the Base Service Station, monitoring well MW-7 will be sampled in addition to MW-6 in July 2001. A figure contouring the approximate BTEX concentrations from July 1997 through October 2000 was not included in this Work Plan due to the data gaps identified above. Following this field work, HydroGeoLogic will prepare a revised Plan B Site Evaluation for AOC 1 which will provide a figure with a more accurate representation of the plumes.

Comment 28 *Page 2-7, Section 2.2.2, Paragraph 7, Sentence 1: Please indicate the date of the TNRCC letter.*

Response HydroGeoLogic will update the text accordingly.

Comment 29 *Page 2-7, Section 2.2.2, Paragraph 7, Sentence 2: Please indicate the number of wells installed and sampled.*

Response HydroGeoLogic will update the text accordingly.

Comment 30 *Page 3-2, Section 3.2.1, Paragraph 6, Sentence 2: Since three 4-hour variable-rate pumping tests will be conducted, please change "10-hour variable-rate" to "12-hr variable-rate".*

Response **HydroGeoLogic will modify the text accordingly.**

Comment 31 *Page 3-3, Section 3.2.2, Paragraph 1, Sentence 1: Please delete the word "of" between "area" and "between".*

Response **HydroGeoLogic will update the text accordingly.**

Comment 32 *Page 3-4, Section 3.2.2, Paragraph 2: Please specify the rationale for the choice of selected groundwater parameters. Also, in addition to the parameters presented in the paragraph, Table 3.1 of the FSP lists other parameters, namely Anions, Methane, Ethane, and Ethene. Since both the paragraph and the Table refer to the same activity, it is recommended that a consistent list of parameters be used.*

Response **The selected groundwater parameters were chosen to provide data on groundwater conditions at AOC 1 in respect to contaminant extent and concentrations, as well as to aid in the design of a potential groundwater treatment system. Both the work plan and FSP will be updated to reflect all necessary analytical parameters.**

Comment 33 *Page 3-5, Table 3.2 (FSP), Column 2: Since an existing well will be used, it is recommended that the number of borings be changed from 3 to 2.*

Response **HydroGeoLogic will modify the text accordingly.**

Comment 34 *Page 5-8, Section 5.5 (FSP): Last word should be changed from "5.9" to "5.8".*

Response **HydroGeoLogic will modify the text accordingly.**

Comment 35 *Page 5-11, Section 5.9.1.2 (FSP): The last sentence states where the water will be discharged, however, there is no groundwater treatment system in the vicinity. A pumping test of 72 hours at 7 gpm will produce over 30,000 gallons of water. Please explain how will this water be contained.*

Response **HydroGeoLogic will elaborate on the method of handling the discharged groundwater, a contractor will deliver frac tanks capable of containerizing a minimum of 40,000 gallons of water. After completion of the pump test, the frac tanks will be transported to the groundwater treatment system located on White Settlement Road, adjacent to SWMUs 22 and 24. The groundwater will be passed through the treatment system and discharged to the discharge ponds located on the Carswell Golf Course. If the treatment system cannot**

handle the pump test groundwater will be transported off-site to a contractor operated treatment facility. The appropriate text addressing treatment of the pump test groundwater will be added to the FSP.

FINAL
WORK PLAN
AREA OF CONCERN 1
GROUNDWATER REMEDIATION INVESTIGATION
NAS FORT WORTH JRB, TEXAS

Prepared for

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

Contract Number F41624-95-D-8005

Prepared by

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June 2001

REPORT DOCUMENTATION PAGE

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6 AUTHOR (S)

HydroGeoLogic, Inc

7 PERFORMANCE ORGANIZATION NAMES (S) AND ADDRESS (S)

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8 PERFORMANCE ORGANIZATION REPORT NUMBER

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13 ABSTRACT (Maximum 200 words)

The Final Work Plan for AOC 1 groundwater remediation investigation discusses the additional data gap investigation and aquifer test to be performed to prevent petroleum hydrocarbons from emanating NAS Fort Worth JRB, Texas The work plan describes the installation of one recovery and three monitoring wells for the aquifer test and data gap investigation, as well as detailed procedures to be followed in order to help define aquifer characteristics aiding in the design of an interim groundwater remediation system

14 SUBJECT TERMS

15 NUMBER OF PAGES

16 PRICE CODE

17 SECURITY CLASSIFICATION OF REPORT	18 SECURITY CLASSIFICATION OF THIS PAGE	19 SECURITY CLASSIFICATION OF ABSTRACT	20 LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	Unlimited

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TAB

WORK PLAN

PREFACE

HydroGeoLogic, Inc. (HydroGeoLogic) is under contract to prepare a Corrective Measures Implementation (CMI) Work Plan to support the construction of an interim groundwater remediation system at the Naval Air Station Fort Worth Joint Reserve Base (NAS Fort Worth JRB), formerly Carswell Air Force Base (AFB), Texas. The interim remediation system is intended to address groundwater contamination resulting from historical releases of petroleum hydrocarbons at Area of Concern 1 (AOC 1), former Base Service Station (BSS) and former Base Gas Station. This work plan addresses the aquifer test and data gap investigation to be performed to facilitate the preparation of a CMI Work Plan for an interim groundwater remediation system. This work plan was prepared under Contract Number F41624-95-D-8005, Delivery Order 16 issued to HydroGeoLogic. The U.S. Air Force Center for Environmental Excellence (AFCEE) Contracting Officer's Representative (COR) is Mr. Don Ficklen. HydroGeoLogic's Project Manager is Mr. Todd Harrah.

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LIST OF ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AFCEE	U.S. Air Force Center for Environmental Excellence
AFP 4	Air Force Plant 4
AOC	area of concern
AST	aboveground storage tank
bgs	below ground surface
BSS	Base Service Station
BTEX	benzene, toluene, ethylbenzene, and total xylenes
CAP	Corrective Action Plan
CFR	Code of Federal Regulations
cm/sec	centimeters per second
CMI	Corrective Measures Implementation
COR	Contracting Officer Representative
FSP	Field Sampling Plan
ft/d	feet per day
gpd/ft^2	gallons per day per square foot
gpm	gallons per minute
HDPE	high density polyethylene
HSP	Health and Safety Plan
HydroGeoLogic	HydroGeoLogic, Inc.
IRP	Installation Restoration Program
IT	International Technologies Corporation
JRB	Joint Reserve Base
LNAPL	light, non-aqueous phase liquid
LPST	Leaking Petroleum Storage Tank
MSD	matrix spike duplicate
NAS	Naval Air Station
NGVD	National Geodetic Vertical Datum
NOV	notice of violation
OWS	Oil Water Separator

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

PID	photoionization detector
PST	petroleum storage tank
PVC	polyvinyl chloride
PWI	Perry Williams, Inc.
QAPP	Quality Assurance Project Plan
QC	quality control
Radian	Radian Corporation
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RI/FS	remedial investigation/feasibility study
S	specific yield
SCR	Site Closure Request
SWMU	solid waste management unit
T	transmissivity
TNRCC	Texas Natural Resource Conservation Commission
TWC	Texas Water Commission
USACE	U.S. Army Corp of Engineers
UST	underground storage tank
VOC	volatile organic compound

TAB

SECTION L.0

FINAL
WORK PLAN
AREA OF CONCERN 1
GROUNDWATER REMEDIATION INVESTIGATION
NAS FORT WORTH JRB, TEXAS

1.0 INTRODUCTION

The objective of the field investigation covered by this work plan is to conduct an additional data gap investigation and to determine shallow aquifer characteristics aiding in the design of an interim groundwater remediation system at area of concern (AOC) 1, Naval Air Station (NAS) Fort Worth Joint Reserve Base (JRB), Texas. AOC 1 comprises two former refueling facilities, the Base Service Station (BSS) at Building 1518 and the Base Gas Station at Building 1268 (Figure 1.1). The primary contaminants of concern are benzene, toluene, ethylbenzene, and total xylenes (BTEX). The hydrogeologic data generated from the aquifer test will be used to support the development of a Corrective Measures Implementation (CMI) Work Plan for an interim remediation system to prevent further migration of groundwater contaminants off Federal property.

1.1 BACKGROUND

On February 7, 1991, the Texas Natural Resource Conservation Commission (TNRCC) issued former Carswell Air Force Base (AFB) a Resource Conservation Recovery Act (RCRA) Hazardous Waste Permit (HW-50289). This permit requires a RCRA Facility Investigation (RFI) of all solid waste management units (SWMUs) and AOCs listed in Permit Provision VIII, as well as those SWMUs and AOCs subsequently added to the list; in order to determine if any hazardous constituents listed in the 40 Code of Federal Regulations (CFR) Part 264, Appendix IX have been released into the environment. AOC 1 operations have included the management of fuels in underground and aboveground storage tanks; therefore, all investigation and remediation requirements fall under the jurisdiction of the TNRCC Petroleum Storage Tank (PST) Division. The investigation requirements stated for AOC 1 in the RCRA Permit will be satisfied when investigation and corrective measure requirements under the TNRCC PST Division have been completed.

1.2 SITE HISTORY

The former BSS was built and became operational in 1972. There were four 10,000-gallon fiberglass underground storage tanks (USTs) installed on the north side of the facility, with an additional 600-gallon waste oil tank placed on the southeast side of Building 1518. In November 1994, gasoline was discovered in an adjacent drainage ditch that runs along Rogner Drive. A loss of 1,900 gallons of gasoline was recorded that month, with the subsequent discovery of a leaking fuel line from one pump, which was repaired soon afterwards. The former BSS was added to the Installation Restoration Program (IRP) in 1987 and Radian

Corporation (Radian) conducted an initial site investigation. The site was originally identified as a potential source of petroleum hydrocarbon contamination in the 1980's under the U.S. Air Force IRP (International Technologies Corporation [IT Corp.], 1996). Gasoline contamination was verified in the vicinity of the four former USTs servicing the station in the early 1990s (Figure 1.2), and the site was designated as an IRP Site ST16 for further investigations, in an effort to determine the nature and extent of contamination (U. S. Army Corps of Engineers [USACE], 1994). In April 1992, Former Carswell AFB reported the subsurface release of gasoline from the former BSS to the Texas Water Commission (TWC). The TWC, now TNRCC, issued a Notice of Violation (NOV) to Carswell AFB for a petroleum release to the adjacent West Fork Trinity River. The BSS was issued leaking petroleum storage tank (LPST) ID No. 104524 and was cited by the TWC as the suspected source of the surface water release (IT Corp., 1996). Former Carswell AFB has initiated several contracts to assess the extent of contamination and to address information required by TWC (WC Environmental Group, 1993).

In May 1993, Perry Williams, Inc. (PWI) was contracted by the USACE to remove the four 10,000-gallon fiberglass USTs, one 600-gallon waste oil tank, associated piping, and perform disposal in-place of the remaining piping from the USTs. The intent of this removal action was not to achieve "clean closure", but to remove the threat of possible petroleum releases into the West Fork Trinity River (WC Environmental Group, 1993). The service bays, concrete fuel islands, and awnings were left in place. Following the removal of the USTs, samples were collected and the excavation was backfilled with 432 cubic yards of stockpiled soils from the tank excavation and capped with a high density polyethylene (HDPE) liner, which was covered with 36 cubic yards of top soil, and a vegetative cover (grass) was put in place (WC Environmental Group, 1993; IT Corp., 1996). The remaining area of the BSS was paved, with the exception of the UST excavation area. After going unused for a number of years, the U.S. Navy renovated and reopened the BSS in 1999. The U.S. Navy is currently using three above ground storage tanks (ASTs) for fuel storage, located approximately over the location of the former UST excavation site (Figure 1.3). Monitoring wells BSS-B and MW-5 were abandoned to support the placement of the new ASTs at the BSS.

The former Base Gas Station began operation in the 1950s. This facility originally used three USTs for fuel storage, but the facility converted the fuel storage capability to ASTs sometime between 1960 and 1970 (IT Corp., 1996). After this conversion, the storage components at the station consisted of five 12,000-gallon ASTs and one 6,000-gallon AST, in addition to the associated spill prevention components and piping. The facility remained active until 1989, when operations were ceased and the equipment was left in place. In February 1994, the firm of Metcalf and Eddy was contracted by AFCEE to remove the ASTs and other associated equipment from the former Base Gas Station (IT Corp., 1996). During the AST and equipment removal, it was evident that the soil had been impacted with petroleum hydrocarbons and the scope of work had to be modified. Stained soils in the vicinity of the ASTs were not excavated during demolition of the ASTs and ancillary facilities. Two test pits were dug, and the excavated soils were sampled and returned to the excavation until additional

characterization of the soil could be completed (IT Corp., 1996). This area was covered by gravel and asphalt and is currently unused by the base.

A number of investigations have been performed over the last decade to assess the extent of petroleum hydrocarbon contamination in soil and groundwater at the former BSS and the former Base Gas Station. Some of the investigation, remediation, and monitoring information can be found in A.T. Kearney, 1989; HydroGeoLogic, 1998, 1999, 2001; IT Corp., 1996, Law Environmental, 1996; Maxim Engineers, Inc., 1992; Metcalf & Eddy, 1994; Radian, 1991; Target Environmental Services, Inc., 1993; USACE, 1994. Recent investigations driving groundwater monitoring since the latter half of 1997 include the Plan B Risk Assessment of the Base Gas Station which is included in the NAS Fort Worth Assessment Report (IT Corp., 1997a), and the Base Gas Station Corrective Action Plan (CAP) (IT Corp., 1997b).

A baseline risk assessment was conducted by the USACE in 1993 at both the Base Gas Station and BSS, and the results were compared to the TNRCC Plan A Target Concentrations by IT Corporation. The maximum benzene concentrations identified at the Base Gas Station for groundwater and soil were 2.9 mg/L and 0.94 mg/kg, respectively (IT Corp., 1997b). The maximum benzene concentrations identified at the BSS for groundwater and soil were 13 mg/L and 14 mg/kg, respectively (IT Corp., 1997b). Since both the Base Gas Station and BSS had concentrations in groundwater and soil above the TNRCC Plan A criteria, a Plan B Risk Assessment was conducted. The results of the Plan B cumulative risk assessment for the on-site and off-site exposure pathways indicated that there was no unacceptable human health risk for the current and future exposure pathways (IT Corp., 1997a). Therefore, the recommendation contained in the CAP was limited to groundwater monitoring for a period of one year. In a letter dated July 16, 1997, the TNRCC concurred with both the conclusions and recommendations of the Plan B Risk Assessment and CAP.

AOC 1 was sampled on a quarterly basis from October 1997 to July 1998 and semi-annually during April and October 2000. Figure 1.3 displays contours of the October 1997 through July 1998 data indicating the former BSS and former Base Gas Station BTEX plumes. HydroGeoLogic submitted the Site Closure Request (SCR) to the TNRCC, November 29, 1999. Upon evaluation of the SCR and current site conditions by a new TNRCC PST project manager, a request was made of the U.S. Air Force to implement two additional rounds of groundwater sampling and surface water sampling, in addition to installing and sampling three off-site monitoring wells in the year 2000, to fully delineate the down gradient extent of the plume. In May 2000, following a meeting with the TNRCC PST Coordinator, three AOC 1 monitoring wells were installed off-site (WHGLTA036, WHGLTA037, and WHGLTA038) to monitor potential BTEX migration. Groundwater and surface water results from May and October 2000 are presented in Figure 1.4.

Prior to the completion of the TNRCC's initial request made in 1999, a subsequent letter dated January 28, 2000, was issued by the U.S. Air Force requesting two additional quarterly groundwater and surface water sampling events to be conducted at AOC 1 in April 2001 and

July 2001. During April 2001, nine existing AOC 1 monitoring wells were sampled for volatile organic compounds (VOCs) (BGSMW03, BGSMW05, BGSMW06, MW-6, SAV-2, MW-10, WHGLTA036, WHGLTA037, and WHGLTA038). Analytical results for April 2001 are not available at this time; however, during the April 2001 Semi-Annual Groundwater Monitoring Program light non-aqueous phase liquid (LNAPL) was identified at monitoring well WHGLTA038. During July 2001, the previous nine monitoring wells will be sampled for VOCs, in addition to existing monitoring well MW-7, and newly installed monitoring wells WHGLTA057, WHGLTA058, and WHGLTA059.

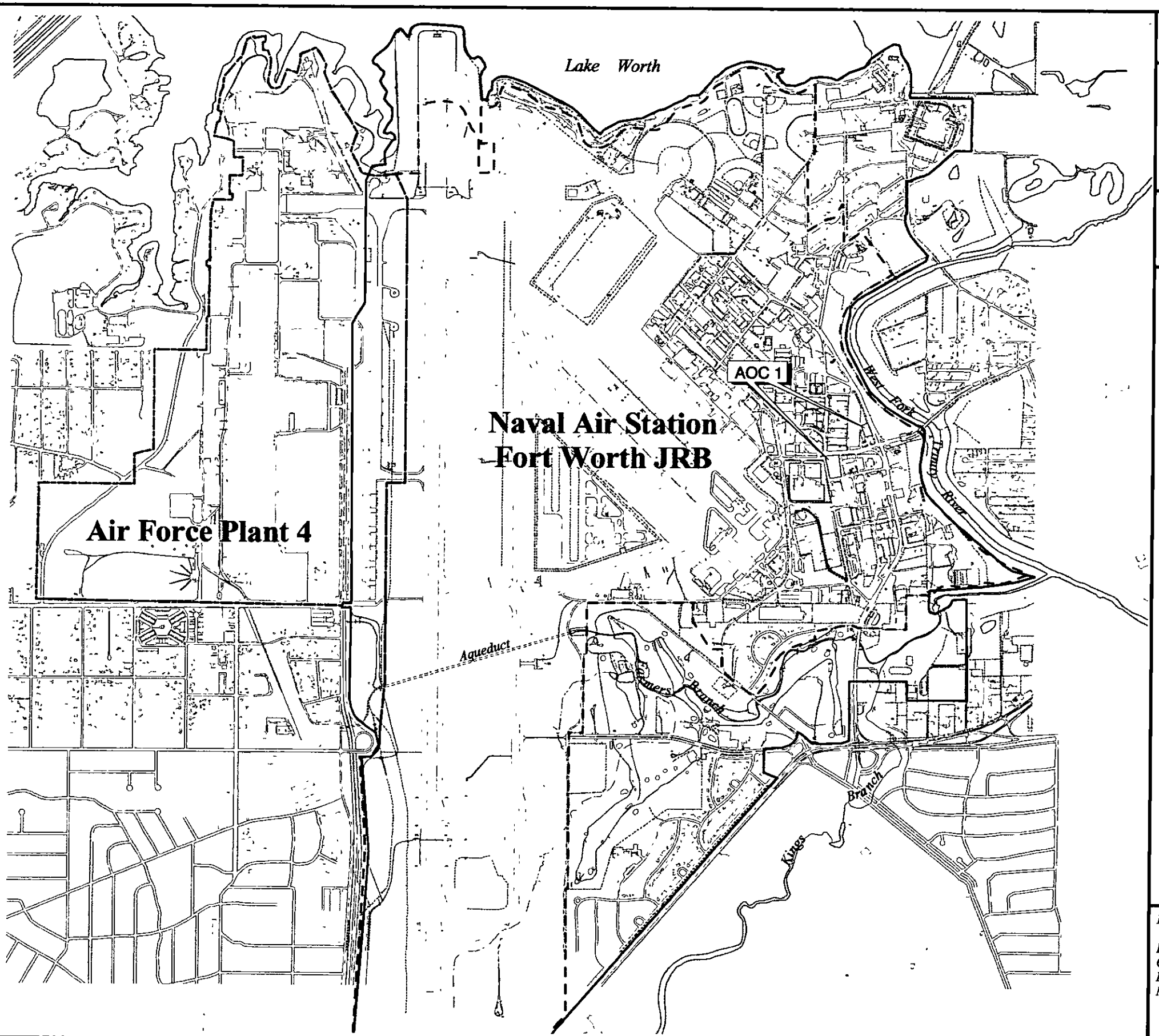
A minor amount of additional groundwater sampling is planned in conjunction with this Work Plan. The additional work will be performed separately from the ongoing groundwater monitoring at AOC 1, and is being performed to address specific plume delineation data gaps and to collect field and analytical data in support of the preparation of the CMI Plan. A complete summary of the investigation history for AOC 1 will be provided within the Revised Plan B report scheduled for submission in the fall of 2001.

1.3 ORGANIZATION

Section 2.0 of this work plan includes a site description, while Section 3.0 provides the project tasks and data needs for the aquifer test. The data assessment, records, and reporting requirements are described in Section 4.0, and Section 5.0 lists references. Field sampling procedures and field measurement and documentation forms are contained in Appendix A. Appendix B contains the Health and Safety Plan (HSP).

