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DRAFT FINAL RISK ASSESSMENT ASSUMPTIONS DOCUMENT NORTHERN AND CENTRAL LOBES OF TRICHLOROETHENE PLUME NAS FORT WORTH TX
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NAVAL AIR STATION FORT WORTH JRB CARSWELL FIELD TEXAS

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HYDRO GeoLogic INC.

DRAFT FINAL
RISK ASSESSMENT ASSUMPTIONS DOCUMENT
NORTHERN AND CENTRAL LOBES OF THE TRICHLOROETHENE PLUME
NAS FORT WORTH JRB, TEXAS

AF CENTER FOR ENVIRONMENTAL EXCELLENCE

Prepared for

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

July 2002

HydroGeoLogic, Inc.
1155 Herndon Parkway
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DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
BROOKS AIR FORCE BASE TEXAS

05 July 2002

MEMORANDUM FOR RUBEN MOYA (EPA REGION 6)

FROM: Mr. Don Ficklen
HQ AFCEE/ERD
3207 Sidney Brooks
Brooks AFB, TX 78235

SUBJECT: Naval Air Station Fort Worth Joint Reserve Base
Draft Final Risk Assessment Assumptions Document
Northern and Central Lobes of the TCE Plume
EPA ID No. TX7572024605
TNRCC Hazardous Waste Permit No. HW-50289

Dear Mr. Moya,

Two copies of the Draft Final Risk Assessment Assumptions Document (RAAD) for the Northern and Central Lobes of the Trichloroethene Plumes at NAS Fort Worth JRB in Fort Worth, Texas are enclosed for your review. The RAAD presents the methodology that will be used to conduct the risk assessment. The RAAD is intended to expedite the risk assessment process by eliminating any differences that may exist between the regulators and the Air Force concerning the risk assessment approach.

Please feel free to distribute this document to any of the EPA risk assessors who will be involved in the development of the report. The southern lobe Risk Assessment was reviewed primarily by Cheryl Overstreet from your office. I assume that you will be submitting one set of comments collectively from Gary Miller, any risk assessors, and yourself. These comments, along with the comments from the TNRCC reviewers can be either submitted in writing, or if you prefer, a conference call can be held among all the involved parties to answer any questions or comments.

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

Sincerely,

Mr. Don Ficklen
Restoration Team Chief

Printed on Recycled Paper

cc:
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Mr. Ray Risner

HydroGeoLogic, Inc. Memorandum

TO: All parties previously involved in the Review of the Baseline Risk Assessment for the Focused Feasibility Study, Former Carswell AFB, Texas

DATE: July 5, 2002

SUBJECT: **Significant Changes in Approach between Northern and Southern Lobe Risk Assessments**

In order to expedite the review this document, the following major differences between the recently completed risk assessment on the Former Carswell AFB and the approaches described in this Risk Assessment Assumptions Document (RAAD) are provided below·

- Inclusion of industrial/commercial workers in addition to maintenance workers on NAS Fort Worth.
- For calculation of exposure point concentrations for current exposure to surface water, pooling the seep data with the surface water data
- Use of the groundwater modeling results to estimate the future exposure point concentrations of TCE in groundwater and in the West Fork Trinity River. Development of an appropriate dilution factor to address dilution of the groundwater by the river flow (Section 3 2)
- Use of summa canister data instead of Johnson and Ettinger model for inhalation of soil gas vapors (Section 3.3)
- For residents on the NAS Fort Worth property, use of adult and child receptors for both cancer risks and non-cancer hazards instead of child receptor for non-cancer hazards and age-adjusted receptor for cancer risks. This approach was used because it is highly unlikely that the same individual would live on-base as a child and be stationed there as an adult (Tables 5.1 and 5 2).
- For adult resident on NAS Fort Worth property, use of the 50th percentile exposure duration (9 years) instead of the 95th percentile. Because military personnel are transferred frequently to different installations, it is highly unlikely that an onsite resident would spend 30 years living on NAS Fort Worth (Table 5 1 and 5.2).
- Use of Virginia DEQ construction trench model to estimate exposure of construction workers to volatiles in a construction trench (Section 5.4).

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NORTHERN AND CENTRAL LOBES OF THE TRICHLOROETHENE PLUME
NAS FORT WORTH JRB, TEXAS

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Prepared for

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

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July 2002

734 6

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TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

Page

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AFP4	Air Force Plant 4
AOC	Area of Concern
BCF	bioconcentration factor
BRAC	Base Realignment and Closure
BTEX	benzene, toluene, ethylbenzene, and xylenes
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COPC	chemicals of potential concern
CSF	cancer slope factor
CSM	conceptual site model
DCE	dichloroethene
EPA	U.S. Environmental Protection Agency
ERA	Ecological Risk Assessment
FS	Feasibility Study
ft	feet
HEAST	Health Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment
HI	hazard index
HQ	hazard quotient
HydroGeoLogic	HydroGeoLogic, Inc.
IRIS	Integrated Risk Information System
IRP	Installation Restoration Program
JRB	Joint Reserve Base
LOAEL	lowest observed adverse effect level
μg/L	micrograms per liter
NAS	Naval Air Station
NCEA	National Center for Environmental Assessment
NDI	Non Destructive Inspection
NFA	no further action

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

NOAEL	no observed adverse effect level
OPR	Office of Primary Responsibility
OWS	oil/water separators
PCL	protective concentration level
POL	petroleum, oil, and lubricant
PRB	permeable reactive barrier
RAAD	Risk Assessment Assumptions Document
RBC	risk-based screening concentration
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RFI	RCRA Facility Investigation
RI/FS	remedial investigation/feasibility study
RME	reasonable maximum exposure
ROD	Record of Decision
RRS	Risk Reduction Standard
SI	Site Investigations
SWMU	Solid Waste Management Unit
TCE	trichloroethene
TNRCC	Texas Natural Resource Conservation Commission
UCL	upper confidence level
USAF	U.S. Air Force
USGS	U.S. Geological Survey
UST	underground storage tank
VOC	volatile organic compound
WAA	Waste Accumulation Area

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RISK ASSESSMENT ASSUMPTIONS DOCUMENT NORTHERN AND CENTRAL LOBES OF THE TRICHLOROETHENE PLUME NAS FORT WORTH JRB, TEXAS JULY 2002

1.0 INTRODUCTION

The intent of this project is to perform a Human Health Risk Assessment (HHRA) and an Ecological Risk Assessment (ERA) to evaluate risks posed by contamination present at the Naval Air Station (NAS) Fort Worth Joint Reserve Base (JRB) section of the former Carswell Air Force Base (AFB). This Risk Assessment Assumptions Document (RAAD) has been prepared in order to obtain concurrence from the regulatory agencies on the proposed manner in which the HHRA and ERA will be performed. This risk assessment will follow the format of the previously approved HHRA and ERA for the Southern Lobe Trichloroethene (TCE) Plume (HydroGeoLogic, 2001a) with the exceptions noted in this document.

The risk assessment is intended to reflect appropriate guidance provided by U.S. Environmental Protection Agency (EPA) (1989, 1995, and 1998) for human health risk assessment and guidance provided by the Texas Natural Resources Conservation Commission (TNRCC) (2000) for ecological risk assessment. EPA's Part D risk assessment guidance (1989) provides standardized tables that present data and calculated values that are to be used in the risk assessment. Part D guidance will be used to present the majority of the risk assessment. However, since the Terrace Alluvium groundwater risk characterization will take the form of risk isopleth maps rather than single numerical estimates of risk, some of the risk characterization will not specifically conform to the Part D format.

1.1 SITE LOCATION

The NAS Fort Worth JRB is located on 2,264 acres of land in Tarrant County, Texas, eight miles west of downtown Fort Worth (Figure 1.1). The base is bordered by Lake Worth to the north; the West Fork Trinity River, River Oaks, and Westworth Village to the east; the Carswell Golf Course [Base Realignment and Closure (BRAC)] property to the south; other urban areas of Fort Worth to the northeast and southeast; White Settlement to the west and southwest; and Air Force Plant 4 (AFP4) to the west (Figure 1.2).