TAB

FIGURES



HydroGeoLogic, Inc —Aquifer Testing Work Plan
NAS Fort Worth JRB, Texas

Figure 1.1
Area of Concern 1
Location Map
NAS Fort Worth JRB

U.S. Air Force Center for Environmental Excellence

Legend

- NAS Fort Worth JRB (Carswell Field)
- Property Boundary of Air Force Plant 4
- Former Carswell Air Force Base
- Area of Concern 1

N

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Revised 05/02/01 asp
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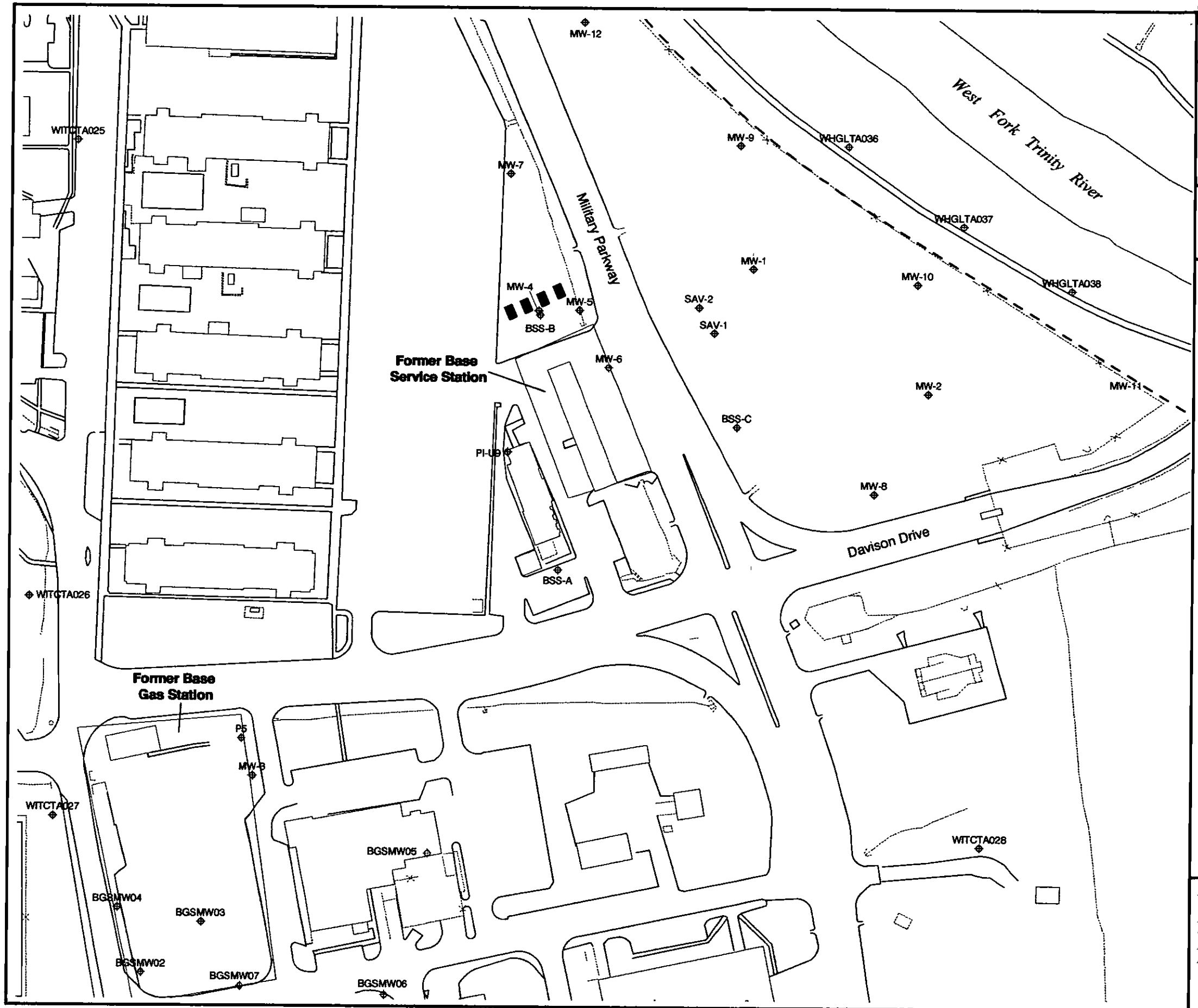
HYDRO GeoLogic Inc.



HydroGeoLogic, Inc --Aquifer Testing Work Plan
NAS Fort Worth JRB, Texas

Figure 1.2

Area of Concern 1
Site Plan and Monitoring Well Locations
NAS Fort Worth JRB, Texas

U.S. Air Force Center for Environmental Excellence

Legend

- NAS Fort Worth JRB (Carswell Field)
- Area of Concern 1 Location
- Former Underground Storage Tank Locations
- AOC 1 Semiannual Monitoring Well Locations
- Existing Monitoring Well Locations
- Damaged Monitoring Well Locations
- Former Monitoring Well Locations

N

90 0 90 180

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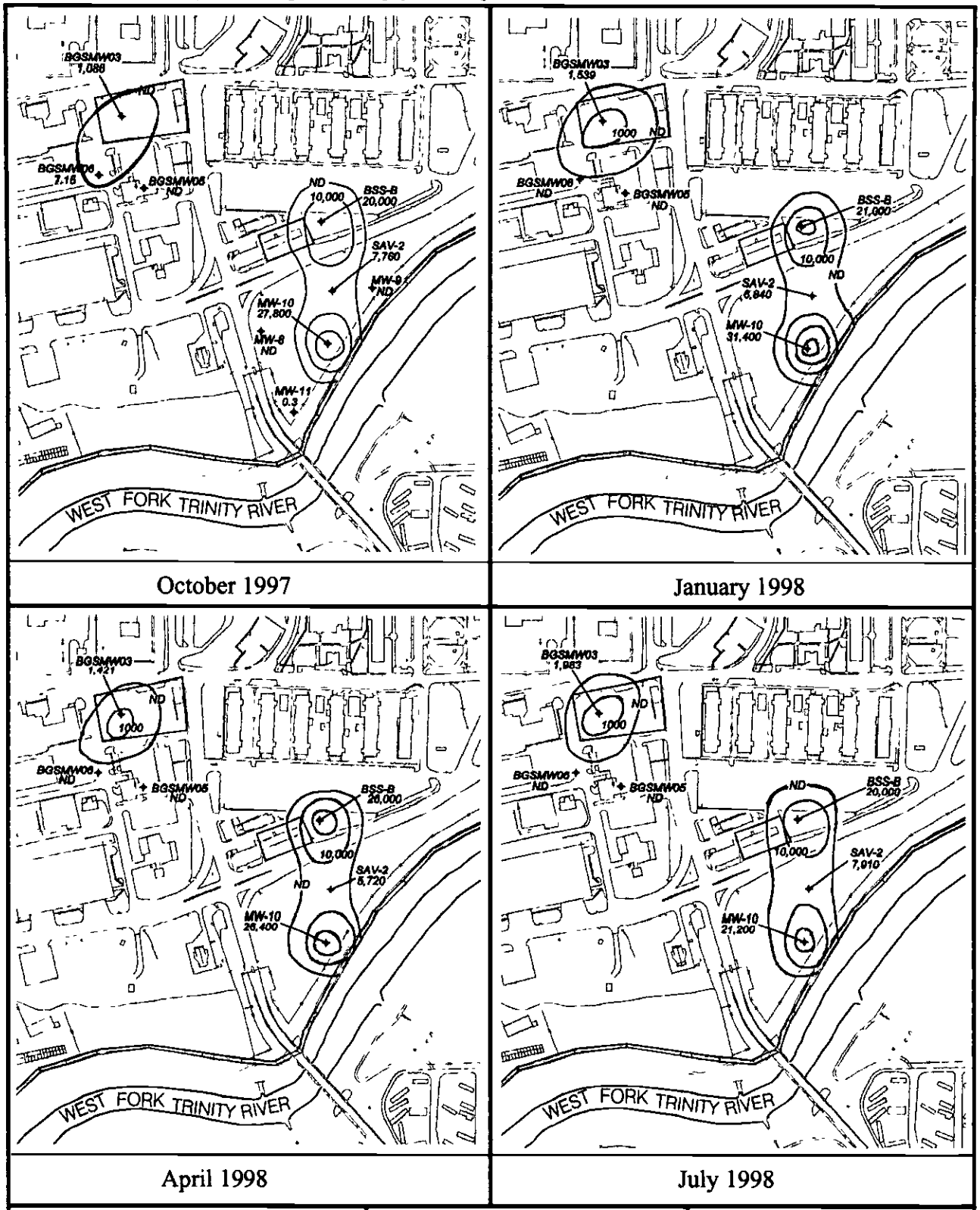

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Project AFC001-16DB
Created: 03/30/99 jbelcher
Revised 06/13/01 asp
Source Jacobs, 1996

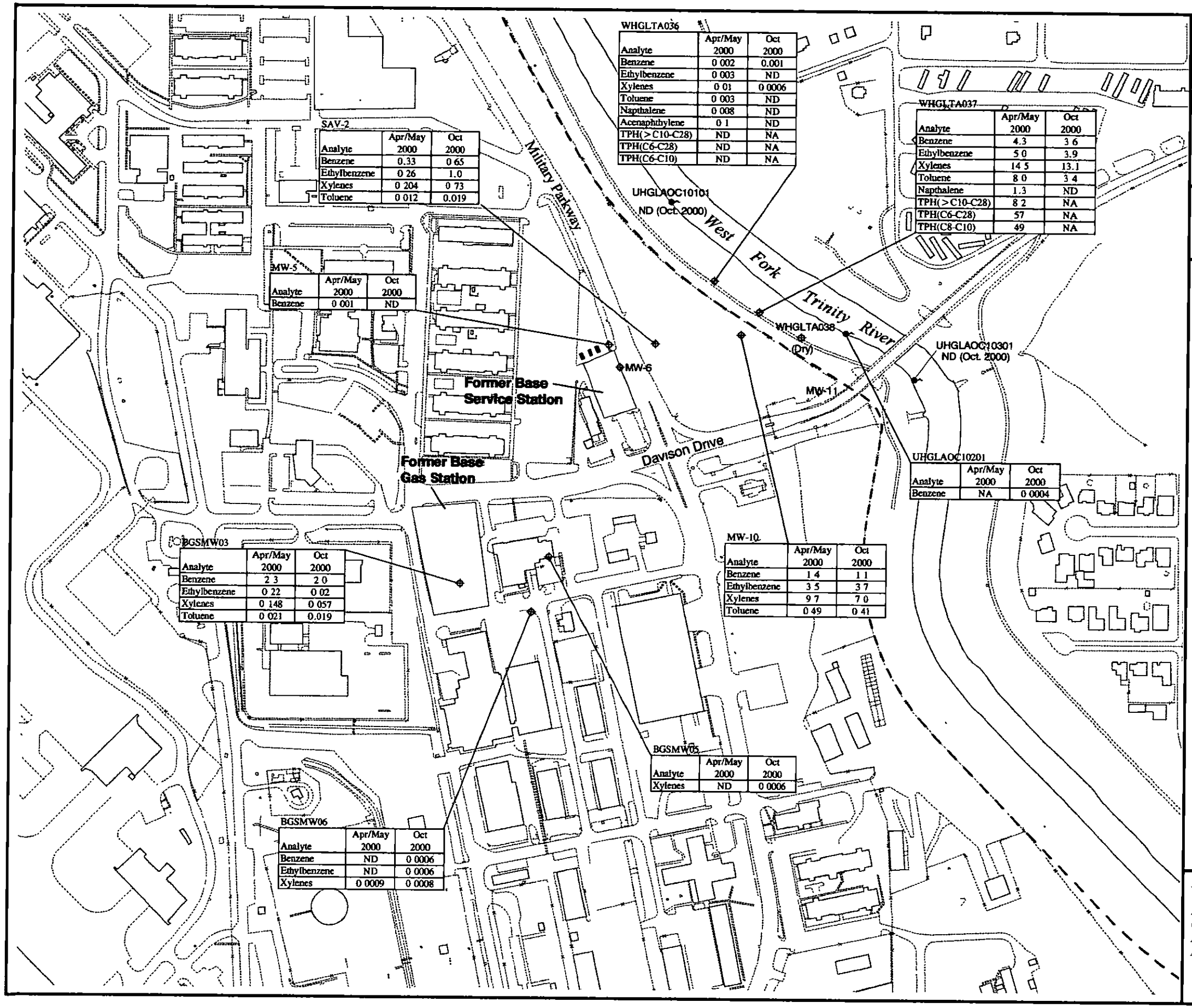
HYDRO GeoLogic

Legend

7,760	Total BTEX in µg/L
ND	Not Detected
+	Monitoring Well
———	Isoconcentration Boundary

Scale in Feet
0 125 250

Figure 1.3
October 1997 through July 1998
Total BTEX Plume Map
NAS Fort Worth JRB, TX



HydroGeoLogic, Inc —Aquifer Testing Work Plan
NAS Fort Worth JRB, Texas

Figure 1.4
AOC 1
April/May 2000 and
October 2000 BTEX Concentrations
in Groundwater and Surface Water
NAS Fort Worth JRB, Texas

U.S. Air Force Center for Environmental Excellence

Legend

- Semiannual Monitoring Well Locations
- Damaged Monitoring Well Locations
- Surface Water Sample Locations (December 2000)
- AOC 1 Location
- Present AST Locations at AOC 1
- ND Not Detected
- NA Not Analyzed

Notes: All concentrations reported in mg/L.
Only concentrations detected greater than Method Quantitation Limit (MQL) are presented.

MW-6 will be sampled in April/July 2001 in place of MW-5.

N

300 0 300

SCALE IN FEET

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Created. 03/14/01 apassarelli
Revised. 06/22/01 jb
Map Source· HGL ArcView Database

HYDRO GeoLogic Inc.

TAB

SECTION 2.0

2.0 SITE DESCRIPTION

On October 1, 1994, the U.S. Air Force transferred the majority of the property that constituted Carswell AFB to the U.S. Navy to become NAS Fort Worth JRB, Texas. NAS Fort Worth JRB is located on 2,555 acres of land in Tarrant County, Texas, eight miles west of downtown Fort Worth (Figure 2.1). The main base comprises 2,264 acres and is bordered by Lake Worth to the north; the West Fork Trinity River, River Oaks, and Westworth Village to the east; other urban areas of Fort Worth to the northeast and southeast; White Settlement to the west and southwest; and Air Force Plant 4 (AFP 4) to the west. The area surrounding NAS Fort Worth JRB not used for Department of Defense operations is used for a mix of industrial, commercial, residential, and recreational purposes (A.T. Kearney, 1989).

AOC 1 is located in the eastern portion of the former Carswell AFB and is comprised of the former BSS and the former Base Gas Station (Figure 1.1). The former BSS is located at the northwest corner of the intersection of Davison Drive and Military Parkway near the eastern edge of NAS Fort Worth JRB (Figure 1.2). The former BSS is located approximately 500 feet west of the western bank of the West Fork Trinity River and approximately 450 feet west of the eastern installation boundary (IT Corp., 1996). The former Base Gas Station is located at the intersection of Warehouse Street and Davison Drive (Figure 1.2).

2.1 PHYSIOGRAPHY

The NAS Fort Worth JRB is located along the border zone between two physiographic provinces. The southeastern part of the base is situated within the Grand Prairie section of the Central Lowlands Physiographic Province. The Central Lowlands Physiographic Province 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, which 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 and Benbrook Texas, U.S. Geological Survey topographic maps showing the relief of the NAS Fort Worth JRB area.

2.2 GEOLOGY

The geologic units of interest for the region, from youngest to oldest, are as follows: (1) the Quaternary Alluvium (including fill material and terrace deposits), (2) the Cretaceous Goodland Limestone, (3) the Cretaceous Walnut Formation, (4) the Cretaceous Paluxy Formation, (5) the Cretaceous Glen Rose Formation, and (6) the Cretaceous Twin Mountains Formation. A generalized cross section of the geology beneath NAS Fort Worth JRB is presented in Figure 2.2 and 2.3 (Radian, 1989). The areal limits of surface exposure of these units at NAS Fort Worth JRB are shown in Figure 2.4. The relationship between these hydrogeologic units and geologic units is illustrated in Figure 2.5. 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.

A generalized cross section of AOC 1 is illustrated in Figure 2.6. In general, silt and clay with varying amounts of sand and gravel occur to depths of 5 to 20 feet below ground surface. Underlying the silt and clay is a sand and gravel unit that normally increases in grain size with increasing depth. The sand deposits are fine-to coarse grained and composed predominantly of quartz grains. Gravel is mostly limestone and fossilized limestone shell fragment ranging in size from fine to cobbles.

The two aquifers beneath the NAS Fort Worth site are the Quaternary alluvium aquifer and the aquifer in the Paluxy Formation. These aquifers are separated by an aquitard of predominantly dry limestone of the Goodland and Walnut Formations. The aquitard creates a barrier to downward migration from the Quaternary to the Paluxy in the vicinity of the BSS and Base Gas Station. The existence of bedrock adjacent to the West Fork Trinity River in the vicinity of AOC 1 has not been confirmed through drilling activities. Groundwater flow in the Quaternary alluvium aquifer beneath the stations is northeast and east toward the West Fork Trinity River (Figure 2.7). Data collected as part of historical and recent investigations indicate that groundwater in the area of AOC 1 migrates eastward, and ultimately discharges, at least in part, into the West Fork Trinity River.

Surface water drainage across the former Base Gas Station and the former BSS is from west to east. A storm water ditch and culvert is located beside the former BSS on the west side of Military Parkway. A storm water ditch and culvert also run along the northern edge of Davison Drive before crossing under the intersection of Davison and Military Parkway, where the combined surface water flow discharges into the West Fork Trinity River. The majority of surface water run off from AOC 1 is collected and discharged in this storm drain system. In the past, the combined flow of the storm water system collected at the East Gate was passed through the East Gate Oil Water Separator (OWS) prior to being discharged to the river. However, this interceptor and OWS are infrequently utilized due to mechanical problems with interceptor pumping systems.

2.3 GROUNDWATER

2.3.1 Terrace Alluvium Deposits

The uppermost groundwater in the area occurs within the pore space of the grains of coarse sand and gravels deposited by the West Fork Trinity River. In some parts of Tarrant County, primarily in those areas adjacent to the West Fork Trinity River, groundwater from the terrace deposits is used for irrigation and residential use. Groundwater from the terrace deposits is rarely used as a source of potable water due to its limited distribution and susceptibility to surface/storm water pollution (USGS, 1996).

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

Flow between aquifers is restricted by the Goodland/Walnut Formations; therefore, the terrace alluvial groundwater has no significant hydraulic connection to the underlying aquifers at NAS Fort Worth JRB. The primary water flow in the terrace deposits is generally eastward toward the West Fork Trinity River, although localized variations exist across the entire site. The hydraulic gradient across the base is variable, reflecting variations in the flow direction and localized recharge. Discharge from the aquifer occurs into surface water on-site, specifically Farmers Branch Creek.

A potentiometric surface map of NAS Fort Worth JRB and AFP 4 alluvial terrace groundwater derived from data collected in July 2000 is presented as Figure 2.7. The groundwater elevation data show an easterly trend in groundwater flow over the area of NAS Fort Worth JRB toward the West Fork Trinity River (HydroGeoLogic, 2000).

2.3.2 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 7.3×10^{-11} centimeters per second (cm/sec) to 1.2×10^{-9} cm/sec for the NAS Fort Worth JRB and AFP 4 area. This corresponds to a vertical flow rate that ranges between 1.16×10^{-3} feet per day (ft/d) to 5.22×10^{-3} ft/d (ESE, 1994).

2.3.3 Paluxy Aquifer

The Paluxy Aquifer is an important source of potable groundwater for the Fort Worth area. Many of the surrounding communities, particularly White Settlement, 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.

2.3.4 Glen Rose Aquitard

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

2.3.5 Twin Mountains Aquifer

The Twin Mountains Formation is the oldest and deepest water supply source used in the NAS Fort Worth JRB area. The Twin Mountains Formation occurs approximately 600 feet below NAS Fort Worth JRB, with a thickness of between 250 to 430 feet. Recharge to the Twin Mountains Aquifer occurs west of NAS Fort Worth JRB, where the formation 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).

2.3.6 Surface Water

NAS Fort Worth JRB is located within the Trinity River Basin, adjacent to Lake Worth. Lake Worth receives a limited amount of storm water runoff from NAS Fort Worth JRB during and immediately after rainfall events. Part of the eastern boundary of NAS Fort Worth JRB is defined by the West Fork Trinity River. The West Fork Trinity River flows 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 Trinity River. The base is partly drained by Farmers Branch Creek, a tributary of the West Fork Trinity River. Farmers Branch Creek begins within the community of White Settlement and flows eastward. Just south of AFP 4, Farmers Branch flows under the runway within two large culverts commonly referred to as the "aqueduct". Most of the base drainage is intercepted by a series of storm drains and culverts, directed to OWSs, and discharged to the West Fork Trinity River

downstream of Lake Worth. A small portion of the north end of the base drains directly into Lake Worth.

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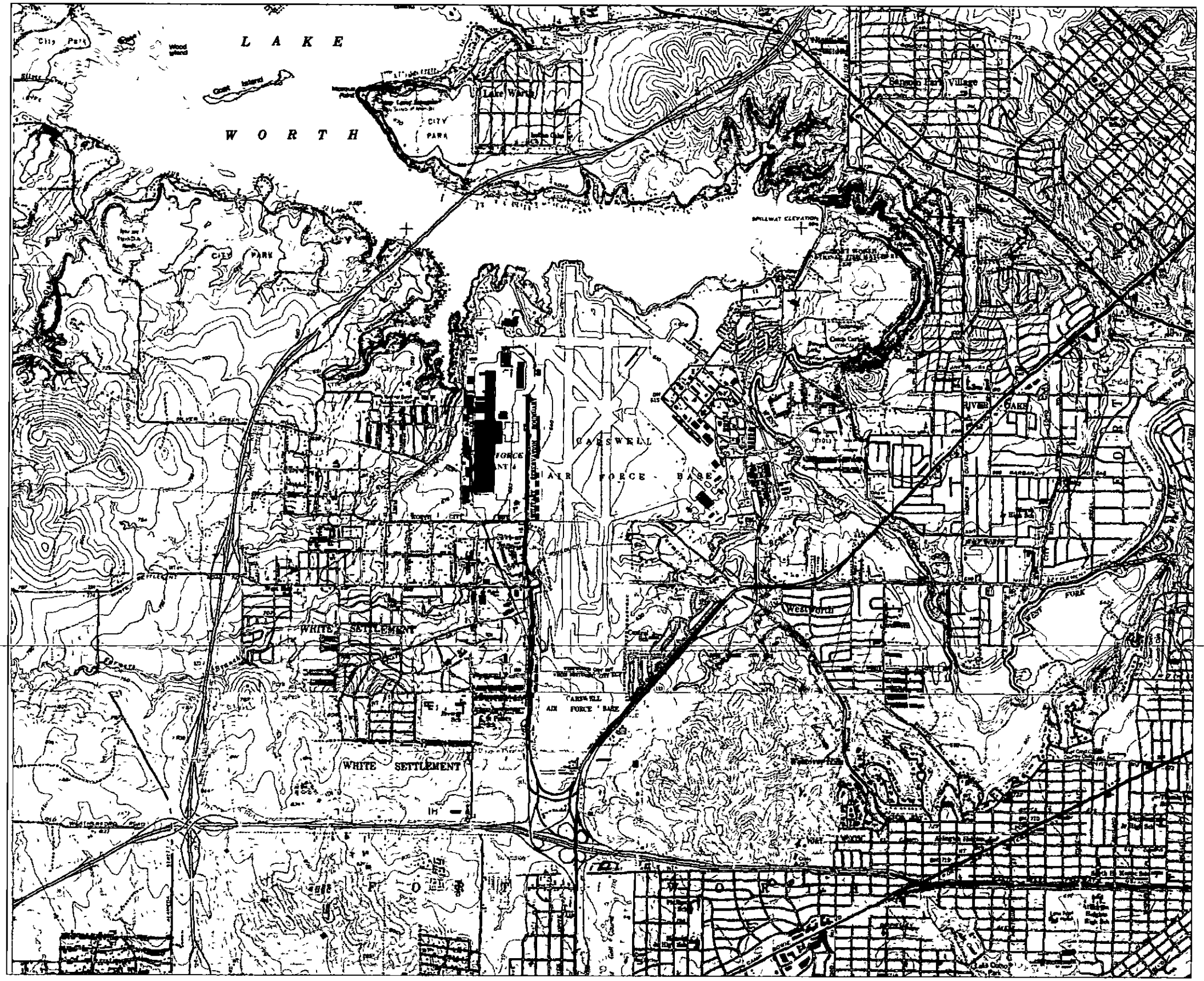
TAB

FIGURES



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

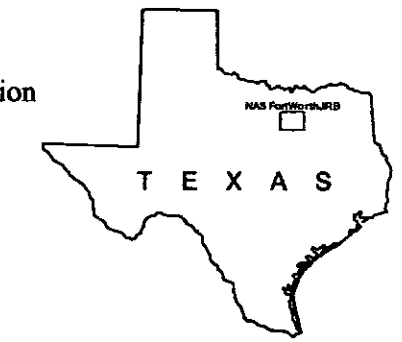
Figure 2.1

NAS Fort Worth JRB
Regional Topographic Map

Air Force Center for
Environmental Excellence
Brooks AFB, Texas

Legend

Site Location



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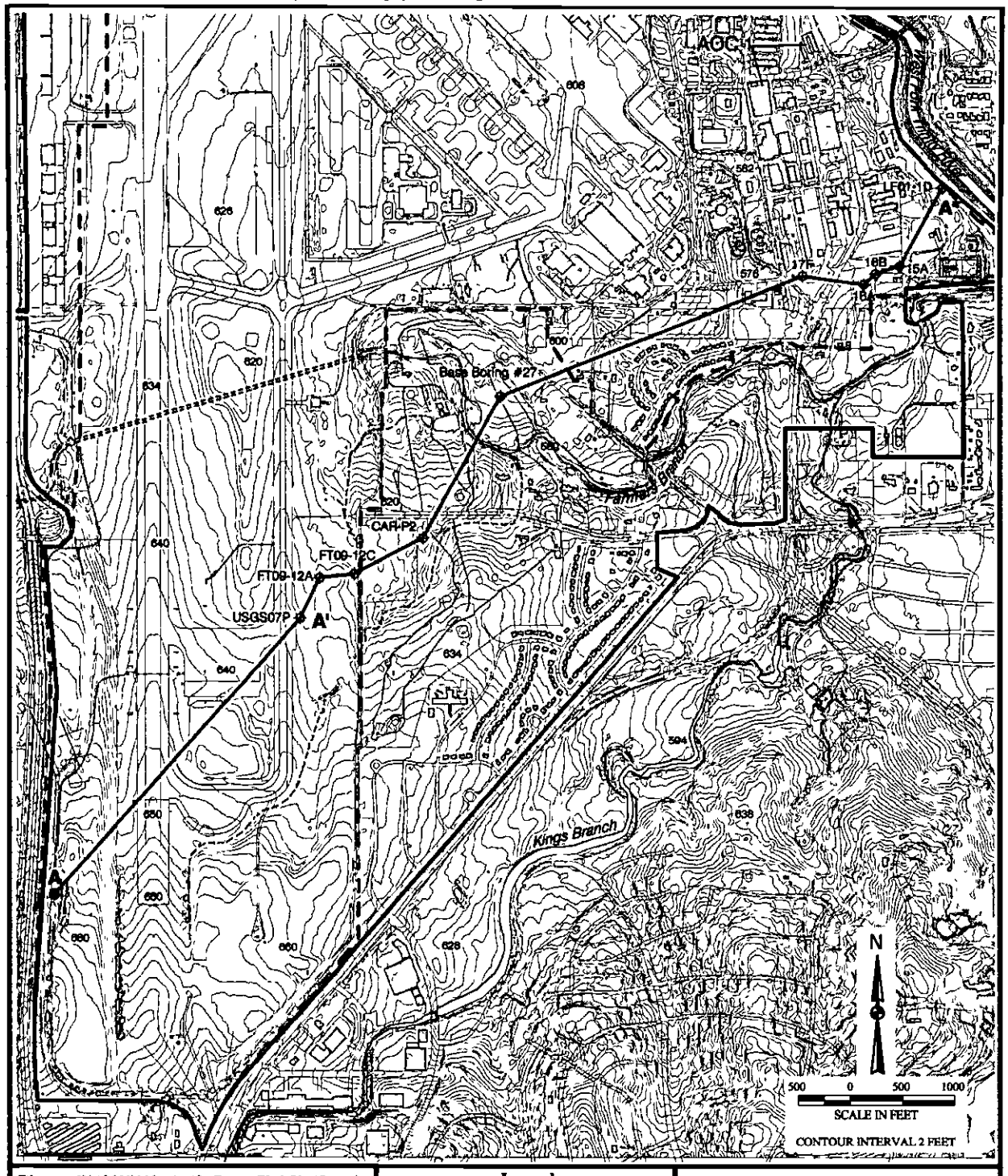
HYDRO GeoLogic



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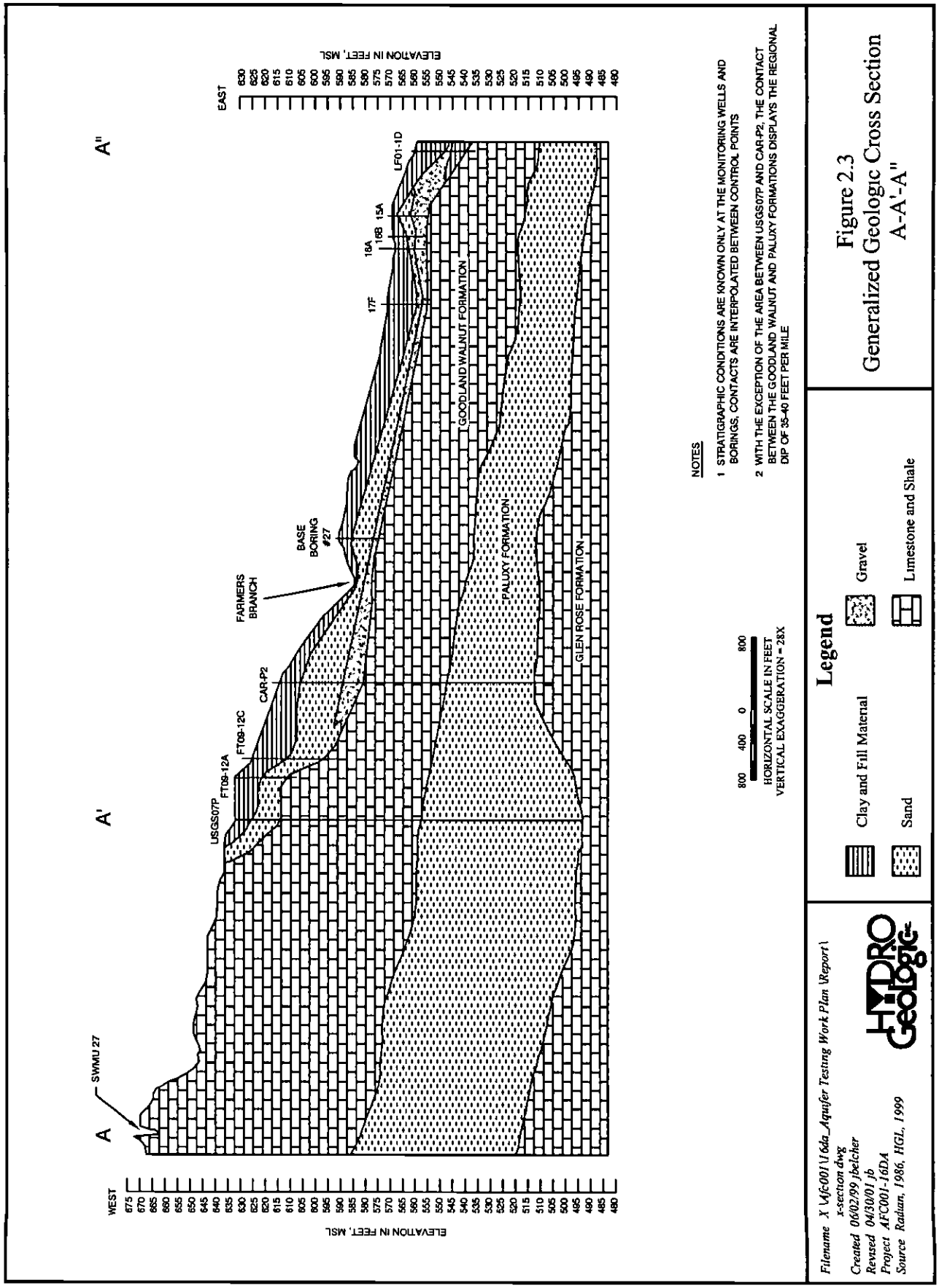
Created 03/11/99 jbelcher
Revised 04/30/01 jb
Source HydroGeoLogic, Inc—GIS Database

HYDRO GeoLogic

Legend

- NAS Fort Worth JRB Boundary
- Former Carswell AFB Boundary
- AOC 1 Location
- 660 Topographic Contour

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


A
A'
A"
WEST
EAST
ELEVATION IN FEET, MSL
SWMU 27
USGS07P
FT09-12A
FT09-12C
CAR-P2
FARMERS BRANCH
BASE BORING #27
17F
16A
16B
15A
LF01-1D
GOODLAND WALNUT FORMATION
PALUXY FORMATION
GLEN ROSE FORMATION
NOTES
1 STRATIGRAPHIC CONDITIONS ARE KNOWN ONLY AT THE MONITORING WELLS AND BORINGS, CONTACTS ARE INTERPOLATED BETWEEN CONTROL POINTS
2 WITH THE EXCEPTION OF THE AREA BETWEEN USGS07P AND CAR-P2, THE CONTACT BETWEEN THE GOODLAND WALNUT AND PALUXY FORMATIONS DISPLAYS THE REGIONAL DIP OF 35-40 FEET PER MILE
800 400 0 800
HORIZONTAL SCALE IN FEET
VERTICAL EXAGGERATION = 28X
Legend
Clay and Fill Material
Gravel
Sand
Limestone and Shale
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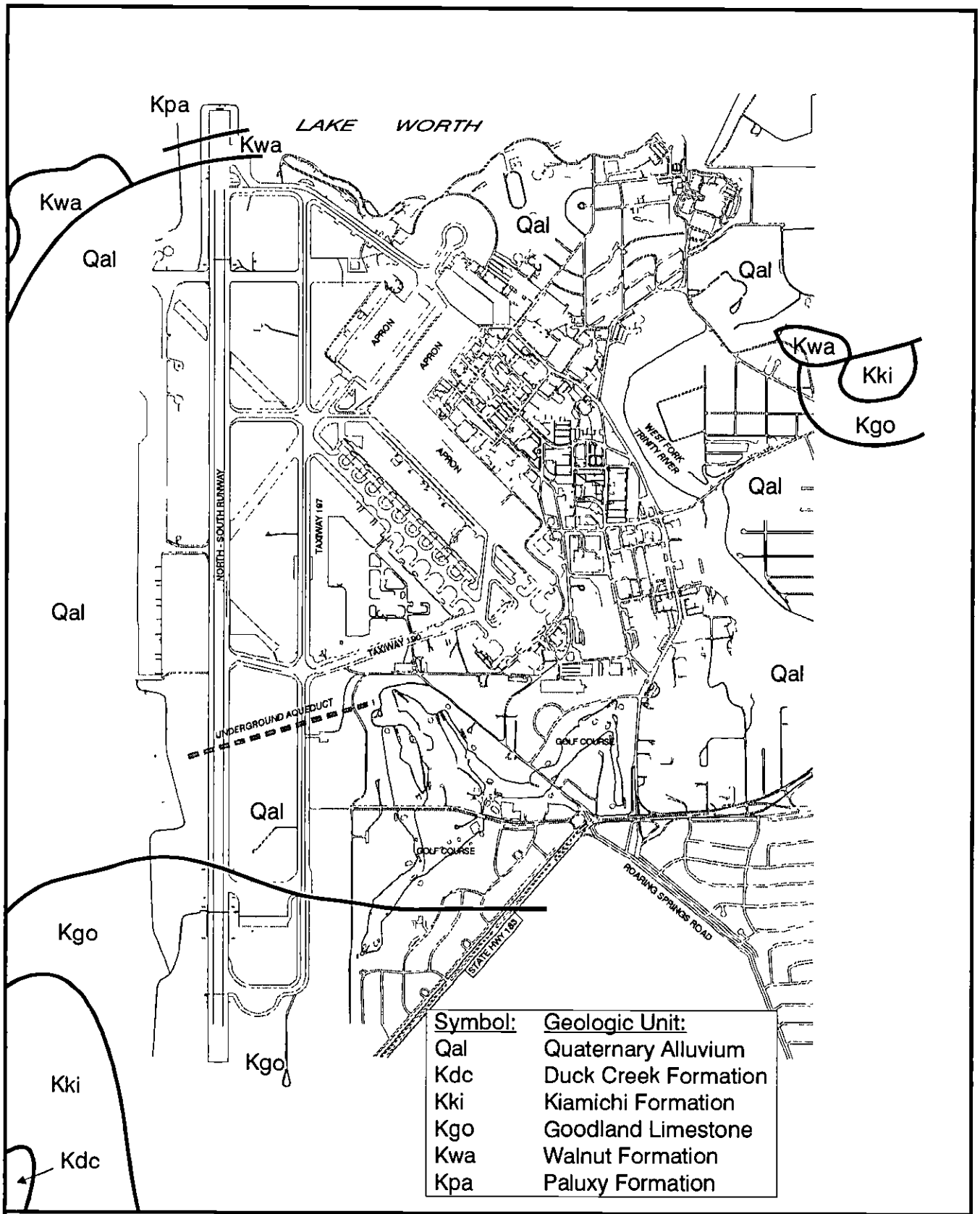
Created 06/02/99 jbelcher
Revised 04/30/01 jb
Project AFC001-16DA
Source Radian, 1986, HGL, 1999
HYDRO Geologic
Figure 2.3
Generalized Geologic Cross Section
A-A'-A"



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Project AFC001-16DA
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HYDRO GeoLogic INC.

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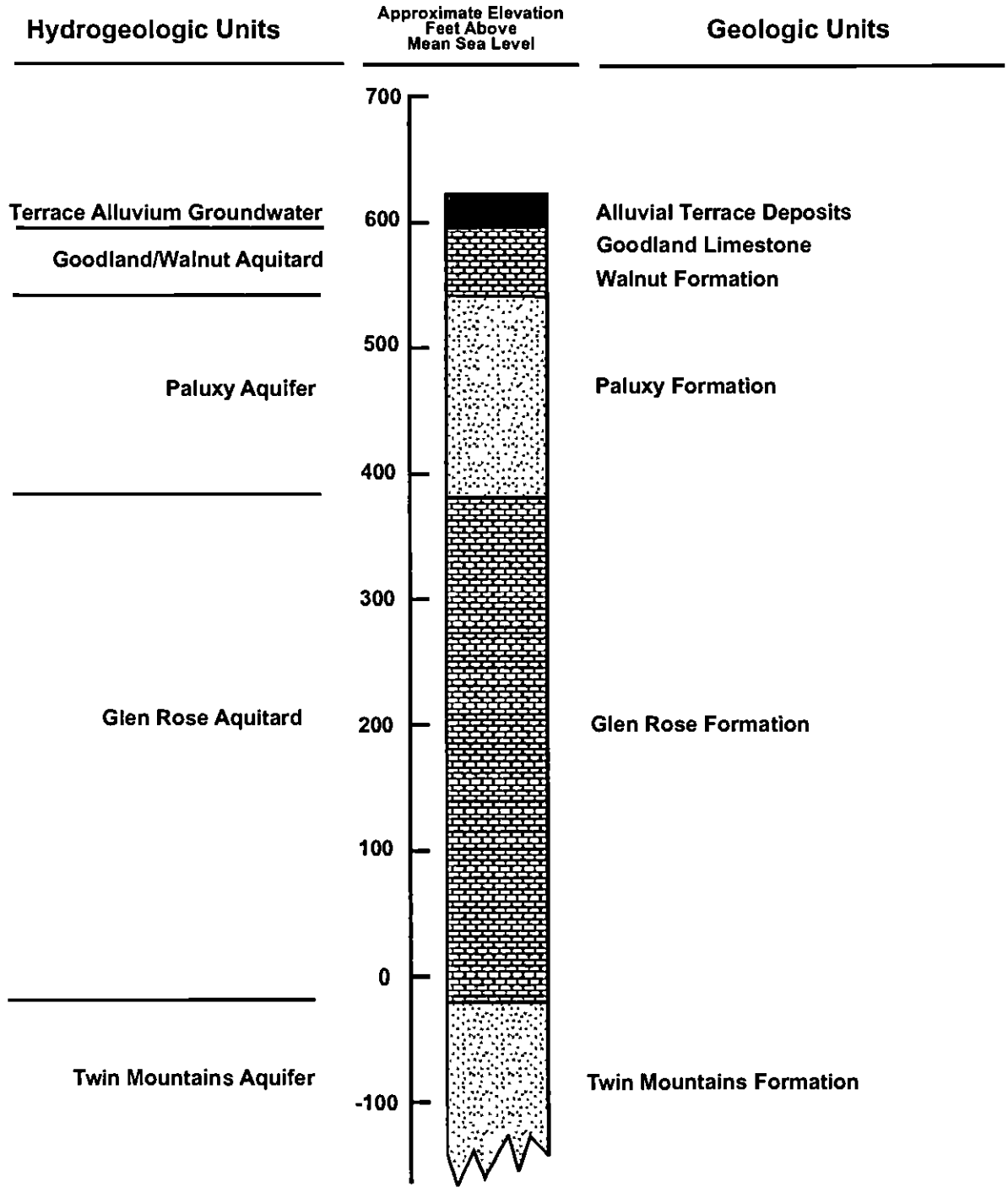
Figure 2.4
Areal Distribution of Geologic Units