1.2 SITE HISTORY AND PRIOR INVESTIGATIONS

1.2.1 Air Force Plant 4

AFP 4 was placed on the National Priority List in August 1990 because of a large release of TCE arising from past disposal practices at AFP 4. While the source areas are currently being remediated under Comprehensive Environmental Response, Compensation, and Liability Act

(CERCLA) among the EPA Region IV, the TNRCC, and Aeronautical Systems Command, the dissolved TCE plume appears to have migrated toward the east of AFP 4 and extends under NAS Fort Worth JRB and the Former Carswell AFB. The regional TCE plume can be subdivided into northern, central, and southern lobes. The northern lobe is migrating primarily eastward from an AFP 4 source area. The southern lobe is migrating in a southeast direction and appears to follow a paleochannel of the West Fork Trinity River (Parsons, 1998). A risk assessment was completed on the southern lobe in May 2002. This risk assessment will cover the remaining portions of the TCE plume on the NAS Fort Worth JRB.

The investigation of groundwater contamination beneath AFP4 was initiated in 1984. A remediation investigation/feasibility study (RI/FS) for AFP4 was initiated in 1990 and the completed RI/FS was approved in 1995. The proposed plan remedial action was issued in 1995 and the Record of Decision (ROD) signed in 1996 (CH2M Hill, 2000).

In March 1984, the Installation Restoration Program (IRP) was initiated at AFP4 by the U.S. Air Force (USAF). The Phase 1 investigation identified 21 sites as sources of contamination. Shallow groundwater contaminated with TCE beneath the East Parking Lot at AFP4 (just west of the AFP4/NAS Fort Worth JRB boundary) was one of the 21 sites identified for remediation under the IRP (CH2M Hill, 1984).

Additional studies were conducted by Hargis & Associates (Hargis & Associates, Inc., 1989) and Radian (Radian, 1987) to evaluate the geology and to the determine presence, magnitude, extent, direction, and rate of movement of any identified contaminants at AFP4, including the East Parking Lot groundwater plume. As a result of these studies, the presence of TCE, dichloroethene (DCE), and chromium in groundwater beneath the AFP4 East Parking Lot, and the distribution of these contaminants from the AFP4 site onto NAS Fort Worth JRB, was confirmed (CH2M Hill, 2000).

Currently several remediation and monitoring programs are in place or planned at AFP4:

- Electrical Resistance Heating at the Building 181 source area;
- Groundwater Pump and Treat at the East Parking Lot (just downgradient of the Building 181 Source Area);
- Long Term Monitoring of the TCE Plume;
- Permeable Reactive Barrier (PRB) downgradient of Plant 4 in the southern lobe TCE Plume; and,
- Additional delineating in the northern portion of AFP 4 (planned for 2003).

The locations of each remedial action is shown on Figure 1.3.

1.2.2 NAS Fort Worth JRB

Multiple investigations have been conducted at NAS Fort Worth JRB since the base-related Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) were first identified in 1984. To date, 20 AOCs and 68 SWMUs have been identified. Of these, 13 AOCs and 43 SWMUs have been determined to require no further action and are currently considered closed by the TNRCC. All SWMUs and AOCs are listed in Table 1.1 and Table 1.2, respectively.

Basewide groundwater sampling was initiated in April 1995 to monitor downgradient groundwater plume extent and migration patterns while the various site investigations are ongoing. Quarterly sampling was performed between April 1995 and April 1996 (Law Engineering, 1996); and quarterly since January 1997 by CH2M Hill (CH2M Hill, 1996) and HydroGeoLogic (HydroGeoLogic, 2001b). The sampling frequency was reduced to a semi-annual schedule in 2001 based on the limited changes in the plume between quarters (Ellis, 2002a). To date, 22 sampling rounds have been conducted.

Eleven landfill areas are suspected to have operated at NAS Fort Worth JRB between 1942 and 1975. These landfills were used for the disposal of municipal waste, construction debris (in the form of concrete, asphalt, wood, and trees), nickel cadmium batteries, drums of waste paints, thinners, oils, PD-680, medical waste, and potentially small amounts of undocumented hazardous materials. Of these landfills, two are located within the TCE plume SWMU 17 (Landfill 7) and SWMU 29 (Landfill 2). Two other landfills, SWMUs 28 (Landfill 1) and SWMU 30 (Landfill 9), are located downgradient of the TCE plume. The remaining landfills are either located within the southern lobe of the TCE plume or in the southern portion of the base that is not affected by the TCE plume.

A Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) of each SWMU was performed in order to determine the nature and extent of soil contamination at each of the subject SWMUs in accordance with the requirements outlined in the RCRA Hazardous Waste Permit. To date, there have been no significant detections of chemicals of potential concern (COPCs) at any of the landfills located within or potentially downgradient of the northern lobe of the TCE plume.

One hundred thirty-one underground storage tanks (USTs) have been identified as having potentially existed at NAS Fort Worth JRB. An evaluation of the records pertaining to the 131 USTs concluded that only 20 of the USTs required some form of action under the U.S. Air Force IRP to achieve closure from the TNRCC and transfer of the regulatory responsibility for compliance, where appropriate, to the Navy. These actions have included either a submittal of previously collected site characterization data for TNRCC review or an investigation of current site conditions. Currently, there are 13 USTs awaiting some form of approval action from the TNRCC. All other USTs are closed (HydroGeoLogic, 1999).

Table 1.1
Solid Waste Management Units at NAS Fort Worth JRB, Texas

SWMU	Description	OPR
1	Pathological Waste Incinerator (NFA)	BRAC
2	Pathological Waste Storage Shed (NFA)	BRAC
3	Metal Cans (NFA)	BRAC
4	Facility Dumpsters (NFA)	BRAC
5	Building 1628 Waste Accumulation Area	ERA
6	Building 1628 Wash Rack and Drain	ERA
7	Building 1628 Oil/Water Separator (NFA)	ERA
8	Building 1628 Sludge Collection Tank (NFA)	ERA
9	Building 1628 Work Station Waste Accumulation Area (NFA)	ERA
10	Building 1617 Work Station Waste Accumulation Area (NFA)	ERA
11	Building 1617 Waste Accumulation Area (NFA)	ERA
12	Building 1602 Waste Accumulation Area	ERA
13	Building 1710 Visual Information Center Work Station Former Waste Accumulation Areas (NFA)	ERA
14	Building 1060 Bead Blaster Collection Tray (NFA)	ERA
15	Building 1060 Paint Booth Vault (NFA)	ERA
16	Building 1060 Waste Accumulation Area (NFA)	ERA
17	Landfill No.7	ERA
18	Fire Training Area No.1 (NFA)	BRAC
19	Fire Training Area No.2	BRAC/ERA
20	Waste Fuel Storage Tank	BRAC/ERA
21	Waste Oil Tank	BRAC/ERA
22	Landfill No.4 (NFA)	BRAC
23	Landfill No.5 (NFA)	BRAC
24	Waste Burial Area (NFA)	BRAC
25	Landfill No.8 (NFA)	BRAC/ERA
26	Landfill No.3 (NFA)	ERA
27	Landfill No.10 (NFA)	ERA
28	Landfill No.1	ERA
29	Landfill No.2	ERA
30	Landfill No.9	ERA
31	Building 1050 Waste Accumulation Area	ERA
32	Building 1410 Waste Accumulation Area (NFA)	ERA
33	Building 1420 Waste Accumulation Area (NFA)	ERA
34	Building 1194 Waste Accumulation Area (NFA)	ERA
35	Building 1194 Vehicle Refueling Shop Oil/Water Separation System	ERA
36	Building 1191 Waste Accumulation Area (NFA)	ERA
37	Building 1191 Vehicle Maintenance Shop Oil/Water Separation System	ERA
38	Building 1269 Polychlorinated Biphenyl Transformers Building (NFA)	BRAC