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Revised 04/30/01 jb
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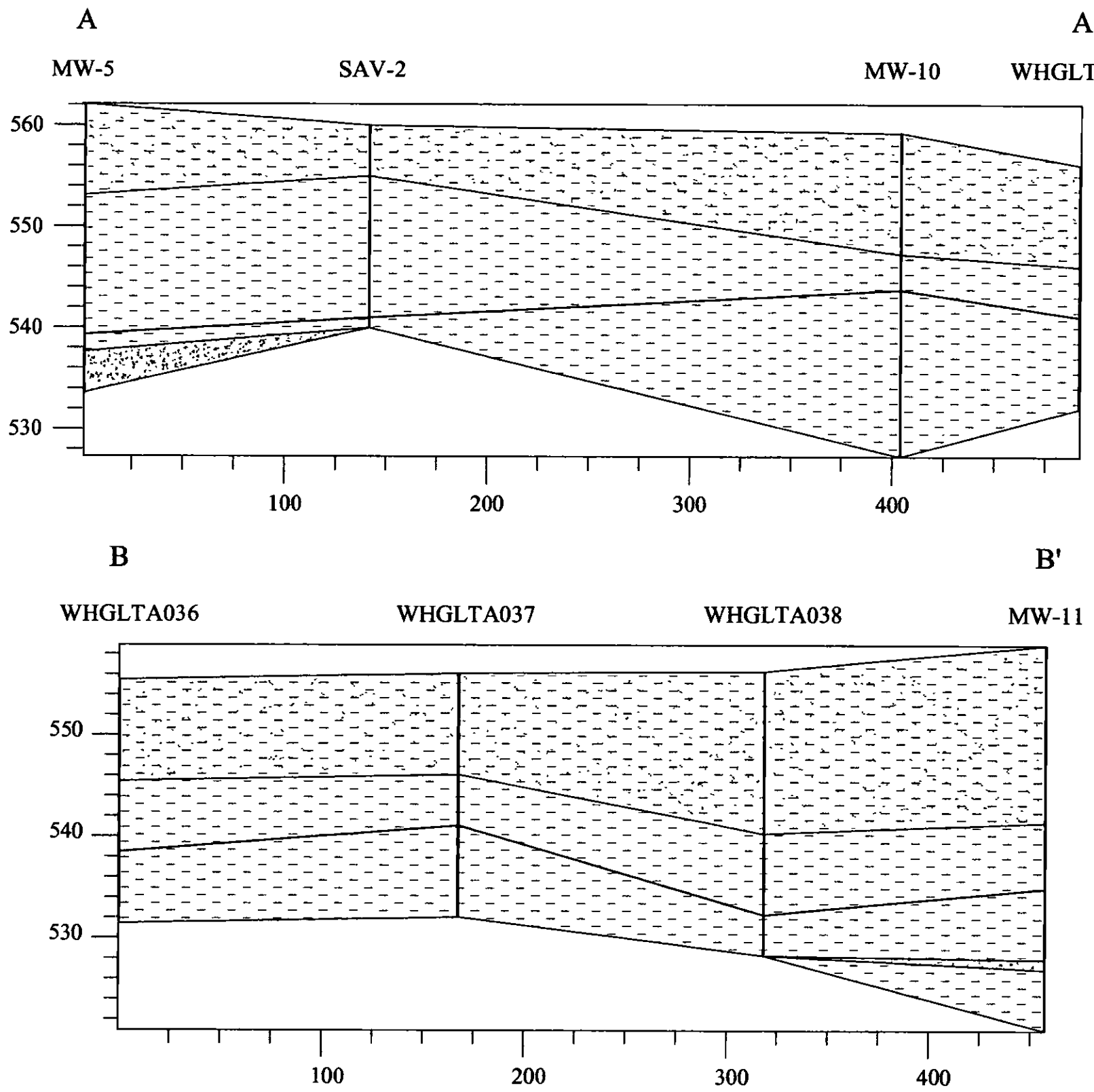
Map Source Radian, 1989

HYDRO GeoLogic Inc.

Figure 2.5
Stratigraphic Column Correlating Hydrogeologic Units and Geologic Units



Vertical Exaggeration = 5x

HydroGeoLogic, Inc —Aquifer Testing Work Plan
NAS Fort Worth JRB, Texas

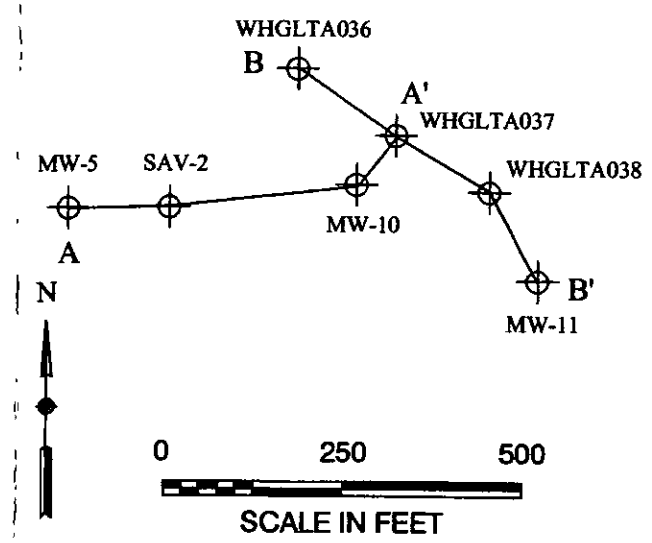
Figure 2.6

AOC 1
Cross Section and
Cross Section Map

U.S. Air Force Center for
Environmental Excellence

Legend

- Sandy Clayey Silt
- Sand with Clay Layers
- Sand & Gravel
- Water Table
- Monitoring Well



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Revised: 06-13-01 asp
Map Source.

HYDRO GeoLogic INC

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

Figure 2.7

Water Level Elevations
Terrace Alluvium
July 2000

U.S. Air Force Center For Environmental Excellence

Legend

- NAS Fort Worth JRB (Carswell Field)
- Former Carswell Air Force Base
- 600 Groundwater Elevation Contour (ft msl)
- Monitoring Well
- 533 76 Groundwater Elevation (ft msl)

N

0 500 1000 2000

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Project AFC001-16DB
Created 01/22/00 jbelcher
Revised. 06/13/01 jb
Map Source HydroGeoLogic, Inc GIS Database

HYDRO GeoLogic

TAB

SECTION 3.0

3.0 PROJECT TASKS

The following sections present the proposed field investigation tasks.

3.1 IDENTIFICATION OF DATA NEEDS

The objective of this investigation is to collect additional hydrogeologic and chemical data to fill data gaps remaining from previous investigations. The collected data will be used in conjunction with all existing data to design an interim containment system for groundwater contamination resulting from petroleum hydrocarbon releases from the former BSS and the former Base Gas Station.

The primary objectives have been identified for this project, and are summarized as follows:

- Perform aquifer characterization in the vicinity of the former BSS and the Federal property boundary adjacent to the West Fork Trinity River. A recovery well will be installed at this location and it will be evaluated for hydraulic conductivity, transmissivity (T), and specific yield (S). A dedicated monitoring well will also be installed to augment existing monitoring wells in providing pumping drawdown data.

- Fill data gaps with respect to plume delineation. This will be accomplished by installing and sampling two additional monitoring wells at selected locations to more closely define the downgradient extent of the BTEX plume near the West Fork Trinity River.

3.2 FIELD INVESTIGATION TASKS

The proposed field tasks described in the following sections will be conducted to achieve the investigation objectives. The field tasks described in the following sections were selected based on the type of data needed to complete the design of an interim containment system. Mobilization to the field is expected to begin as soon as the work plan is approved by AFCEE. Suggested monitoring well locations may shift due to localized site-specific conditions such as utilities, fences, and structures encountered during the field implementation.

3.2.1 Aquifer Testing

One monitoring well (WHGLTA057) and one recovery well (WHGLRWAOC101) will be installed on NAS Fort Worth JRB within the northern boundary of the AOC 1 BTEX plume (Figure 3.1). When WHGLTA057 and WHGLRWAOC101 are installed, the headspace will be continuously monitored using a photoionization detector (PID) and the borings will be terminated when no detectable VOCs are present in the headspace of the soil. Each well will be installed and then screened in the Terrace Alluvium. If VOCs are encountered at bedrock (approximately 40 feet below ground surface [bgs]), the wells will be installed to bedrock and screened within the Terrace Alluvium. If visible soil staining is observed, samples will be collected and analyzed for VOCs by EPA Method SW8260B.

Recovery well WHGLRWAOC101 will be installed approximately 75 feet north of existing monitoring well MW-2 and 50 feet south of existing monitoring well MW-10. Recovery well WHGLRWAOC101 will be a 6-inch polyvinyl chloride (PVC) well with a continuous wrap PVC screen. WHGLRWAOC101 will be sampled for VOCs after development using low flow purging. Monitoring well WHGLTA057 will be installed approximately 25 feet west of recovery well WHGLRWAOC101. Monitoring well WHGLTA057 will be a 2-inch PVC well with a slotted PVC screen. Both the WHGLRWAOC101 and WHGLTA057 will be screened from the bottom of the well and the length of the screen will penetrate the entire saturated zone and extend five feet into the vadose zone.

The data obtained during the aquifer test will be used to calculate the aquifer transmissivity and specific yield. Several analysis methods will be applied to evaluate the aquifer test data including: the Neuman solution for unconfined aquifers, the Cooper-Jacob straight-line method, and the Theis solution. Monitoring wells WHGLTA057 and existing monitoring wells MW-2 and MW-10 will be used to measure drawdown (i.e., the difference between ambient and stressed water levels) during the aquifer test (Figure 3.1). Multiple observation wells provide a greater opportunity for evaluating aquifer heterogeneity and/or anisotropy.

The aquifer test will consist of performing a 72-hour constant-rate pumping test using recovery well WHGLRWAOC101 as the pumping well. Prior to performing the constant rate test, a 12-hour variable-rate pump test (i.e., step test) will be performed to determine the optimal pumping rate for the subsequent constant-rate test. During the step test, water will be withdrawn from recovery well WHGLRWAOC101 at three different rates. During each discrete step, the pumping rate will be maintained at a constant rate for 4 hours and groundwater drawdown in the recovery well WHGLRWAOC101 and the two monitoring points will be measured during the step test and during the subsequent recovery period. Pressure transducers will also provide uninterrupted groundwater levels throughout the step test. At the end of the first two 4-hour time periods, the pumping rate will be increased. The initial pumping rate for the first step of the step test will be approximately 3 gallons per minute (gpm). The planned pumping rates for the subsequent two steps will be 6 gpm and 8 gpm, however these pumping rates may be changed in the field. The 8 gpm pumping rate for the final step should be close to the maximum pumping rate that can be sustained in the recovery well WHGLRWAOC101. After completion of the step test, the pump will be shut off and water levels will be allowed to recover. Data from the resulting step test will be analyzed using the aquifer testing software, AQTESOLV, which allows the evaluation of variable-rate pumping test data. In addition, the specific capacity of the well will be calculated and, based on these analyses, a target pump rate will be selected for the constant-rate test.

Once the target pump rate has been determined and water levels in the vicinity of well have recovered to ambient conditions, the constant-rate pumping test will be initiated. The pumping rate will be set to the target pump rate of 7 gpm and allowed to continue uninterrupted for 72 hours. Recovery well WHGLRWAOC101 and the two monitoring wells will be measured for changes in water elevations as specified in the Field Sampling Plan (FSP). Pressure transducers will be used to monitor water levels in recovery well WHGLRWAOC101 and the three observation wells throughout the duration of the variable-rate test.

Prior to initiating the aquifer tests (i.e., step test and constant-rate test), at least 24-hours of background water levels will be collected in recovery well WHGLRWAOC101 and the observation monitoring wells. During this 24-hour period and during the aquifer tests, barometric pressure data will be obtained from the Naval Training Meteorology and Oceanography Detachment, located on NAS Fort Worth JRB. This will eliminate the need to measure and record barometric pressure during the aquifer tests. The background water level and the barometric pressure data may be used to correct the aquifer test data for climatic changes that may occur during the test.

3.2.2 Additional Plume Delineation

Two additional monitoring wells (WHGLTA058 and WHGLTA059) will be installed within the AOC 1 BTEX plume to better define the extent of the plume in the area between the Federal property boundary and West Fork Trinity River. The proposed monitoring well locations are illustrated on Figure 3.1. Monitoring wells, WHGLTA058 and WHGLTA059 will be installed outside the boundaries of the Former Carswell AFB and will require the acquisition of rights-of-way from any affected landowners. When WHGLTA058 and WHGLTA059 are installed, the headspace will be continuously monitored using a PID, and the borings will be terminated when no detectable VOCs are present in the headspace of the soil. Each well will be installed and then screened in the Terrace Alluvium. If VOCs are encountered at bedrock (approximately 40 feet bgs), the wells will be installed to bedrock and screened within the Terrace Alluvium. If visible soil staining is observed, samples will be collected and analyzed for VOCs by EPA Method SW8260B.

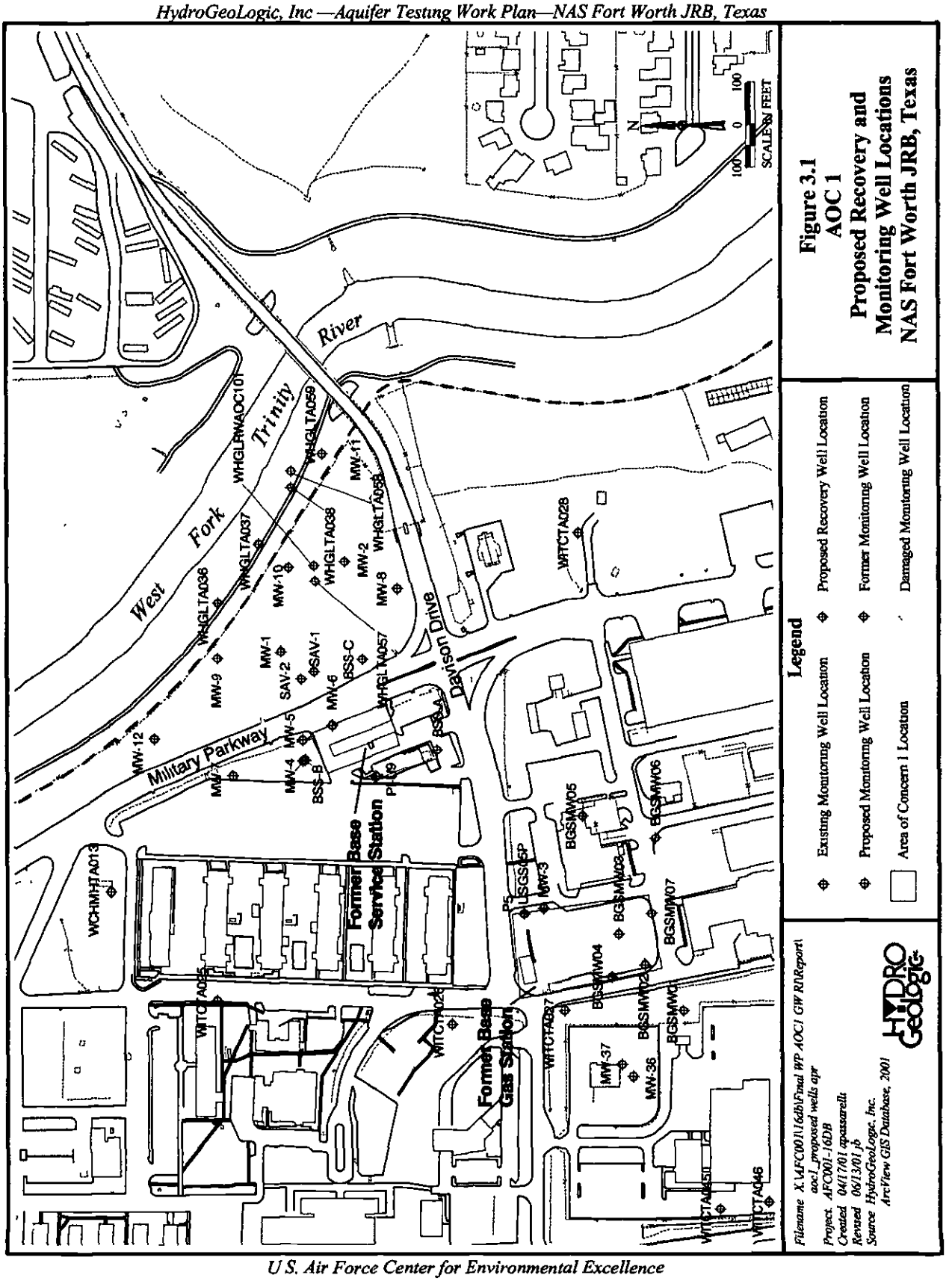
The delineation monitoring wells WHGLTA058 and WHTLA059 will be installed as 2-inch PVC wells with slotted screens. The screens will be set at the bottom of the well and penetrate the entire saturated zone. The wells will be developed after installation, purged (low flow), and then the groundwater will be sampled for the parameters listed in Table 3.1, and will be performed in accordance with the method requirements presented in the 2000 Basewide Quality Assurance Project Plan (QAPP) (HydroGeoLogic, 2000). Field quality control (QC) samples, including matrix spike/matrix spike duplicate (MS/MSD) samples, field duplicates, trip blanks, and equipment blanks, will be collected at the frequencies specified in Table 2.3 of the FSP presented in Appendix A of this work plan.

Table 3.1
Groundwater Sampling Analytical Methods and Parameters

Method	Parameter
E130.1 or E130.2	total hardness
E160.1	dissolved solids
E160.2	suspended solids
E160.3	total solids
E310.1	alkalinity
Field measurement	pH
SW6010B	calcium, manganese, magnesium, and iron
SW8260B	VOCs
SW9056	chloride
SW9060	total organic carbon

TAB

FIGURES


West Fork Trinity River
Military Parkway
Davison Drive
Former Base Service Station
Former Base Gas Station
WHGLTA036
WHGLTA037
WHGLTA038
WHGLTA057
WHGLTA058
WHGLTA059
WHGLFWAOC101
MW-1
MW-2
MW-4
MW-5
MW-6
MW-8
MW-9
MW-10
MW-11
MW-12
SAV-1
SAV-2
BSS-A
BSS-B
BSS-C
WHCHMHTA013
WHTCTA025
WHTCTA026
WHTCTA027
WHTCTA028
WHTCTA045
WHTCTA046
BGSMW01
BGSMW02
BGSMW03
BGSMW04
BGSMW05
BGSMW06
BGSMW07
MW-36
MW-37
USGSSP
P5
P6
N
SCALE IN FEET
100
0
100
Legend
Existing Monitoring Well Location
Proposed Monitoring Well Location
Area of Concern 1 Location
Proposed Recovery Well Location
Former Monitoring Well Location
Damaged Monitoring Well Location
Figure 3.1
AOC 1
Proposed Recovery and
Monitoring Well Locations
NAS Fort Worth JRB, Texas
Filename X:\AFC001\16db\Final WP AOC1 GW RI\Report\aoc1_proposed wells.apr
Project AFC001-16DB
Created 04/17/01 apassarelli
Revised 06/13/01 jb
Source HydroGeoLogic, Inc. ArcView GIS Database, 2001
HYDRO GeoLogic

TAB

SECTION 4.0

4.0 DATA ASSESSMENT, RECORDS, AND REPORTING REQUIREMENTS

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

4.1 DATA ASSESSMENT

The project chemist will review and validate all data received from the laboratory. This review will be conducted in accordance with the protocols detailed in the 2000 Basewide QAPP (HydroGeoLogic, 2000), and will consist of the following elements:

- **Sampling and Analysis Completeness** – To determine that all environmental and field QC samples were collected and analyzed for the parameters listed in this work plan. Relevant field records will also be examined.

- **Evaluation of Holding Times** - To determine that all samples analyzed within the holding times for extraction and analysis specified in the QAPP.

- **Evaluation of Quality Control (QC)** – To determine that instrument calibration, QC sample analysis, and method performance criteria were met for each analyte in each sample analysis. Where QC criteria are not met, the reviewer will determine whether the laboratory took proper corrective action, and whether these corrective actions were effective.

- **Instrument Sensitivity** - To determine if the detection and reporting limit requirements specified in the 2000 Basewide QAPP for these analyses have been met.

If QC discrepancies for which corrective actions were not performed or were not effective are noted in the data review process, the affected data will be qualified in accordance with the 2000 Basewide QAPP. Qualified data will receive the data qualifiers described in Table 8.1 of the QAPP. Qualified data will be considered usable unless severe deficiencies require that the affected results be rejected. Following the data review process, the percentage of usable data will be determined and compared to the groundwater data completeness goal of 95%. If the completeness goal is not met, the data will be evaluated with respect to the primary contaminants of concern (BTEX and other fuel-related VOCs) to determine if project data meet the objectives presented in Section 3.1. If these objectives are not met, resampling and analysis may be necessary.

4.2 RECORD KEEPING

Records of field and laboratory activities will be documented on the standard forms included as Attachment B of the accompanying FSP. Project data such as groundwater level

measurements, boring logs, survey data, well construction forms, chain-of-custody forms, and equipment calibration logs will be reviewed for accuracy and completeness. These documents will be reviewed by the Project Manager daily and retained in the project files.

4.3 REPORTING REQUIREMENTS

The information gathered during the activities will be used to complete the design of the AOC 1 BTEX groundwater plume interim remediation system. The conclusions of the aquifer test will be presented to the regulatory community and will be summarized in the Draft CMI Work Plan and Revised Plan B reports.

TAB

SECTION 5.0

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TAB

APPENDIX A FIELD SAMPLING PLAN

FINAL
FIELD SAMPLING PLAN
AREA OF CONCERN 1
GROUNDWATER REMEDIATION INVESTIGATION
NAS FORT WORTH JRB, TEXAS

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

Contract Number F41624-95-D-8005
Delivery Order 0016

June 2001

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FIELD SAMPLING PLAN
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Prepared by

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

June 2001

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LIST OF ACRONYMS AND ABBREVIATIONS

AFCEE	U.S. Air Force Center for Environmental Excellence
AOC 1	Area of Concern 1
ASTM	American Society for Testing and Materials
BTEX	benzene, toluene, ethylbenzene, xylene
°C	degrees Celsius
CFR	Code of Federal Regulations
COC	chain of custody
DNAPL	dense non-aqueous phase liquid
DO	dissolved oxygen
EC	electrical conductance
Eh	oxidation-reduction potential
EPA	U.S. Environmental Protection Agency
ERPIMS	Environmental Restoration Program Information Management System
FSP	Field Sampling Plan
HSA	hollow stem auger
HydroGeoLogic	HydroGeoLogic, Inc.
IDW	investigative derived waste
JRB	Joint Reserve Base
L/min	liters per minute
lbs/gal	pounds per gallon
LNAPL	light non-aqueous phase liquid
mL	milliliter
MS	matrix spike
MSD	matrix spike duplicate
NAS	Naval Air Station
NGVD	National Geodetic Vertical Datum
NTU	nephelometric turbidity unit
ORP	oxidation-reduction potential
OVM	organic vapor monitor

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

PAH	polynuclear aromatic hydrocarbon
PEST/PCBs	pesticides/polychlorinated biphynels
PID	photoionization detector
PM	Project Manager
POC	point-of-contact
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
QC	quality control
RCRA	Resource Conservation and Recovery Act
TAC	Texas Administrative Code
TAT	turnaround time
TNRCC	Texas Natural Resource Conservation Commission
TOC	total organic carbon
USCS	United Soil Classification System
VOC	volatile organic compound

FINAL
FIELD SAMPLING PLAN
AREA OF CONCERN 1
GROUNDWATER REMEDIATION INVESTIGATION
NAS FORT WORTH JRB, TEXAS

1.0 SITE RECONNAISSANCE AND PREPARATION

Prior to this groundwater remediation investigation, a site reconnaissance of Area of Concern (AOC) 1 will be performed to check each proposed well location for accessibility for installation, sampling, and for performing the aquifer test. In addition, the logistics for the investigative derived wastes (IDW) produced during the aquifer test and groundwater sampling will be identified. The HydroGeoLogic Inc. [HydroGeoLogic] field office is located on 1346A Range Road, Naval Air Station (NAS) Fort Worth Joint Reserve Base (JRB), Texas and is designated as the central location for sample tracking, packaging, and preparation for shipping.

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2.0 FIELD OPERATIONS

The overall project field logistics and activities necessary to complete the installation of soil borings and groundwater monitoring wells is discussed in this section. All field work will be conducted in accordance with the site Health and Safety Plan (HSP) (Appendix B). The point-of-contact (POC) at NAS Fort Worth JRB is Mr. Michael Dodyk.

2.1 BOREHOLE DRILLING, LITHOLOGIC SAMPLING, AND LOGGING

2.1.1 General Drilling Procedures

All drilling activities shall conform to 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.

Soil borings through the Terrace Alluvium will be advanced using a hollow stem auger (HSA). HydroGeoLogic and its subcontractors will take measures to prevent cross-connection or cross-contamination of the zones or aquifers when installing the boreholes.

A log of drilling activities will be kept in a bound field notebook. Information in the log book will include location, time on site, personnel and equipment present, down time, materials used, samples collected, measurements taken, and any observations or information that would be necessary to reconstruct field activities at a later date. At the end of each day of drilling, the drilling supervisor will complete a Log of Daily Time and Materials Form.

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.

2.1.2 Sampling and Logging

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

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

Identification of the United Soil Classification System (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.

All samples will be monitored with an organic vapor monitor (OVM) (e.g., photoionization detector (PID)). The samples shall 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 their hazardous characteristics. Materials suspected to be hazardous because of abnormal color, odor, or OVM readings will be containerized in conformance with Resource Conservation and Recovery Act (RCRA), state, and local requirements.

2.2 MONITORING WELL CONSTRUCTION

2.2.1 Monitoring Well Borehole Requirements

Monitoring wells will be installed using HSA drilling techniques during this investigation. The inside diameter of the borings will be at least 4 inches larger than the outside diameter of the casing and well screen. The total outside diameter of the boring will not exceed 14 inches.

The completed monitoring wells will be sufficiently straight to allow passage of pumps or sampling devices and will be plumb within 1 degree of vertical where the water level is greater than 30 feet below land surface, unless otherwise approved by Air Force Center for Environmental Excellence (AFCEE).

The following information will be recorded for each boring log:

- Unique boring or well identification,
- Purpose of boring (e.g., soil sampling, monitoring well),
- Location of boring,
- Names of drilling contractor and logger,
- Start and finish dates and times,
- Drilling method,
- Types of drilling fluids and depths at which they were used,
- Diameters of surface casing, casing type, and methods of installation,
- Depth of encountered saturated conditions,
- Lithologic descriptions and depths of lithologic boundaries,
- Sampling-interval depths,
- Zones of caving or heaving,
- Drilling rate, and
- Drilling rig reactions (i.e., chatter, rod drops, and bouncing).

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

2.2.2 Casing Requirements

The casing requirements that will be followed are the following: (1) all casing will be new, unused, and decontaminated according to the specifications of Section 10.3, (2) glue will not be used to join casing, and casings will be joined only with compatible welds or couplings that shall not interfere with the planned use of the well, (3) all polyvinyl chloride (PVC) will conform to the ASTM Standard F-480-88A or the National Sanitation Foundation Standard 14 (Plastic Pipe System), (4) the casing will be straight and plumb within the tolerance stated for the borehole, and (5) the driller shall cut a notch facing north in the top of the casing to be used as a measuring point for water levels.

The delineation monitoring wells for this project will be constructed using flush threaded 2-inch diameter Schedule 40 PVC casing. The additional monitoring well being installed to serve, as an observation well for the aquifer test will be constructed using flush threaded 2-inch diameter Schedule 40 PVC casing. The recovery well for the aquifer test will be constructed using flush threaded 6-inch diameter Schedule 40 PVC casing. The notches cut in the top of the monitoring well casings for water level measuring points will be oriented on the north side of each casing for uniformity.

2.2.3 Well Screen Requirements

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

The recovery well for the aquifer test will be installed with a 6-inch continuous wire wrap PVC screen. It is anticipated that the maximum depth of the recovery well will be approximately 40 feet and will be screened across the entire saturated thickness of the aquifer and extend five feet into the vadose zone. The screen will be capped using flush threaded PVC caps.

The observation wells for the aquifer test will have 2-inch diameter well screens and casing. It is anticipated that the wells will be installed to a maximum depth of approximately 40 feet below grade and will be screened across the entire saturated thickness of the aquifer and extend five feet into the vadose zone. The screen size will be 10-slot (0.010-inch) PVC. The bottom of the screens will be capped using flush threaded PVC caps.

The delineation monitoring wells will be installed as 2-inch diameter PVC wells with slotted screens. The screens will be set at the bottom of the well and penetrate the entire saturated

zone. The screen size in the alluvium will be 10-slot (0.010-inch) PVC. The bottom of the screens will be capped using flush threaded PVC caps.

2.2.4 Annular Space Requirements

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

2.2.5 Filter Pack Requirements

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

The filter pack material will be clean, inert, and well-rounded and will contain less than 2 percent flat particles. The sand will be certified free of contaminants by vendor or contractor. If decontamination is necessary, the methods shall be approved in writing by AFCEE. The grain size of the filter pack material will be determined based on existing grain size analysis prior to mobilization to the field. The filter pack will have a grain size distribution and uniformity coefficient compatible with the formation materials and the screen. This will be calculated as described in Chapter 12, *Ground Water and Wells*, 2nd Edition (Driscoll, 1986).

The filter pack will not extend across more than one water-bearing unit. The filter pack in all wells will be emplaced with a bottom discharge tremie pipe of at least 1½ inches in diameter to prevent bridging. The tremie pipe will be lifted from the bottom of the hole at the same rate the filter pack is set. HydroGeoLogic will record the volume of the filter pack emplaced in the well. If potable water is necessary to place the filter pack, HydroGeoLogic will obtain prior approval from the regulatory agency providing oversight, and will ensure that no contaminants are introduced into the well.

2.2.6 Bentonite Seal Requirements

The bentonite seal will consist of at least 2 feet of bentonite between the filter pack and the casing grout, the bentonite will be hydrated before placement and shall be installed by pump tremie methods, and only 100 percent sodium bentonite shall be used.

2.2.7 Casing Grout Requirements

Casing grout will extend from the top of the bentonite seal to ground surface. The grout will be mixed in the following proportions: 94 pounds of neat Type I Portland or American Petroleum Institute Class A cement, not more than 4 pounds of 100 percent sodium bentonite powder, and

not more than 8 gallons of potable water. All grout will be pump tremied using a side-discharge tremie pipe, and pumping will continue until 20 percent of the grout has been returned to the surface. If the bentonite seal is visible and within 30 feet of the land surface, the 20 percent return is not necessary so long as the tremie pipe is pulled back as the grout is emplaced.

2.2.8 Surface Completion Requirements

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

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

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

2.3 AQUIFER TESTS

Section 3.2.1 of the Work Plan describes the general location, equipment, and procedures that will be used in performing the aquifer test at recovery well WHGLRWAOC101. The following are general AFCEE aquifer testing guidelines, which will be followed during performance of the aquifer test.

2.3.1 Aquifer Testing For Hydraulic Properties

2.3.1.1 Pumping Tests

HydroGeoLogic will use existing monitoring wells as observation wells whenever possible. The pumping rate will be determined by conducting step-tests prior to the pumping test. The well will be pumped at predetermined rates in order to determine the optimum pumping rate. If a lower pumping rate is preferable because of factors such as nearby supply wells, areas with floating product, disposal costs, or limited storage facilities, the lower rate will be approved by AFCEE. At a minimum, barometric pressures should be monitored at the beginning and end of the test in order to evaluate the impact barometric pressure may have had on the test. The test will not begin until water levels in all wells have completely recovered. HydroGeoLogic will monitor and regulate the discharge valve for either a constant-discharge or constant-head test. The discharge rate will be measured at least ten times during the first 100 minutes of the test and at least every time water levels are measured thereafter. Water levels will be measured at least ten times per log cycle for the first 100 minutes of the test and at least once every hour thereafter. Time-drawdown or distance-drawdown data will be analyzed during the test. The test will be terminated when collection of additional data will not affect results (e.g., when water levels are essentially at equilibrium, or when a well in low hydraulic conductivity rocks does not yield sufficient water to continue). Refer to Section 10.4 for specific information regarding waste handling.

2.3.1.2 Other Test Methods

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

2.4 SAMPLE ANALYSIS SUMMARY

All samples collected as a part of the investigation will be analyzed for volatile organic compounds (VOCs) by EPA Method 8260B. In addition, samples for analysis of additional groundwater parameters to aid in the design of a groundwater treatment system will be collected. Refer to Table 2.1 for details.

Table 2.1
Data Quality Levels and Intended Use for Field and Laboratory Data

Sampling Matrix	Parameters	Analytical Method	Field/Lab Analysis	Data Quality Level	Intended Use
Surface Soil	VOCs	PID	Field	Screening	Field screening for selecting samples for lab analysis.
Subsurface Soil	VOCs	PID	Field		To differentiate the stratigraphy, to identify subsurface contaminants.
Soil	VOCs	SW8260B	Laboratory	Definitive	Nature/extent of contaminants
Groundwater	VOCs	SW8260B	Laboratory	Definitive	Nature/extent of contaminants
	Alkalinity	SW310.1	Laboratory	Screening	
Groundwater	Iron	SW6010B	Laboratory	Definitive	Groundwater Treatment System Design
	Manganese	SW6010B	Laboratory	Definitive	
	Magnesium	SW6010B	Laboratory	Definitive	
	Calcium	SW6010B	Laboratory	Definitive	
	Total Hardness	E130.1	Laboratory	Screening	
	Suspended Solids	E160 2	Laboratory	Screening	
	Chlorides	E300.0	Laboratory	Definitive	
	Dissolved Solids	E160.1	Laboratory	Screening	
	Total Solids	E160.3	Laboratory	Screening	
	pH	SW9045C	Laboratory	Screening	
	Alkalinity	E310 1	Laboratory	Screening	
	Total Organic Carbon	E415.1	Laboratory	Screening	

Note:
VOCs - Volatile Organic Compounds

2.4.1 Field Activities

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

The objective of this investigation is to collect additional physical hydrogeologic data to fill data gaps remaining from previous investigations. The collected data will be used in conjunction with all existing data to design a remediation system for the groundwater contamination resulted from petroleum hydrocarbons releases from the former Base Gas Station and former Base Service Station.

The primary objectives has been identified for this investigation, and are summarized below as follows:

- Perform aquifer characterization at the former Base Gas Station and former Base Service Station located at the NAS Fort Worth JRB and former Carswell AFB property boundary. A recovery well will be installed at this location and it will be evaluated for hydraulic conductivity, transmissivity, and specific yield. One additional monitoring well will also be installed to augment existing monitoring wells for providing pumping drawdown data.

- Two monitoring wells will be installed to aid in plume delineation near the periphery of the benzene, toluene, ethylbenzene, and xylenes (BTEX) plume near the West Fork Trinity River.

Table 2.2 provides a summary of the field activities and Table 2.3 presents the number of soil and groundwater samples to be collected and the analytical methods to be performed during the field investigation. The proposed well locations are illustrated in Attachment A of this Field Sampling Plan (FSP). The final well locations may deviate slightly from the proposed locations due to cultural influences such as overhead lines or buried utilities.

Table 2.2
Field Activities Summary
NAS Fort Worth JRB, Texas

HSA Aquifer Test Recovery Well (6" Diameter)	HSA Aquifer Test Monitoring Well (2" Diameter)	HSA BTEX Plume Delineation Wells (2" Diameter)	Total Number of Wells to be Installed
1	1	2	4

Notes:
In addition to the one aquifer test monitoring well to be installed, two existing monitoring wells (MW-10 and MW-2) will be used to monitor draw down during the pump test.

HSA - hollow stem auger
BTEX - benzene, toluene, ethylbenzene, xylenes

Table 2.3
Soil and Groundwater Sample Analysis Summary
NAS Fort Worth JRB, Texas

Task	Method	Matrix	No. of Samples[1]	No. of Equipment Blanks[2]	No. of Ambient Blanks[3]	No. of Trip Blanks[4]	No. of Field Duplicates[5]	No. of MS/MSD[6]	Total No. of Samples
Plume Delineation	SW8260B	Soil	0	0	0	0	0	0	0
Plume Delineation	SW8260B	Groundwater	3	1	1	1	1	1/1	9
Groundwater Treatment System Design	SW6010B E130.1 E160 1 E160.2 E160.3 E310.1 SW9056 SW9060	Groundwater	1	0	0	0	0	0	1

Notes:

1 Soil samples will be collected in five-foot intervals over the entire boring depth for lithologic evaluation. Currently there are no plans to collect soil samples for chemical analysis. However, if visible soil staining is observed a sample(s) may be collected for VOC analysis by EPA Method SW8260B. Therefore, the actual number of soil samples submitted for analysis will vary based on the observations made in the field. Three groundwater samples are planned to be collected and analyzed for VOCs. One sample will be collected monitoring wells (WHGLTA058 and WHGLTA059) and one from recovery well WHGLRWAOC101. In addition, WHGLRWAOC101 will be sampled for the additional list of parameters listed in Table 2.3.
Sites where only one boring will be sampled will be paired with a QC sample from another boring. One equipment blank will be collected per day, per analysis.

3 Ambient blanks for VOCs will only be sampled if VOCs are detected in the ambient air by the photoionization detector (PID) during a sampling effort.

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

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

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

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3.0 PURGING PRIOR TO SAMPLING

Purging of monitoring wells is performed to evacuate water that has been stagnant in the well and may not be representative of the aquifer. Purging will be accomplished using the micropurge technique. Micropurge is a low flow-rate monitoring well purging and sampling method that induces laminar (non turbulent) flow in the immediate vicinity of the sampling pump intake, thus drawing groundwater directly from the sampled aquifer, horizontally through the well screen, and into the sampling device. In order to ensure that the most current techniques are employed for low-flow purging and sampling, recommendations as outlined in U.S. Environmental Protection Agency (EPA) research paper entitled *Low-Flow (Minimal Drawdown) Ground-water Sampling Procedures (April 1996)* have been adapted where practical to augment current AFCEE procedures.

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

3.1 PURGING PROCEDURES

Dedicated and non-dedicated pumps will be set at the middle of the saturated screened interval or slightly above the interval (i.e., a measured depth of 43% of the saturated screened interval below the top of the water table). A minimum of six inches will be maintained between the bottom of the pump and the bottom of the well. These procedures will minimize the potential mixing of stagnant water trapped in the casing above the screen and the resuspension of solids that have collected at the bottom of the well. When lowering a pump, care will be taken to minimize the disturbance of water and solids in the well casing. Under no circumstances will a pump be lowered beyond the final placement depth, and raised back up. If this should occur, the well will be sampled 24 hours later to ensure that equilibrium has been achieved.

Water levels will be continuously recorded to monitor drawdown in the well and to allow for flow rate adjustment before the maximum drawdown is exceeded. When the placement of the pump inhibits the measurement of the water level in the well, purge rates from previous sample events will not be exceeded and the water discharge line will be closely monitored for air bubbles. If air bubbles are detected at any point during purging, the bladder pump will be shut down and the validity of lowering the pump will be evaluated. The goal is to purge the well at a rate that does not draw down the static water level more than 0.33 feet. Groundwater discharge will be calculated from the flow rate using containers of known volumes during purging. This information will be recorded on the Groundwater Field Sampling Data Sheet.

Temperature, pH, electrical conductance (EC), dissolved oxygen (DO), oxidation-reduction potential (Eh), and turbidity will be measured while purging, and recorded on the Groundwater Field Sampling Data Sheet. Measurements will be taken every three to five minutes when flow rates are in the 0.1-0.5 L/min range. Stabilization is achieved after all parameters have

stabilized for three consecutive readings as outlined in Section 5.2. Water samples will be collected immediately after parameter stabilization using the same pump used in purging. Field equipment will be calibrated in accordance with the Final 2000 Basewide Quality Assurance Project Plan (QAPP) (HydroGeoLogic, 2000). Once the AFCEE 3.1 QAPP is finalized, HydroGeoLogic will produce a 2001 Basewide QAPP that will supercede the 2000 Basewide QAPP.

For wells known to have a less than 0.1 L/min flow rate, a flow rate of 0.05-0.1 L/min will be attempted. If the drawdown is greater than 0.33 feet using this flow rate, then the micropurge technique is assumed to be invalid and will be discontinued because groundwater flow to the pump is no longer considered to be laminar across the screen within the aquifer. The flow in the vicinity of the pump now contains a vertical component from the stagnant water column in the filter pack and screened casing.

When micropurging is not effective on wells containing at least 1 feet of water, the well construction data will be reevaluated to determine if the well was properly installed within the water bearing unit. If necessary, during the same sampling event, wells will be redeveloped, in accordance with AFCEE procedures. The well will be purged, and a minimum of 24 hours will be allowed following redevelopment. If redevelopment of the well is not successful in achieving a flow rate conducive to micropurging, the well will be removed from the quarterly sampling event and scheduled for abandonment in accordance with applicable Texas Natural Resources Conservation Commission (TNRCC) requirements. Redevelopment and abandonment of monitoring wells will be delayed during a drought.

Water removed from the well during purging will be containerized. Detailed information concerning IDW is presented in Section 10.4.

4.0 WELL DEVELOPMENT, SURVEYING, AND ABANDONMENT

4.1 SURVEYING

All locations that are required to be surveyed will be measured by a state of Texas licensed 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 and references will be tied to the Texas State Plane Coordinate System (cf. Urquhart, L.C., *1962 Civil Engineering Handbook*, 4th Edition, p. 96 and 97). All surveyed locations will be reported using the Texas State Plane Coordinate System, North Central Zone. The horizontal datum will be the North American Datum of 1983 and the units will be in U.S. Survey feet. The vertical datum will be the National Geodetic Vertical Datum (NGVD) of 1988 and the units will be in U.S. Survey feet. The X-coordinate will be the East-West axis; the Y-coordinate will be the North-South axis. The reference location is the origin. The surveyed control information for all data collection points will be recorded and displayed in a table. 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. Vertical control will be to the NGVD and will be within 0.01 feet for all sampling locations.