Table 1.1 (continued)
Solid Waste Management Units at NAS Fort Worth JRB, Texas

SWMU	Description	OPR
39	Building 1643 Waste Accumulation Area (NFA)	ERA
40	Building 1643 Oil/Water Separation System (NFA)	ERA
41	Building 1414 Oil/Water Separation System, Field Maintenance Squadron Aerospace Ground Equipment	ERA
42	Building 1414 Waste Accumulation Area (NFA)	ERA
43	Building 1414 Non Destructive Inspection (NDI) Waste Accumulation Point (NFA)	ERA
44	Building 1027 Oil/Water Separation System at the Aircraft Washing Hangar	ERA
45	Building 1027 Waste Oil Tank Vault at the Aircraft Washing Hangar (NFA)	ERA
46	Building 1027 Waste Accumulation Area (NFA)	ERA
47	Building 1015 Jet Engine Test Cell Oil/Water Separator	ERA
48	Building 1048 Fuel Systems Shop Floor Drains (NFA)	ERA
49	Aircraft Washing Area No.1	ERA
50	Aircraft Washing Area No.2	ERA
51	Building 1190 Central Waste Holding Area (NFA)	ERA
52	Building 1190 Oil/Water Separation System	ERA
53	Storm Water Drainage System (NFA)	ERA
54	Storm Water Interceptors	ERA
55	East Gate Oil/Water Separator	ERA
56	Building 1405 Waste Accumulation Area (NFA)	ERA
57	Buildings 1432/1434 Waste Accumulation Area (NFA)	ERA
58	Pesticide Rinse Area (NFA)	BRAC
59	Building 8503 Weapons Storage Area Waste Accumulation Area	BRAC
60	Building 8503 Radioactive Waste Burial Site (NFA)	BRAC
61	Building 1320 Power Production Maintenance Facility Waste Accumulation Area	ERA
62	Landfill No.6	ERA
63	Entomology Dry Well (NFA)	ERA
64	French Underdrain System	ERA
65	Weapons Storage Area Disposal Site (NFA)	BRAC
66	Sanitary Sewer System (Basewide Coverage)	BRAC/ERA
67	Building 1340 Oil/Water Separator (NFA)	ERA
68	POL Tank Farm (NFA)	ERA

Notes:
OPR - Office of Primary Responsibility
BRAC - Base Realignment and Closure
ERA - Environmental Restoration Account
NFA - No further action
POL - Petroleum, oil, and lubricant

Table 1.2
Areas of Concern at NAS Fort Worth JRB, Texas

AOC	Description	OPR
1	Former Base Service Station/Former Base Gas Station	BRAC/ERA
2	Airfield Groundwater	ERA
3	Waste Oil Dump (NFA)	ERA
4	Fuel Hydrant System (NFA)	ERA
5	Grounds Maintenance Yard (NFA)	BRAC
6	RV Parking Area (NFA)	ERA
7	Former Base Refueling Area (NFA)	ERA
8	Aerospace Museum (NFA)	BRAC
9	Golf Course Maintenance Yard (NFA)	BRAC
10	Building 1064 Oil/Water Separator	ERA
11	Building 1060 Oil/Water Separator	ERA
12	Building 4210 Oil/Water Separator	ERA
13	Building 1145 Oil/Water Separator (NFA)	ERA
14	Unnamed Stream (NFA)	BRAC
15	Building 1190 Storage Shed (NFA)	ERA
16	Family Camp (NFA)	BRAC
17	Suspected Former Landfill (NFA)	ERA
18	Suspected Former Fire Training Area A (NFA)	ERA
19	Suspected Former Fire Training Area B	ERA

Notes:
OPR - Office of Primary Responsibility
BRAC - Base Realignment and Closure
ERA - Environmental Restoration Account
NFA - No further action

All reported or discovered UST-related releases involved fuel hydrocarbons including waste oil, diesel, kerosene, jet fuel, and gasoline. Based on investigations performed at the UST sites, no evidence was found, or exists, to support any UST having contributed chlorinated hydrocarbons to the site's TCE plume. The only UST related site that requires active remediation is AOC 1. AOC 1 is comprised of a former Base Gas Station (closed in 1989) and a re-activated Base Service Station. Both facilities had fuel hydrocarbon releases but the release from the Base Service Station (early '90s) created a dissolved hydrocarbon plume that extends off-site and is encroaching on the West Fork Trinity River. The COPC from this release is benzene. All other COPCs are either below the TNRCC screening levels or fall below acceptable risk (Plan B) levels. Benzene, toluene, ethylbenzene, and xylenes (BTEX) levels are decreasing from natural attenuation, and a pump and treat system will be installed to provide hydraulic control of the plume in 2003. No other remedial activities are planned for any of the remaining UST sites (HydroGeoLogic, 2002a).

There have been 16 Waste Accumulation Areas (WAA) investigated at NAS Fort Worth JRB. Of these investigations, one WAA, SWMU 12, indicated evidence of groundwater contamination. All other WAAs have been closed or have been recommended for closure under the TNRCC Risk Reduction Standard (RRS) Program. During the investigation of SWMU 12, elevated levels of benzene were detected. Hot spot removals were completed at SWMU 12 and further sampling has indicated that benzene levels have decreased. Based upon the sampling results, HydroGeoLogic has requested closure of SWMU 12 under RRS2. Final status of SWMU 12 is pending TNRCC review (Ellis, 2002b).

A total of 21 oil/water separators (OWS) have been investigated at NAS Fort Worth JRB. Of these, seven OWS have been granted no further action status by the TNRCC. A final RFI report requesting closure for 13 OWS has been submitted to TNRCC. Final status of these OWS is pending TNRCC review (IT Corporation, 1998).

1.3 ORGANIZATION OF RAAD

The RAAD consists of the following sections:

- Section 2: Conceptual Site Model (CSM) for the HHRA and ERA;
- Section 3: Data Compilation and Evaluation;
- Section 4: Exposure Point Concentrations;
- Section 5: Human Intake Assumptions and Exposure Quantification;
- Section 6: Toxicity Assessment;
- Section 7: Risk Characterization; and
- Section 8: Ecological Risk Assessment.

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2.0 CONCEPTUAL SITE MODEL

The CSM describes the contaminant source(s) of a site and how these contaminants are transported or altered over time. The CSM also includes possible pathways by which potential receptors, human and ecological, may be exposed to the various contaminants. The elements necessary to construct a complete exposure pathway and develop the conceptual model include:

- Land use scenarios and potential receptors (both current and future)
- Contaminant sources
- Transport pathways
- Exposure pathway scenarios

2.1 LAND USE SCENARIOS AND POTENTIAL RECEPTORS

2.1.1 Current Land Use Scenarios and Potential Receptors

NAS Fort Worth JRB is an active military installation. As typical of active military installations, the property encompasses a wide range of land uses. On the installation there are stores, restaurants, work areas, offices, construction projects, and residences. To the south of NAS Fort Worth JRB is the portion of the former Carswell AFB that is designated for transfer under the BRAC program. The risks associated with the BRAC property were assessed under the Southern Lobe TCE Plume Risk Assessment and its addenda (HydroGeoLogic, 2001a). The BRAC property will be used as a golf course. South of the golf course is a residential area. To the north, NAS Fort Worth JRB is bounded by Lake Worth. Lake Worth serves as a drinking water supply for the City of Fort Worth. Along the western boundary of the Naval Air Station is AFP4, an industrial facility currently operated by Lockheed. To the east, the NAS Fort Worth JRB boundary abuts the West Fork Trinity River. This river may be used for recreational purposes, and is also classified for drinking water use. East of the river is a residential area. Thus, the land uses on and surrounding NAS Fort Worth JRB are residential, industrial, commercial and recreational.

Beneath the site is a shallow aquifer known as the Terrace Alluvium and a deeper aquifer called the Paluxy Aquifer (Figure 2.1). In some parts of Tarrant County along the Trinity River, groundwater from the Terrace Alluvium may be used for irrigation and by residents. However, due to limited distribution, poor yield and susceptibility to surface and stormwater pollution, the Terrace Alluvium is not often used as a potable water source. No potable water supply wells are completed in the Terrace Alluvium on or within 0.5 miles of NAS Fort Worth JRB. The current land use scenario does not include the use of the Terrace Alluvium groundwater.

The Paluxy Aquifer is a source of potable water for many of the communities surrounding NAS Fort Worth JRB, including the community of White Settlement located south of the site. At the moment, there are no drinking water wells completed in the Paluxy Aquifer on or within 0.5 miles of NAS Fort Worth JRB. The installation obtains its potable water from the

City of Fort Worth, which draws its water from Lake Worth. The current land use scenario does not include the use of the Paluxy Aquifer groundwater.