4.2 MONITORING WELL DEVELOPMENT

The monitoring well development requirements are the following: (1) all newly installed monitoring wells will be developed no sooner than 24 hours after installation to allow for grout curing, (2) all drilling fluids used during well construction will be removed during development, (3) wells will be developed using surge blocks and bailers or pumps (prior approval for any alternate method will be obtained, in writing, from AFCEE before well construction begins), and wells will be developed until the turbidity of the well is less than or equal to 10 nephelometric turbidity units (NTU) and remains within a 5 NTU range for at least 30 minutes and the stabilization criteria in Section 5.2 are met, if a period of 4 hours has elapsed and turbidity has not stabilized at < 10 NTUs and all other criteria have been met, the development will stop, providing the turbidity is above 40 NTUs. (4) discharge water color and volume will be documented, (5) no sediment will remain in the bottom of the well, (6) no detergents, soaps, acids, bleaches, or other additives will be used to develop a well, and (7) all development equipment will be decontaminated according to the specifications of Section 10.3.

4.3 ABANDONMENT OF BOREHOLES

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

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

4.4 ABANDONING MONITORING WELLS

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

5.0 SAMPLING PROCEDURES

5.1 WATER LEVEL MEASUREMENT

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

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

5.2 GROUNDWATER SAMPLE COLLECTION

At newly developed wells, groundwater samples will be collected after a minimum 24-hour period has elapsed from the conclusion of monitoring well development or redevelopment activities. If a pump has been raised, groundwater samples will be collected 24 hours after the depth to the dedicated pump has been changed.

Groundwater samples will be collected after the critical water quality indicators have stabilized for three consecutive readings. Stabilization will be defined as follows (EPA, 1996):

- temperature $\pm$ 1 degrees Celsius (°C)
- pH $\pm$ 0.1 units
- EC $\pm$ 3 %
- DO $\pm$ 0.10 mg/L or 10% of value (whichever is greater)
- Eh $\pm$10 mV, and
- turbidity $\pm$ 10 % or less than 10 NTUs

Turbidity readings below 10 NTUs are desired, especially when metal samples are to be collected. When turbidity is high, the purge time will be extended in order for turbidity to reach 10 NTUs; however, if turbidity stabilizes above 10 NTUs for 15-30 minutes, then turbidity will be considered stable as defined above. Groundwater samples will be collected using the same pump used in the purging procedure. If the parameters do not stabilize after one to two hours when the drawdown indicates a laminar flow, a subset (pH, EC, and turbidity or DO) will be used as the stabilization parameters. If subset parameters do not stabilize, then the sample will be collected when a maximum number of parameters stabilize, and the

anomalous parameters will be brought to the Field Coordinator's attention. Field equipment will be calibrated in accordance with the Final 2000 Basewide QAPP (HydroGeoLogic, 2000) and Section 10.2 of this document.

Before sample collection, the flow through chamber used to measure parameters will be disconnected and the flow rate adjusted to maintain the established purge rate. VOC sample bottles will be pre-preserved by the laboratory. The sample will be collected from the pump discharge line using a slow, controlled pour down the side of a tilted sample vial to minimize volatilization and loss of preservative. The sample vial will be filled until a meniscus is visible and the sample vial will be immediately sealed. When the bottle is capped, it will be inverted and gently tapped to ensure that no air bubbles are present in the vial. If, after the initial filling bubbles are present, the vial will be discarded and the VOC sampling effort will be repeated. If repeated attempts result in VOC samples containing air bubbles, the laboratory will be contacted to see if they can meet the turnaround time (TAT) required for analysis of non-preserved VOC samples (7 days). If the laboratory can meet the TAT, the VOC samples will not be preserved for any samples meeting these criteria. 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 re-opened, composited, homogenized, or filtered.

Following the collection of VOC samples, the remaining water samples will be collected in the following order: semi-VOCs, including polynuclear aromatic hydrocarbons (PAHs); organochlorine pesticides/polychlorinated biphenyls (PEST/PCBs); organophosphorus pesticides; herbicides; dioxins/furans; metals, including mercury and cyanide; total organic carbon (TOC); methane; ferrous iron (Fe (II)); alkalinity; and common anions.

Any further sample preservation completed in the field will involve the addition of preservative from pre-measured vials provided by the laboratory. Field confirmation of preservation will not be required. Field filtering of metals will not occur.

Required sample containers, preservation methods, volumes and holding times are given in Table 6.1. Sampling equipment will be decontaminated in accordance with Section 10.3 upon completion of sampling activities.

5.2.1 Surface Soil Sampling

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

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

In addition to records outlined in Section 9.0, unusual surface conditions that may affect the chemical analyses will be recorded, such as (1) asphalt chunks that may have been shattered by mowers, thus spreading small fragments of asphalt over the sampling area, (2) distance to roadways, aircraft runways, or taxiways, (3) obvious, deposition of contaminated or clean soil at the site, (4) evidence of dumping or spillage of chemicals, (5) soil discoloration, and/or (6) unusual condition of growing plants, etc.

5.2.2 Subsurface Soil Sampling

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

As soon as the split-spoon is opened, the soil will be monitored for organic vapors using a PID. Air monitoring results will be recorded on the boring log and in the field logbook. Section 10.1.1 details field screening procedures for soils.

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

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

5.2.2.1 Hollow Stem Auger Sampling

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

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

5.2.3 Surface Water Sampling

Surface water sampling will be conducted at three separate locations (UHGLAOC10102, UHGLAOC10202, UHGLAOC10103) and analyzed for VOCs by EPA Method SW8260B. The specific surface water sampling locations are displayed on Figure 1.4 of the Work Plan.

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

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

Samples shall be collected from the active portion of the stream on the side nearest the source of contamination or suspected plume. Water samples are collected using a Van Dorn Sampler or Kemmerer Sampler when grab samples are required, or using an autosampler (discrete or composite samples) with the inlet line located at the desired sampling depth. If approved by AFCEE, surface water samples may be collected by direct filling of sample bottles. Samples from multiple locations are combined in a decontaminated bucket (nonvolatile samples only) and aliquots are taken for composite samples.

The following records shall be maintained in addition to those in Section 9.0, (1) the width, depth, and flow rate of streams, (2) surface water conditions (e.g., floating oil or debris, gassing), (3) the location of any discharge pipes, sewers, or tributaries, and (4) instrument calibration.

6.0 SAMPLE HANDLING

The purpose of this section is to identify types of sample containers, sample volumes, methods of preservation, sample identification, sample holding times, sample packaging, and shipping method.

6.1 SAMPLE CONTAINERS

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

6.2 SAMPLE VOLUMES, CONTAINER TYPES, AND PRESERVATION REQUIREMENTS

Sample volumes, container types, and preservation requirements, and holding times for the specific analytical methods performed on AFCEE samples are listed in Table 6.1. The pH of preserved samples will be checked by the laboratory prior to analysis. Sample holding time tracking begins with the collection of samples and continues until the analysis is complete. Holding times for methods used in this FSP are specified in Table 6.1.

6.3 SAMPLE IDENTIFICATION

Each sample collected will be assigned a unique sample identification number. The unique Environmental Restoration Program Information Management System (ERPIMS) well identification will be used for each sample. Sample containers will be labeled with the sample number and will be entered on the COC form. To eliminate any bias by the laboratory, the relationship between the unique sample identification number for duplicate samples and the associated samples will be known only to HydroGeoLogic.

The following information will be written on the field sampling report and on the sample label when samples are collected for laboratory analysis:

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

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

Name	Analytical Methods	Container[a]	Preservation[b, c]	Minimum Sample Volume or Weight	Maximum Holding Time
Total Hardness	E130.1 or E130.2	P,G	4°C	100 mL	7 days
Dissolved Solids	E160 1	P,G	4°C	100 mL	7 days
Suspended Solids	E160.2	P,G	4°C	100 mL	7 days
Total Solids	E160.3	P,G	4°C	100 mL	7 days
Alkalinity	E310.1	P, G	4°C	50 mL	14 days
Metals	SW6010B	P, G, T	HNO_3 to pH < 2, 4°C	500 mL or 8 ounces	180 days (water and soil)
Volatile organics (including BTEX and MTBE)	SW8260B	G	4°C, 0.008% $Na_2S_2O_3$ (HCl to pH < 2	2 x 40 mL	14 days; 7 days if unpreserved by acid (water)
Common Anions	SW9056 (or E300.0)	P, G	none requested	50 mL	28 days for Br^-, F^-, Cl^- and SO_4^{-2}; 48 hours for NO_3^-, NO_2^-, and PO_4^{-3}
Total Organic Carbon	SW9060 SW9060M	P, G, T	4°C; HCL or H_2SO_4 to pH < 2	500 mL or 4 ounces	28 days (water and soil)

Notes:
[a] Polyethylene (P); glass (G) with Teflon® - lined cap (amber glass for water samples), unless otherwise noted; 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 0.6 g ascorbic acid is only required when residual chlorine is present.

Each sample will be assigned a unique identification number that describes where and what type of sample was collected. The number that will be used in the field will consist of a maximum 13 digit alphanumeric code. Once data is ready to be entered into the ERPIMS database, the alphanumeric code will be truncated to 10 digits. This system is explained in detail as follows:

abbbccccdd-ee

where:

a represents the medium (e.g., W=monitoring well, B = soil boring, or U = surface water sample).

bbb represents HydroGeoLogic designation (e.g. HGL)

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

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

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

The numbering system for the monitoring wells will be based on a continuation of the HydroGeoLogic wells previously installed within the Terrace Alluvium. The first well of this project will begin with number 057. For example, the first soil sample collected during the installation of the boring for the first well will be identified as WHGLRWAOC101- 01. Duplicate samples will be submitted to the laboratory blind. A note in the field log book and the Field Sampling Report form will identify the location and sample number that has been duplicated. Groundwater samples will follow a similar identification system that is described below.

xxxxxxxxxzzaa
where:

xxxxxxxxx represents the well identification or well name (e.g., WHGLTA059)

zz represents the medium (WG for water-ground)

aa indicates the sampling event number for groundwater, surface water, and soil (e.g., 01, 02, 03, etc.)

For example, the groundwater sample collected from monitoring well WHGLTA059 during the July 2001 sampling event would be WHGLTA059WG01. Duplicate samples will be submitted to the laboratory blind. Duplicate samples will be assigned consecutive numbers in the office such as DUP01WG01, DUP02WG01, etc. A note in the field log book and the Field Sampling Report Form will identify the location and sample number that has been duplicated.

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

aabbccdd

where:

aa represents medium (e.g. TB = trip blank, AB = ambient blank, EB = equipment blank)

bb represents the month, e.g. 07

cc represents the day, e.g. 15

dd represents the year, e.g. 01

For example, an equipment blank collected on the 15th day of July in the year 2001 will be "EB071501".

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

6.4 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.

HydroGeoLogic shall maintain COC records will be maintained for all field and field quality control (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.

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

- Unique COC identification number
- Unique sample identification number
- Date and time of sample collection
- Source of sample (including name, location, and sample type)
- Designation of Matrix Spike/Matrix Spike Duplicate (MS/MSD)
- Number of containers/samples
- Preservative used, if any
- Analyses required
- Name of collector(s)
- Serial numbers of custody seals and transportation cases (if used)

- Custody transfer signatures and dates and times of sample transfer from the field to transporters and to the laboratory or laboratories
- Bill of lading or transporter tracking number (if applicable)

All samples will be uniquely identified, labeled, and documented in the field at the time of collection in accordance with Section 6.1.3 of this Appendix. 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 (40 milliliter (mL) VOA vial filled with water) will be included in every cooler and to determine the internal temperature of the cooler upon receipt of the cooler at the laboratory.

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7.0 FIELD QUALITY CONTROL SAMPLES

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

7.1 AMBIENT BLANK

The ambient blank consists of ASTM Type II reagent-grade water poured into a VOC sample vial at the sampling site in the same vicinity as the associated samples. It is handled like an environmental sample and transported to the laboratory for analysis. Ambient blanks are prepared only when VOC samples are collected 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. An ambient blank will be collected downwind of any possible VOC sources when ambient sources are proximal to the sample site.

7.2 EQUIPMENT BLANK

An equipment blank is a sample of ASTM Type II reagent-grade water poured into or over, or pumped through a 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. One equipment blank will be collected on each day that decontamination of sampling equipment occurs. Equipment blanks will be collected immediately after the equipment has been decontaminated. The blank will be analyzed for all laboratory analyses requested for environmental samples collected that day.

7.3 TRIP BLANK

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

7.3.1 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. Ten percent of all water samples will be field duplicates.

8.0 FIELD PERFORMANCE AND SYSTEM AUDITS

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

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

The first three items above will be checked for completeness. Sampling and decontamination operations will be reviewed to determine if they are performed as stated in the project-specific work plan, or as directed by the Task Manager. The informal document control audit will consist of checking each document for completeness, including items such as signatures, dates, and project numbers.

A systems audit of field operations may be required by the project-specific work plan and will be used to review the total data generation, which includes on-site review of the field operational system, physical facilities for sampling, and equipment calibrations. A performance audit may be conducted by the Project Manager (PM) and Task Manager during the first week of sampling if deemed necessary by the PM, Task Manager, Project Chemist, or Client. The audit may focus on verifying that proper procedures are being followed so that subsequent sample data will be valid. Before the audit, a checklist will be prepared by the PM and Task Manager that will serve as a guide for the performance audit. The audit may verify whether or not:

- Collection of samples follows the available written procedures
- COC procedures are followed for traceability of samples origin
- Appropriate QC checks are being made in the field and documented in the field log book
- Specified equipment is available, calibrated, and working properly
- Sampling crews are adequately trained
- Record-keeping procedures are being followed, and appropriate documentation is maintained
- Corrective action procedures are followed

An audit report summarizing the results and corrections will be prepared and filed in the project files.

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9.0 RECORD KEEPING

Field records sufficient to recreate all sampling and measurement activities, and to meet all ERPIMS data loading requirements, will be maintained. The requirements listed in this section apply to all measuring and sampling activities. Requirements specific to individual activities are listed in the section that addresses each activity. The information will be recorded with indelible ink in a permanently bound notebook with sequentially numbered pages. These records will be archived in an easily accessible form and made available to the contracting office representative or authorized representative upon request.

The following information will be recorded for all field activities: (1) location, (2) date and time, (3) identity of people performing activity, and (4) weather conditions. For field measurements: (1) the numerical value and units of each measurement, and (2) the identity of and calibration results for each field instrument, will also be recorded. In addition to this information, the following information will be recorded each time a well is purged and sampled: (1) depth to water before, during, and after purging, (2) the total depth of the well (if accessible), (3), depth to the top of the pump and the screened interval, (4) the condition of each well, (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, DO, temperature, EC, Eh, and turbidity. This information will be encoded in ERPIMS files when required.

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

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10.0 FIELD MEASUREMENTS AND OPERATIONS

10.1. PARAMETERS

10.1.1 Field Screening of Soils and Rock Borings

During HSA drilling activities at AOC 1, soil samples will be monitored for organic vapors using an OVM. Headspace analysis will be performed on each lithologic and analytical soil sample collected. A portion of the recovered soil sample will be placed into a quart-size, resealable plastic bag, and the bag will be labeled, sealed, and shaken to mix the sample. The sample will be allowed to volatilize in a shaded area for approximately 15 minutes after which a headspace reading will be taken by punching through the bag with an OVM sampling tip. The OVM shall be calibrated using a standard of known concentration (e.g., isobutylene at 100 parts per million) in accordance with the requirements of the Final Basewide QAPP (HydroGeoLogic, 2000). The sampling tip will not be placed in the soil, but in the headspace of the bag. A background headspace value will be obtained from an empty resealable plastic bag handled in a manner identical to the plastic bag containing the screening sample. The headspace reading and the background reading will be recorded on the Soil Boring Log. Rock cores will be screened by passing the tip of the screening instrument over the recovered core section. Field screening will be performed immediately after the core is removed from the core barrel. The headspace reading will be recorded on the Soil Boring Log.

10.1.2 Field Parameters for Water Samples

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

10.2 EQUIPMENT CALIBRATION AND QUALITY CONTROL

All equipment will be calibrated according to manufacturers' instructions outlined in the Final 2000 Basewide QAPP (HydroGeoLogic, 2000). Calibration of all instruments will be conducted at the start of each day of sampling and the information will be recorded on the calibration log. Field parameters (temperature, pH, EC, DO, Eh, and turbidity) will be measured using a flow through chamber in line with the pump during purging. Specific calibration procedures are outlined below.

- Temperature and oxidation reduction potential do not require field calibration. Proper maintenance of the probes will ensure consistent measurements and when discrepancies are noted, the probes will be returned to the manufacturer for repair and calibration.

- The pH will be field-calibrated with two buffer solutions which include the range of actual groundwater pH measurements. The stability of the calibration will be verified through the analysis of one standard periodically throughout the day as deemed necessary by the Field Investigation Task Manager.

- The EC probe will be calibrated with a 1,000 microsiemen solution.

- The DO probe will be calibrated with a 100% saturated environment. The probe will be checked for potential drift at the end of each day.

- Turbidity will be measured with a nephelometer (also known as a turbidimeter). It will be calibrated using a set of laboratory certified calibration vials.

- The hand-held portable PID is used to screen the air vapors when the well casing cap is removed and monitor the breathing zone. It will be calibrated daily with 100-ppm isobutylene in air standard.

10.2.1 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 Task Manager, who will initiate actions necessary for the repair or replacement of defective equipment. Equipment maintenance logs are kept updated and on file. Power supplies of battery-powered instruments will be checked daily. Rechargeable instruments will be recharged daily.

10.3 EQUIPMENT DECONTAMINATION

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

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

The following procedure will be used to decontaminate sampling and drilling devices such as split spoons and augers that can be hand-manipulated. For sampling and smaller drilling devices, the equipment will be scrubbed with a solution of potable water and Alconox™, or equivalent laboratory-grade detergent. The equipment will then be rinsed with copious quantities of potable water followed by a rinse with ASTM Type II reagent-grade water. High pressure liquid chromatograph-grade water and distilled water purchased in stores are not acceptable substitutes for ASTM Type II Reagent-Grade Water. The equipment will then be

rinsed with pesticide-grade methanol followed by a rinse with pesticide-grade hexane. The equipment will then be allowed to air dry on a clean surface or rack, such as Teflon™, stainless steel, or oil-free aluminum, elevated at least 2 feet above ground. If the sampling device will not be used immediately after being decontaminated, it will be wrapped in oil-free aluminum foil, or placed in a closed container made of stainless steel, glass, or Teflon™.

Decontamination areas as necessary for personnel and portable equipment will be set up at each well location, and at the field office. The flow through chamber will be decontaminated at the end of the sample event according to the manufacturer's directions. The probes of the temperature, pH, EC, DO, Eh, and turbidity will be rinsed with ASTM reagent-grade water at the end of each day. The measurement vials for the turbidity meter will be rinsed with deionized water before and after each use and the vials will be decontaminated at the end of the sampling event. A mild acid, such as vinegar, will be used to remove any water stains. No decontamination is required for the PID.

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

All fluids generated during decontamination activities will be placed in United Nations approved steel 55-gallon drums. All drums will be properly labeled as to content and shall be staged in a central location designated by the base representative for temporary storage pending removal and disposal. All fluids generated during decontamination will be handled in accordance with section 10.4.

10.4 WASTE HANDLING

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

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

IDW will be properly containerized and temporarily stored at each site, prior to transportation. Depending on the constituents of concern, fencing or other special markings may be required. The number of containers will be estimated on an as-needed basis. Acceptable containers will be sealed in either 55-gallon drums or temporary holding tanks. The containers will be transported in such a manner to prevent spillage or particulate loss to the atmosphere. The pumped water will be discharged to a frac tank(s) capable of containing a minimum of 40,000 gallons of water. After completion of the pump test, the frac tanks will be transported to the groundwater treatment system located on White Settlement Road, adjacent to SWMUs 22 and 24. The groundwater will be passed through the treatment system and discharged to the discharge ponds located on the Carswell Golf Course. If the treatment system cannot handle the pump test groundwater, the groundwater will be transported off-site to a contractor operated treatment facility.

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

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

The delineation monitoring wells will be installed as 2-inch PVC wells with slotted screens. The screens will be set at the bottom of the well and penetrate the entire saturated zone. The wells will be developed after installation, then purged (low flow) and sampled for the following parameters in groundwater: VOCs, Iron, Magnesium, Calcium, Manganese, Suspended Solids, Dissolved Solids, Total Solids, Total Hardness, Alkalinity, Chlorides, pH, and TOC.

The proposed well locations are illustrated in Attachment A of this FSP. The final well locations may deviate slightly from the proposed locations due to cultural influences such as overhead lines or buried utilities.

10.5 SITE RESTORATION

Each sampling location will be returned to its original condition when possible. Efforts will be made to minimize impacts to 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 will be transported to the designated locations.

11.0 REFERENCES

American Society for Testing and Materials, 1990, Standard Practice for Description and Identification of Soils (D-2488-90).

Driscoll, Fletcher G., 1986, Groundwater and Wells, 2nd Edition.

HydroGeoLogic, Inc., 2000, Final Basewide Quality Assurance Project Plan, NAS Fort Worth JRB, Texas.

Texas Natural Resource Conservation Commission, 1997. Texas Administrative Code, Environmental Quality, Chapter 238 Well Drillers and Water Well Pump Installers.

U.S. Environmental Protection Agency (EPA) Research Paper, Apr. 1996, Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures.

Urquhart, L.C., 1962, Civil Engineering Handbook 4th Edition, Water Measurement Manual, Bureau of Reclamation.

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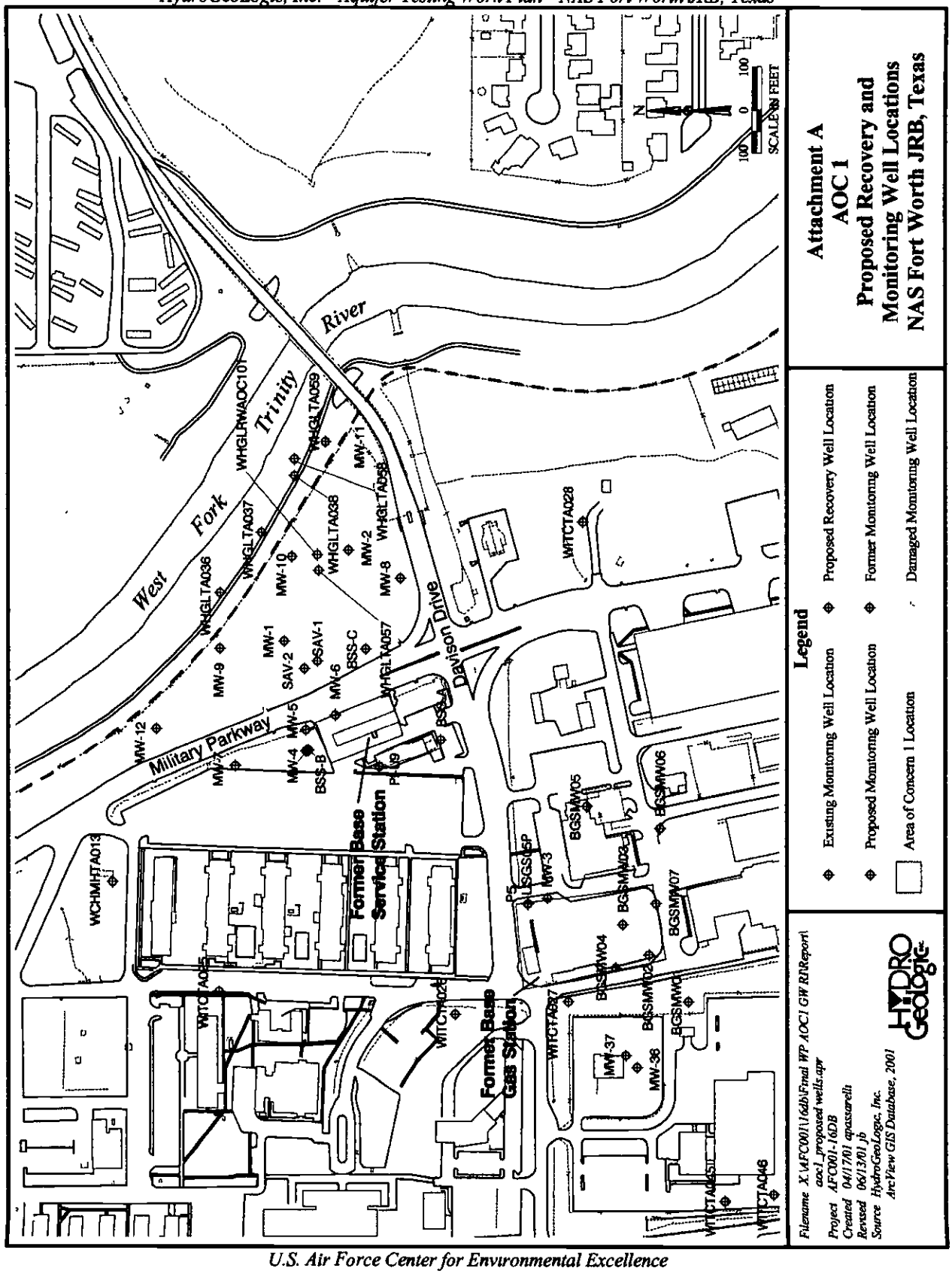
ATTACHMENT A

PROPOSED WELL LOCATIONS


Attachment A
AOC 1
Proposed Recovery and
Monitoring Well Locations
NAS Fort Worth JRB, Texas
Legend
Existing Monitoring Well Location
Proposed Recovery Well Location
Proposed Monitoring Well Location
Former Monitoring Well Location
Area of Concern 1 Location
Damaged Monitoring Well Location
Filename X:\AFC001\16db\Final WP AOC1 GW RI\Report\aoc1_proposed wells.apr
Project AFC001-16DB
Created 04/17/01 apassarelli
Revised 06/13/01 jb
Source HydroGeoLogic, Inc. ArcView GIS Database, 2001
HYDRO GeoLogic
SCALE IN FEET
100
0
100
N
West Fork Trinity River
Military Parkway
Davison Drive
Former Base Service Station
Former Base Gas Station
WCHMHTA013
WHGLTA036
WHGLTA037
WHGLRWAOC101
WHGLTA059
WHGLTA038
WHGLTA058
WHGLTA057
WTCTA028
WTCTA027
WTCTA044
WTCTA046
MW-1
MW-2
MW-3
MW-4
MW-5
MW-6
MW-8
MW-9
MW-10
MW-11
MW-12
MW-36
MW-37
SAV-1
SAV-2
BSS-A
BSS-B
BSS-C
BGSMW03
BGSMW04
BGSMW05
BGSMW06
BGSMW07

ATTACHMENT B

FIELD FORMS

PAGE___OF___

WATER LEVEL/PUMPING TEST RECORD

PROJECT_____ **SITE**_____

WELL_____ **MEASURING POINT**_____

DATE/TIME_____ **WEATHER**_____

STATIC WATER LEVEL (ft)_____ **BAROMETRIC PRESSURE**_____

PUMPING WELL_____ **DISTANCE TO PUMPING WELL**_____

START OF TEST_____ **END OF TEST**_____

TEST TYPE (DRAWDOWN/RECOVERY)_____

Date & Time	Time (t) (min)	Depth to Water (s) (ft)	Δ (s) (ft)	Q (gpm)	Comments

PAGE___OF___

WATER LEVEL/PUMPING TEST RECORD (Cont'd)

PROJECT______________________________ **SITE**______________________________

WELL______________________________ **DATE**______________________________

Date & Time	Time (t) (min)	Depth to Water (s) (ft)	Δ (s) (ft)	Q (gpm)	Comments

HYDRO GeoLogic

BORING LOG

Borehole ID. _____
Sheet _____ of ____

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

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

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HYDRO GeoLogic

BORING LOG (cont'd)

Borehole ID: _____
Sheet ____ of ___

Project Name	Project Number	Location

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

HYDRO GeoLogic

WELL DEVELOPMENT RECORD

WELL/PIEZOMETER ID _____
SHEET _____ of _____

AFIID: _____ LOCID: _____ SITEID.

PROJECT NAME: _____ PROJECT NO : _____ DATE:

LOCATION: _____ DATE INSTALLED. _____

TOTAL DEPTH (FTOC) _____ CASING DIAMETER _____ LOGCODE: HGL-H

METHODS OF DEVELOPMENT

☐ Swabbing ☐ Bailing ☐ Pumping ☐ Describe _____

Equipment decomtaminated prior to development ☐ Yes ☐ NO

Describe _____

EQUIPMENT NUMBERS.

pH Meter _____ EC Meter _____ Turbidity Meter _____ Thermometer _____

CASING VOLUME INFORMATION:

Casing ID (inch)	1 0	1.5	2 0	2 2	3 0	4 0	4 3	5 0	6 0	7 0	8 0
Unit Casing Volume (A) (gal/ft)	0 04	0 09	0 16	0 2	0 37	0 65	0 75	1 0	1 5	2 0	2 6

PURGING INFORMATION:

Measured Well Depth (B) _____ ft

Static Water Level Depth (C) _____ ft.

Length of Static Water Colume (D) _____ (B) - _____ (C) = _____ ft.

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

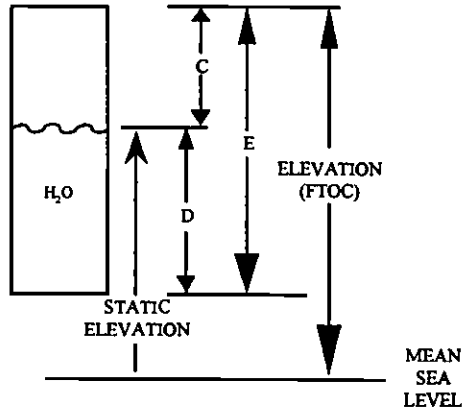
Total Purge Volume = _____ (gal)

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

Pumping Depth (PUMPDEP) = _____ (ft)

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

Recovery Time (LECTIME) = _____ (min)



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

HYDRO GeoLogic

AQUIFER TEST DATA FORM

AQUIFER TEST DATA

LOCATION _____ SLUG VOLUME (FT^3) _____

LOCATION I.D. _____ LOGGER CODE _____

LOGDATE _____ ACCEPTANCE CODE _____

TEST METHOD: _____

COMMENTS: _____

_____

_____

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

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

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

_____ _____

FORM COMPLETED BY / DATE TECHNICAL REVIEWER / DATE

HYDRO GeoLogic

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: _____

HYDRO GeoLogic Inc.

SLUG TEST DATA FORM

SLUG TEST DATA

LOCATION _____ SLUG VOLUME (FT^3) _____

LOCATION I.D. _____ LOGGER CODE _____

LOGDATE _____ ACCEPTANCE CODE _____

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

COMMENTS: _____

_____

_____

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

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

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

_____ _____

FORM COMPLETED BY / DATE TECHNICAL REVIEWER / DATE

HYDRO GeoLogic

MONITOR WELL STATIC WATER LEVEL FORM

PROJECT NAME:_____ DATE: _____

PROJECT NO.: _____

WATER LEVEL INDICATOR ID NO.: _____ FIELD BOOK NO.: _____

LOCATION: _____ PAGE NO.: _____

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

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

Comments: _____

_____

_____

Sampler _____ Observer _____

HYDRO GeoLogic

MONITOR WELL PURGING FORM

PROJECT : _____ DATE: _____

LOCATION. _____ EXPLOSIMETER BOREHOLE READING _____

WELL ID: _____ PURGE VOLUME (3 WELLBORE VOLUMES): _____ (L)

WELL DEPTH: _____

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

Note: Condition of the well: _____

pH - Calibrate at start and before last reading.

Sampler _____ Observer _____

HYDRO GeoLogic

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/	EXTRACTION	ANALYTICAL	ANALYSIS
SIZE/TYPE	#	PREPARATION	METHOD	METHOD	

NOTABLE OBSERVATIONS

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

pH _____ Temperature _____ Dissolved oxygen _____ Specific Conductivity_____

GENERAL INFORMATION

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

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

SHIPPED TO: _____

COMMENTS: _____

SAMPLER: _____ OBSERVER: _____

MATRIX TYPE CODES

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

SAMPLING METHOD CODES

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

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HYDRO GeoLogic WELL CONSTRUCTION DETAILS AND ABANDONMENT FORM

FIELD REPRESENTATIVE: _____

DRILLING CONTRACTOR: _____

DRILLING TECHNIQUE: _____
AUGER SIZE AND TYPE: _____

BOREHOLE IDENTIFICATION: _____
BOREHOLE DIAMETER: _____
WELL IDENTIFICATION: _____

WELL CONSTRUCTION START DATE: _____
WELL CONSTRUCTION COMPLETE DATE. _____

SCREEN MATERIAL: _____
SCREEN DIAMETER: _____
STRATUM-SCREENED INTERVAL (FT): _____

CASING MATERIAL: _____
CASING DIAMETER. _____

TYPE OF FILTER PACK: _____
GRADIATION: _____
AMOUNT OF FILTER PACK USED: _____

TYPE OF BENTONITE: _____
AMOUNT BENTONITE USED: _____

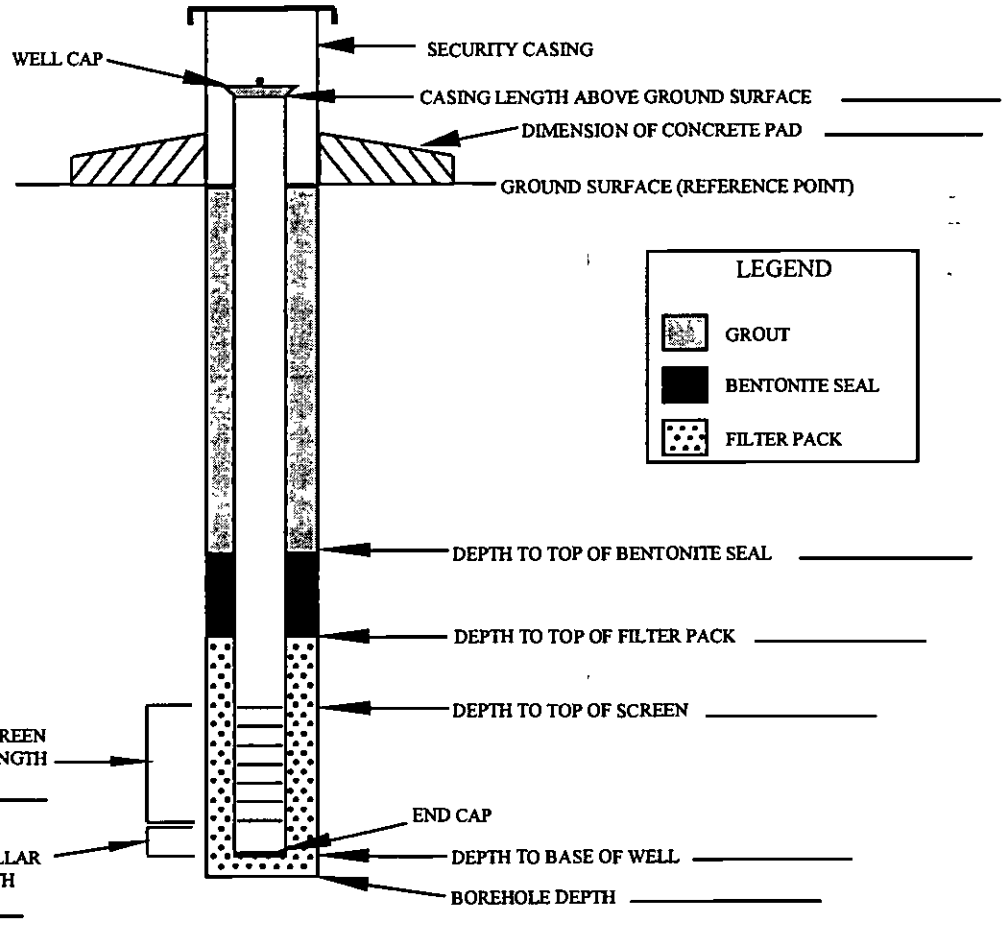
TYPE OF CEMENT: _____
AMOUNT CEMENT USED: _____
GROUT MATERIALS USED: _____

DIMENSIONS OF SECURITY CASING: _____

TYPE OF WELL CAP: _____
TYPE OF END CAP: _____

COMMENTS:

SPECIAL CONDITIONS
(describe and draw)



NOT TO SCALE

INSTALLED BY: _____ INSTALLATION OBSERVED BY: _____

DISCREPANCIES: _____

HYDRO GeoLogic

GROUNDWATER FIELD SAMPLING DATA SHEET

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

Field Parameters

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

Observations

Notes:
Signed/Sampler(s).

TAB

APPENDIX B HEALTH & SAFETY PLAN

FINAL
HEALTH AND SAFETY PLAN
BASEWIDE GROUNDWATER SAMPLING AND ANALYSIS PLAN
NAS FORT WORTH JRB, TEXAS

Prepared for

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

May 2001

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FINAL
HEALTH AND SAFETY PLAN
BASEWIDE GROUNDWATER SAMPLING AND ANALYSIS PLAN
AT NAS FORT WORTH JRB, TEXAS

PROJECT:	U.S. Air Force Center for Environmental Excellence
PROJECT NUMBER:	Contract No. F41624-95-D-8005-0033 HydroGeoLogic Project No. AFC001
PROJECT SITE LOCATION:	NAS Fort Worth JRB, Texas
PROJECT MANAGER:	Todd Harrah
HEALTH AND SAFETY OFFICER:	James Heringer
SITE SAFETY OFFICER:	TBA
PLAN PREPARERS:	Michael J. Rodtang, P.G., Kenneth J. Hurley
PLAN REVIEWER:	James Heringer
PREPARATION DATE:	May 2001

APPROVED BY:

5/4/01

James Heringer — Date
HydroGeoLogic, Inc.
Health and Safety Officer

Todd Harrah 5/14/01

Todd Harrah — Date
HydroGeoLogic, Inc.
Project Manager

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LIST OF ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
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
EPA	U.S. Environmental Protection Agency
°F	degrees Fahrenheit
FAR	Federal Acquisition Regulations
FSP	Field Sampling Plan
GSAP	Groundwater Sampling and Analysis Plan
HAZWOPER	Hazardous Waste Site Operations and Emergency Response
HCS	hazard communication standard
HPS	hantavirus pulmonary syndrome
HSO	Health and Safety Officer
HSP	Health and Safety Plan
HydroGeoLogic	HydroGeoLogic, Inc.
IDLH	immediately dangerous to life and health
IDW	investigation derived waste
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
RCO	Responsible Corporate Officer
SSO	Site Safety Officer
T	ambient air temperature
T_{aj}	adjusted air temperature
TCE	trichloroethene
TLV	Threshold Limit Value
UEL	upper explosive limit
	United Nations
USCG	U.S. Coast Guard
WP	Work Plan

FINAL
HEALTH AND SAFETY PLAN
BASEWIDE GROUNDWATER SAMPLING AND ANALYSIS PLAN
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 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 0033. 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 for 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. This HSP applies to groundwater sampling of existing monitoring wells to evaluate the nature and extent of potential contamination basewide. 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 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

The Responsible Corporate Officer (RCO) for this project will be Dr. Peter Huyakorn (Executive 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

The Health and Safety Officer (HSO) for this project will be Mr. James Heringer. The HSO will have the authority to:

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

The HSO 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

The Project Manager (PM) for this project will be Mr. Todd Harrah. The PM has the authority to:

- Coordinate with the HSO on health and safety matters.
- Assign an HSO-approved SSO to the project and, if necessary, assign a suitably qualified replacement.
- Temporarily suspend field activities if 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

The Site Safety Officer (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 all subcontractors' medical monitoring programs are 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.

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2.0 SITE DESCRIPTION INFORMATION

Detailed descriptions of the NAS Fort Worth JRB sites are presented in Section 2.0 of the Draft Final 2001 Basewide Groundwater Sampling and Analysis Plan (GSAP) (HydroGeoLogic, 2001). Please refer to this section for detailed site description information.

NAS Fort Worth JRB is a parcel of the former Carswell AFB that officially closed on September 30, 1993. NAS Fort Worth JRB is bounded on the north by Lake Worth, on the east by Highway 183 and industrial acreage, on the south by Carswell AFB property that is being converted for public redevelopment, and on the west by the base runways and AFP 4. NAS Fort Worth JRB is presently composed of personnel and equipment from three naval air stations.

The areas of interest for this investigation are the northern and southern regional lobes of the trichloroethene (TCE) groundwater plume, as well as benzene, toluene, ethylbenzene, and xylene contamination at Area of Concern 1. Additional contaminants of concern associated with the TCE plumes are *cis*-1,2-dichloroethene and vinyl chloride.

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3.0 SITE INVESTIGATION ACTIVITIES

The field activities to be conducted at the NAS Fort Worth JRB are explained in Appendix C of the GSAP and will include:

- Well inspection and water level measurements.
- Well maintenance.
- Well purging and groundwater sampling with a low-flow bladder pump.
- Investigation derived waste (IDW) management.

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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

The primary concerns from a chemical exposure standpoint are inhalation, ingestion, and absorption by direct skin contact with contaminants in locations expected to be source areas. Based upon the information obtained from previous site investigations (groundwater and soil), the primary chemicals of concern at NAS Fort Worth JRB have been identified and are listed in Table 4.1, along with their exposure limits and recognition properties. The acute and chronic symptoms of overexposure to these chemical contaminants and first aid procedures are presented in Table 4.2. If additional contaminants are identified 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 samples also present hazards to the project personnel who use them. The chemicals likely to be brought to the site for use in this manner include:

- Sodium hydroxide
- Sulfuric acid
- Nitric acid
- Hydrochloric acid
- Methanol
- Hexane
- Alconox™

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)
- Heavy equipment/vehicular activity (Section 11.0)

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

4.3.1 Heat Stress

Heat stress can be a problem especially if 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 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 (equipped 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 is 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, the victim may be unconscious. Should the victim stop breathing, give rescue breathing and be prepared to administer cardiopulmonary resuscitation (CPR).

4.3.3 Noise Hazards

The SSO, or designee, will monitor high noise levels when heavy equipment or machinery is being used on-site or when nearby base activities (e.g., active runways, construction) cause a potential noise hazard. Whenever jet aircraft are being tested, the noise level is far in excess of 85 dB. Personnel in the proximity of the airfield are exposed to these noise levels. Field personnel working in areas where noise levels can be expected to reach or exceed 85 decibels (dB) will be issued and will be required to wear 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. Workers are required to use proper lifting techniques for handling materials, and oversize or heavy loads require "team lift" procedures or mechanical assistance (lift gates, drum dollies, etc.).