Based on the current land use of NAS Fort Worth JRB, the following current receptors have been identified:

- Onsite residents (child and adult)
- Onsite maintenance worker (adult)
- Onsite industrial/commercial worker (adult)
- Construction worker (adult)
- Site visitor (adult)
- Recreational user (offsite, adult and child)

2.1.2 Future Land Use Scenarios and Potential Receptors

There are no plans to change the land use at NAS Fort Worth JRB. Therefore, it is assumed that the future land use on NAS Fort Worth JRB will be a mixture of industrial, commercial and residential uses similar to what currently exists on site. Even though it is unlikely that NAS Fort Worth JRB would use the Terrace Alluvium as a potable water supply in the future, the risk assessment will conservatively include this use of groundwater. The risk assessment will also consider the possible future use of the Paluxy Aquifer beneath the installation as a potable water source. It is assumed that the West Fork Trinity River would be used for recreational purposes in the future. Because the local municipalities obtain potable water from either Lake Worth or the Paluxy Aquifer, it is unlikely that the West Fork Trinity River would be used by local residents as a potable water source. This river, however, is considered to have the potential to be a potable water supply. Therefore, to be conservative, it will be assumed that a future offsite resident may use the West Fork Trinity River as a potable water supply.

2.2 CONTAMINANT SOURCES

As described in Section 1.2, multiple field investigations have been conducted at NAS Fort Worth JRB over the past several years. Based on these prior field investigations, a number of contaminant sources have been identified across the installation.

2.2.1 Groundwater

Prior waste solvent disposal practices at AFP 4 resulted in the release of a large volume of TCE. Over the years, this TCE source generated a plume of groundwater contamination in the Terrace Alluvium that extends eastward from AFP 4 across NAS Fort Worth JRB and the BRAC property (Figure 2.2). The plume is divided into northern, central and southern lobes. Risk assessment and remediation of the southern lobe, which is beneath the BRAC property, was addressed under a separate Risk Assessment and an on-going Feasibility Study (FS) (HydroGeoLogic, 2001a). Remediation of the source areas at AFP 4 is being performed as described in Section 1.2.1. The ROD is currently undergoing its mandatory five year review by Jacobs Engineering. The review should be published in early 2003. The risk assessment described by this document will consider only the northern lobe of the plume on NAS Fort Worth JRB.

In addition to the TCE plume, there have been other, smaller, plumes on NAS Fort Worth JRB in the Terrace Alluvium. Because of the extent to which the TCE plume has traveled, some of the smaller plumes have commingled with the TCE plume. At one time, leaking USTs resulted in four small benzene plumes. Concentrations of BTEX in three of these plumes have decreased to below detection limits. The risk assessment and remediation of the fourth plume at AOC 1 is being addressed under the Petroleum Storage Tank division of the TNRCC (HydroGeoLogic, 2002a).

2.2.2 Soil

Since 1942, most hazardous waste generated through operations and activities at the NAS Fort Worth JRB have been disposed of in landfills, reused on base, or processed through the Defense Property Disposal Office for off-base recycling or disposal. The prior investigations of the different SWMUs and AOCs identified on the NAS Fort Worth JRB property is described in Section 1.2. Based on the investigation of these SMWUs and AOCs, soil contamination is scattered across the installation in discrete areas undergoing RFI or Site Investigations (SI). To date 56 SWMUs and AOCs have been determined to require no further action. For this closure determination to be accepted by the TNRCC, it must be demonstrated that the site does not pose a threat to either human health or ecological receptors. In other words, it is necessary to demonstrate that the concentrations of soil contaminants are either at background levels or are below risk-based concentrations. For the SWMUs and AOCs that are still under investigation, the data collected during their field investigations will be evaluated to determine if each site may be closed or if action is required to ensure protection of human health and the environment. If any of these sites cannot be closed with existing soil concentrations, the site will be remediated as necessary to reduce contaminant levels to the point that they no longer pose a threat to human health or the environment. Either through closure under no further action or closure after remediation, the risks associated with each open SWMU and AOC will be addressed as part of the RFI process for that site. For this reason, this risk assessment will not include exposure to soil.

2.2.3 Stormwater and Surface Water

Stormwater runoff from NAS Fort Worth JRB is another potential source of contamination. 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. This part of the stormwater drainage system is being addressed under the RFI process for SWMU 54. A small portion of the north end of the base drains directly into Lake Worth through an outfall that is permitted under the National Pollutant Discharge Elimination System. Monitoring results for this outfall document compliance with permit discharge limitations (IT Corporation, 1997). The remaining stormwater runoff from NAS Fort Worth JRB drains east towards the West Fork Trinity River or Farmers Branch Creek on the BRAC property.