4.3.5 Utility Hazards

The locations of all underground utilities must be identified and marked prior to initiating any subsurface investigations.

4.4 BIOLOGICAL HAZARDS

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

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

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

4.4.1 Poisonous Animals

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

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

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

and speaking. The symptoms of a brown recluse spider bite can be mild to severe. In the mildest form, the bite can cause pain and swelling like a bee sting or ant bite. If the reaction is severe, the bite area may become swollen, painful, and weep fluid. Swelling and reddening may spread to an entire limb, and if left untreated, the bite may cause necrosis of surrounding tissue and infection. Diarrhea, stomach cramps, and hot/cold flashes may also occur. Victims of poisonous spider bites recover in almost all cases, but an occasional death is reported.

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

4.4.1.1 First Aid Procedures (Snakebite)

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

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

Several other factors must be considered in cases of snakebite:

- Shock. Keep the victim reclined and comfortable, and maintain his or her body temperature.
- Breathing and heartbeat. If breathing stops, give mouth-to-mouth resuscitation. If breathing stops and there is no pulse, perform CPR if you have been trained to do so.
- Identifying the snake. If you can kill the snake without risk or delay, bring it to the hospital for identification, but exercise extreme caution in handling the snake.

- Cleaning the bitten area. You may wash the bitten area with soap and water and blot it dry with sterile gauze. You may apply dressings and bandages, but only for a short period of time.

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

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

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

4.4.1.2 General First Aid for Poisonous Insect Bites/Stings

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

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

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

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

- 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 non-prescription medicine, such as aspirin, for pain.

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

- Give artificial respiration if necessary.

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

4.4.2 Ticks

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

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

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

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

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

4.4.3 Animal-Borne Diseases

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

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

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

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

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

4.4.4 Poisonous Plants

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

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

4.4.4.1 First Aid Procedure

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

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5.0 HAZARD COMMUNICATION

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

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

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

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

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

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

- Appropriate MSDSs will be available to any contractor or subcontractor employee working on projects under HydroGeoLogic'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 three days of finding potential imminent health risks during investigation activities.

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6.0 AIR MONITORING

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

6.1 INSTRUMENTS AND USE

A photoionization detector (PID) equipped with an appropriate lamp will be utilized for detecting the presence of emissions from chemicals of concern. A Dräger pump and colorimetric tubes will be used to confirm any detections observed with the PID in accordance with Table 6.1.

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

- Well development
- Groundwater sampling
- Sampling equipment decontamination/equipment (heavy) decontamination
- Waste characterization, transfer, and disposal

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:

- Open well heads – Upon initial opening
- Environmental sampling – Every sample set
- IDW characterization – Every container to be sampled
- Transfer IDW – From one container to another

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 Dräger pump and colorimetric tubes in accordance with Table 6.1.

6.2.2 Dräger Pump and Tubes

A hand operated Dräger pump with colorimetric tubes will be used to confirm the results of PID testing. If the results of the PID tests show concentrations greater than 0.5 parts per million (ppm) above background concentrations in the breathing zone, then the colorimetric tubes will be used to identify the contaminants in the breathing zone. Colorimetric tubes to be utilized in the event of elevated PID readings will include vinyl chloride, benzene, tetrachloroethene, 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.

6.3 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 field office in Fort Worth, Texas. 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.

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 detection 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. Respirator use must be in accordance with the HydroGeoLogic Heath and Safety Program (located at HydroGeoLogic's Herndon, Virginia, office) and with the requirements of 29 CFR 1910.134(c)(1). 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 change-out interval and at the end of each work day. Cartridge change-out schedules will be determined based on identification and concentration of air contaminants.
- 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.

Prior to upgrading PPE to Level C, the Health and Safety Officer must be notified in order to have him advise the field team.

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. TCE has a short breakthrough time for nitrile gloves. If contact with appreciable quantities of TCE or TCE-containing mixtures is anticipated, inner gloves of polyvinyl alcohol or other chlorinated solvent impermeable material will be under nitrile gloves. 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 (4-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 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 below.

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

8.1.1 Closure of the Personnel Decontamination Station

All disposable clothing and plastic sheeting used during the operation will be double-bagged and contained on-site prior to removal to an approved off-site disposal facility as identified in the Work Plan (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 decontamination of reusable clothing is not possible, the items 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 United Nations 55-gallon drums; each drum will have a removable top cover fitted with a top cover bung (type 17E/H) as identified in the Field Sampling Plan (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 Appendix C of the GSAP.

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.

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10.0 TRAINING REQUIREMENTS

10.1 INITIAL TRAINING

10.1.1 Requirements for HydroGeoLogic Personnel

All investigation personnel to be utilized are currently enrolled in 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 any time, 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 and look up to keep the neck and back straight.
  - Do not twist or turn your body once you have made the lift.

  - Make sure you can carry the load where you need to go before lifting it.
  - Set the load down properly, lower slowly by bending the knees.
  - Always push, not pull, the object when possible.

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

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

- 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 HOUSEKEEPING

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

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

- Daily 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

11.3 WORK LIMITATIONS

All investigation activities will be performed during normal daylight hours.

11.4 CONFINED SPACE ENTRY

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

11.5 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 1910.157 and Subpart L Appendices 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.

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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 perform 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.

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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 plugs/defenders
- Eye wash
- Inner latex or vinyl gloves
- Outer nitrile gloves (disposable 4-mil 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/oxygen (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 Aktiengesellschaft (Kurt Leichnitz), 1989, Detector Tube Handbook, 7th edition, dated July 1989.

HydroGeoLogic, Inc. (HydroGeoLogic), 2001, Final 2001 Basewide Groundwater Sampling and Analysis Plan, May 2001.

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

U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health, 1985, *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*, DHHS (NIOSH) Publication No. 85-115, dated October 1985.

U.S. Environmental Protection Agency (US EPA), 1992, *Standard Operating Safety Guides*, NTIS Publication No. 9285.1-03, dated June 1992.

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

U.S. National Archives and Records Administration, 1997, *Code of Federal Regulations,* Occupational Safety and Health Administration General Industry Standards, 29 CFR 1910; Construction Industry Standards, 29 CFR 1926; 29 CFR 1910.120; 29 CFR 1926.65 "Hazardous Waste Site Operations and Emergency Response."

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HEALTH AND SAFETY FORMS

SITE SAFETY BRIEFING FORM

Project _____
Date _____ Time _____ Job No. _____
Location _____
Type of Work _____

SAFETY TOPICS PRESENTED

Protective Clothing/Equipment _____

Chemical Hazards _____

Physical Hazards _____

Emergency Procedures _____

Hospital/Clinic _____ Phone _____
Hospital Address _____
Special Equipment _____

Other _____

ATTENDEES

Name (Printed)	Signature

Meeting Conducted by: _____
Site Safety Officer: _____

HEALTH AND SAFETY PLAN

COMPLIANCE AGREEMENT FORM

PROJECT: Basewide Groundwater Sampling and Analysis

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

LOCATION: NAS Fort Worth JRB, Carswell Field, Texas

PROJECT NO: AFC001-0033

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: _____

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

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)

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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 materials									
Benzene	1 ppm	500 ppm (Ca[e])	Colorless	Aromatic	Liquid (freezes at 42EF)	1.5-5	1.2	7.8	9.24
bis (2-Ethylhexyl)phthalate	5 mg/m^3	5,000 mg/m^3 (Ca[e])	Colorless	Slight	Oily liquid	ND	0.3% (at 474EF)	ND	ND
n-Butylbenzene	NA	ND	Clear	Aromatic	Liquid	ND	ND (combustible)	ND (combustible)	ND
sec-Butylbenzene	NA	ND	Clear	Aromatic	Liquid	ND	ND (combustible)	ND (combustible)	ND
tert-Butylbenzene	NA	ND	Clear	Aromatic	Liquid	ND	ND (combustible)	ND (combustible)	ND
Chlorobenzene	75 ppm	1000 ppm	Colorless	Almond-like	Liquid	0.2	1.3	9.6	9.07
Chloroform	50 ppm (ceiling)	500 ppm (Ca[e])	Colorless	Pleasant	Liquid	200	NA	NA	11.42
1,4-Dichlorobenzene	75 ppm	150 ppm (Ca[e])	White	Mothball-like	Crystals	ND	2.5	ND	8.98
1,1-Dichloroethane	100 ppm	3,000 ppm	Colorless	Chloroform-like	Oily liquid	ND	5.4	11.4	11.06
1,1-Dichloroethene	None	ND (Ca[e])	Colorless	Mild, sweet	Liquid (gas above 89EF)	50	6 5	15.5	10.00
1,2-Dichloroethene (total)	200 ppm	1,000 ppm	Colorless	Acrid, chloroform-like	Liquid	ND	5.6	12.8	9.65
1,2-Dichloropropane	75 ppm	400 ppm (Ca[e])	Colorless	Chloroform-like	Liquid	ND	3.4	14.5	10.87
Ethylbenzene	100 ppm	2,000 ppm	Colorless	Aromatic	Liquid	4.7-50	1.00	6.70	8.76
Gasoline	ND	ND	Clear	Gasoline	Liquid	ND	1.4	7.6	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				
		(Ca[e])							
Hexane	500 ppm	1,100 ppm	Colorless	Gasoline	Liquid	ND	1.1	7.5	10.18
Isopropylbenzene (cumene)	50 ppm	900 ppm	Colorless	Sharp, aromatic	Liquid	ND	0.9	6.5	8.75
p-Isopropyltoluene (p-cymene)	None	ND	Clear	Aromatic	Liquid	ND	ND (combustible)	ND (combustible)	ND
Methanol	200 ppm	6,000 ppm	Colorless	Pungent	Liquid	5	6.0	36.0	10.84
Methyl tert-butyl ether (MTBE)	None	ND	Colorless	ND	Liquid	ND	ND (combustible)	ND (combustible)	ND
Naphthalene	10 ppm	250 ppm	Colorless to brown	Mothballs	Solid	ND	0.9	5.9	8.12
n-Propylbenzene	None	ND	Clear	Aromatic	Liquid	ND	ND (combustible)	ND (combustible)	D
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 (PCE)	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
1,1,1-Trichloroethane	350 ppm	700 ppm	Colorless	Mild, chloroform-like	Liquid	< 100	7.5	12.5	11.00
1,1,2-Trichloroethane	10 ppm	100 ppm (Ca[e])	Colorless	Sweet, chloroform	Liquid	ND	6	15.5	11.00
Trichloroethene (TCE)	100 ppm	1,000 ppm	Colorless	Chloroform-like	Liquid	20	8.0	10.5	9.45
1,2,4-Trimethylbenzene (pseudocumene)	25 ppm (TLV)	ND	Colorless	Aromatic	Liquid	ND	0 9	6.4	8 27

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				
1,3,5-Trimethylbenzene (mesitylene)	25 ppm (TLV)	ND	Colorless	Aromatic	Liquid	ND	ND (combustible)	ND (combustible)	8 39
Vinyl chloride	1 ppm	ND (Ca[e])	Colorless	Pleasant	Gas (liquid < 7EF)	62.5	3.6	33.0	9.99
Xylenes (total)	100 ppm	900 ppm	Colorless	Aromatic	Liquid	1-1.5	1.1	7.0	8.50
Inorganic materials									
Arsenic	0.05 mg/m^3	5 mg/m^3 (Ca[e])	Colorless	NA	Solution	NA	NA	NA	NA
Hydrochloric acid	5 ppm (ceiling)	50 ppm	Clear to yellowish	Pungent	Solution	<5	NA	NA	12.74
Manganese	5 mg/m^3 (ceiling)	500 mg/m^3	Colorless	NA	Solution	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
Sodium hydroxide	2 mg/m^3	10 mg/m^3	a) White b) Colorless	NA	a) Crystals b) Solution	NA	NA	NA	NA
Sulfuric acid	1 mg/m^3	15 mg/m^3	Colorless, yellow, or brown	Odorless	Solution	NA	NA	NA	ND

Notes:

[a] OSHA Permissible Exposure Limit (PEL) or American Conference of Governmental Industrial Hygienists Threshold Limit Value (TLV)
[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
Sources: NIOSH, 1997
Dräger, 1989

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

Compound	Symptoms of Overexposure	First Aid Treatment
Organic materials		
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
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	
tert-Butylbenzene	Toxic by ingestion, see gasoline	
Chlorobenzene	Irritation to eyes, skin, nose, drowsiness, incoherence; central nervous system depression; in animals: kidney, liver, lung injury	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Chloroform	Irritation to eyes, skin; dizziness, mental dullness, nausea, confusion; headache, fatigue; anesthesia; enlarged liver; carcinogen	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
1,4-Dichlorobenzene	Eye irritation, swollen periorbital; profuse rhinitis; headache, anorexia, nausea, vomiting; weight loss, jaundice, cirrhosis; in animals· liver and kidney injury; carcinogen	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air; respiratory support Ingestion· Medical attention immediately
1,1-Dichloroethane	Irritation to skin; central nervous system depression; liver, kidney, lung damage	Eye: Irrigate immediately Skin: Soap 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
1,1-Dichloroethene	Irritation to eyes, skin, throat; dizziness, headache, nausea; dyspnea; liver, kidney dysfunction; pneumonitis; carcinogenic	Eye: Irrigate immediately Skin: Water flush immediately Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
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
1,2-Dichloropropane	Irritation to eyes, skin, respiratory system, drowsiness, light-headedness; liver and kidney damage; in animals: central nervous system depression; carcinogen	Eye: Irrigate immediately Skin: Soap wash promptly 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
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
Isopropyl benzene	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

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

Compound	Symptoms of Overexposure	First Aid Treatment
Isopropyltoluene	Toxic by ingestion, see gasoline	
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
Methyl tert-butyl ether	No hazard reference available	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
n-Propylbenzene	Toxic by ingestion; see gasoline	
1,1,2,2-Tetrachloroethane	Nausea, vomiting, abdominal pain; tremor in the fingers; jaundice, hepatitis, liver tenderness; dermatitis, monocytosis; kidney damage; carcinogen	Eye: Irrigate immediately Skin: Soap wash immediately Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Tetrachloroethene	Irritation to eyes, nose, and throat; nausea; flushed face and neck; vertigo, dizziness, incoherence; headache, somnolence; skin redness; liver damage; carcinogen	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

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

Compound	Symptoms of Overexposure	First Aid Treatment
1,1,1-Trichloroethane	Irritation to eyes and skin; headache, lassitude, central nervous system depression, poor equilibrium; dermatitis; cardiac arrhythmia; liver damage	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 immediately 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
1,2,4-Trimethylbenzene	Irritation to eyes, skin, nose, throat, and respiratory system; bronchitis; hypochromic anemia; headaches, drowsiness, fatigue, dizziness, nausea, incoherence; vomiting, confusion; chemical pneumonia if aspirated	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
1,3,5-Trimethylbenzene	Irritation to eyes, skin, nose, throat, and respiratory system; bronchitis; hypochromic anemia; headaches, drowsiness, fatigue, dizziness, nausea, incoherence; vomiting, confusion; chemical pneumonia if aspirated	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
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

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

Compound	Symptoms of Overexposure	First Aid Treatment
Inorganic materials		
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
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
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
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; tracheobronchitis; eye and skin burns; dermatitis	Eye: Irrigate immediately Skin: Water flush immediately Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately

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

Notes:

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 tetrachloroethene and TCE colorimetric tubes -if confirmed as tetrachloroethene and/or TCE, then see specific hazard identified below -if denied as tetrachloroethene or TCE, then continue with regular monitoring of breathing zone
		≥25 to <250 ppm above background based on judgment of SSO (if denied as vinyl chloride, benzene, and 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 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 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 based on judgment of SSO	Level C (See Table 7.1)	-continue regular monitoring of breathing zone
Trichloroethene	Colorimetric Tubes	confirmed 50 to 500 ppm 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 ppm 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 based on judgment of SSO	STOP WORK, EVACUATE AREA, NOTIFY PROJECT MANAGER	- requires HSP amendments
Benzene	Colorimetric Tubes	confirmed 5 ppm or greater based on judgment of SSO	STOP WORK, EVACUATE AREA, NOTIFY PROJECT MANAGER	-requires HSP amendments
Tetrachloroethene	Colorimetric Tubes	confirmed 250 ppm or greater based on judgment of SSO	STOP WORK, EVACUATE AREA, NOTIFY PROJECT MANAGER	-requires HSP amendments
Trichloroethene	Colorimetric Tubes	confirmed 500 ppm or greater based on judgment of SSO	STOP WORK, EVACUATE AREA, NOTIFY PROJECT MANAGER	- requires HSP amendments

Table 7.1
Protective Equipment for On-Site Activities

Activity	Level	Protective Equipment
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)

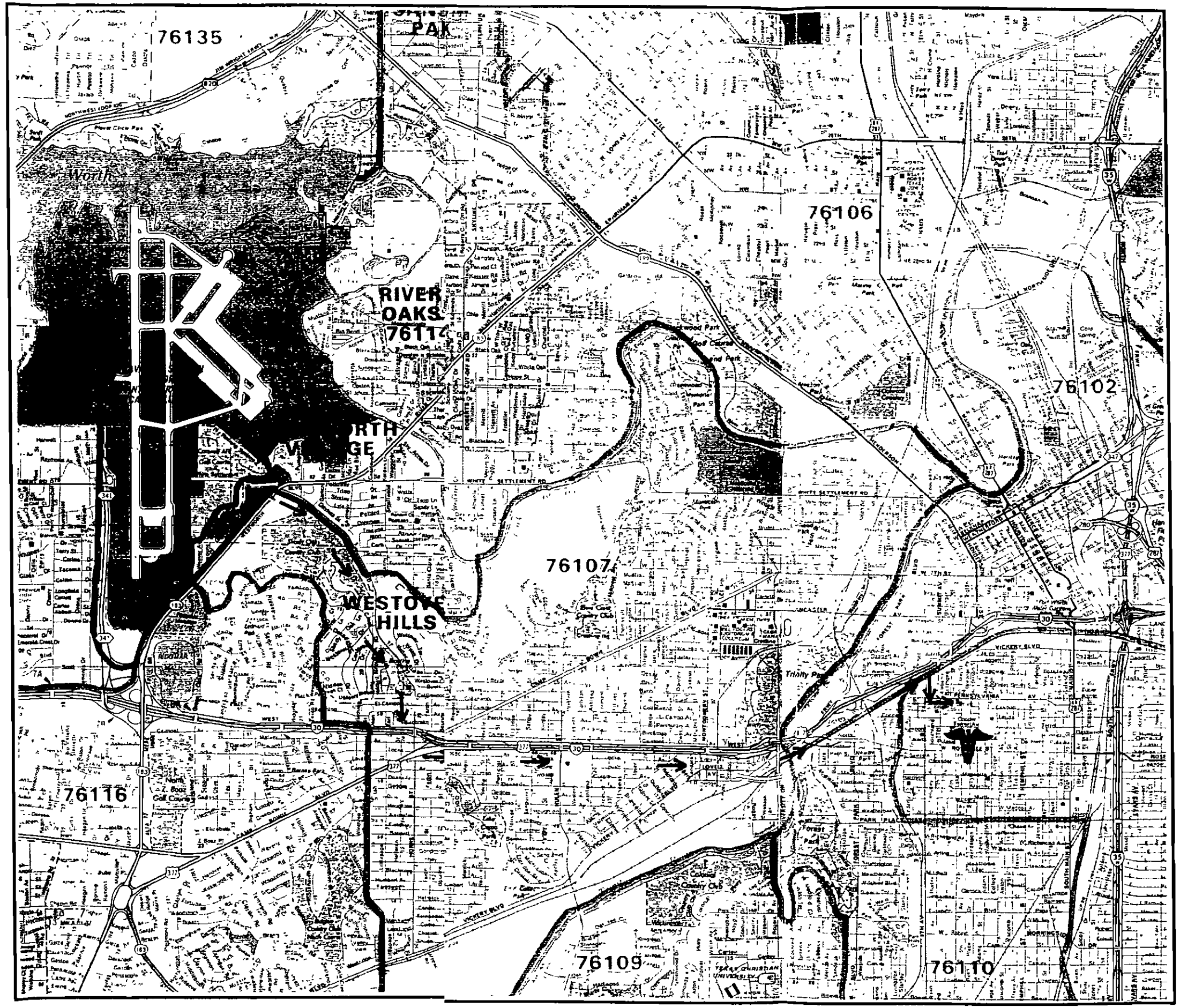
Table 8.1
Six Stages for Decontamination for Modified Level D Protection

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.

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.
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.

FIGURES



- *HydroGeoLogic, Inc —Health and Safety Plan*
  NAS Fort Worth JRB, Texas

Figure 13.1

Nearest Medical Facility to NAS Fort Worth JRB

U.S. Air Force Center for Environmental Excellence

Legend

Hospital

Route to Hospital

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 — 911 or 817-882-2000
1301 Pennsylvania Avenue
Fort Worth, TX 76104-2122

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. 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.

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