No other surface water on the facility serves as a contaminant source.

2.3 TRANSPORT PATHWAYS

The contaminant sources and transport pathways are summarized in Table 2.1 and are described in the sections below.

2.3.1 Groundwater

Contaminants in groundwater will move with the groundwater flow away from the source area. As demonstrated by the distance from the source area under AFP 4 that the TCE plume has traveled, groundwater flow within the Terrace Alluvium is a primary transport process at NAS Fort Worth JRB. The estimated hydraulic conductivity of the Terrace Alluvium groundwater is 2 ft/day to 280 feet (ft)/day based on pumping and slug tests (HydroGeoLogic, 2000a). Although the Terrace Alluvium tends to flow east towards the West Fork Trinity River, localized variations in flow direction exist across the site (Figure 2.3). In addition, there are paleochannels across the site that create discrete areas of more rapid groundwater flow. The influence of these paleochannels is shown in the fingering of the leading edge of the plume (Figure 2.2). Groundwater in the Terrace Alluvium discharges into the West Fork Trinity River and Farmers Branch Creek. Farmers Branch Creek, which was included in the risk assessment for the BRAC property, flows across the BRAC property and NAS Fort Worth JRB, and then discharges to the West Fork Trinity River. The TCE plume has not reached the point of discharge to the West Fork Trinity River. In order to estimate the potential future impact of the TCE groundwater plume on the surface water in the West Fork Trinity River, HydroGeoLogic modeled the movement of the plume. The results are summarized in the *Draft Report Simulation of Groundwater Flow and TCE Transport in the Terrace Alluvial Aquifer in the Vicinity of the Northern Lobe TCE Plume, NAS Fort Worth JRB, Texas* (HydroGeoLogic, 2002b). Based on the model, it is predicted that the TCE plume will reach the West Fork Trinity River in approximately five years (HydroGeoLogic, 2002b).

Recharge to the Terrace Alluvium occurs through infiltration from precipitation and from surface water bodies. Extensive on-site pavement and construction restricts this recharge. Additional recharge, however, potentially comes from leakage in water lines, sewer systems, storm drains, and cooling water systems. This inflow of water to the shallow aquifer locally affects groundwater flow patterns and contamination migration (HydroGeoLogic, 2002c).

Vertical flow between the Terrace Alluvium and the Paluxy Aquifer is restricted by the Goodland/Walnut Formations sandwiched between the aquifers. Except for a small area on the installation, called the "window", there is no significant hydraulic connection between the Terrace Alluvium and the Paluxy Aquifer. Groundwater data indicate that vertical transfer of contaminants from the Terrace Alluvium to the Paluxy Aquifer in the window area is minimal (HydroGeoLogic, 2002c).

Table 2.1
Transport Pathways

Contaminant Source	Transport Processes	Comments
Groundwater	Movement of contaminants in the Terrace Alluvium with the groundwater flow.	Because there are no potential offsite receptors between the NAS Fort Worth JRB property boundary and where the plume would intercept the West Fork Trinity River, the only receptors potentially exposed to groundwater contaminants would be onsite receptors. The contaminant concentrations would be diluted by recharge (precipitation; and leaking water lines, sewers and cooling systems), advection, and dispersion.
	Volatilization of contaminants from the Terrace Alluvium groundwater into the soil gas. Movement of these volatiles upwards through the soil and into buildings.	For the reason noted above, the only receptors potentially exposed to contaminants in the soil gas from the groundwater plume would be onsite.
	Discharge of the Terrace Alluvium groundwater into the West Fork Trinity River and Farmer's Branch Creek.	This discharge occurs offsite. This pathway will be evaluated only for offsite receptors. Because risks associated with chemicals detected in Farmer's Branch Creek were evaluated in the risk assessment for the BRAC property, Farmer's Branch Creek will not be considered in the risk assessment for the Northern Lobe TCE Plume.
	Vertical transport of contaminants from the Terrace Alluvium to the Paluxy Aquifer.	In the Paluxy Aquifer, contaminants would be diluted by advection and dispersion.
Soil	Leaching to groundwater	Because risks due to contamination in the soils are being addressed through the RCRA closure process, the soil-to-groundwater pathway will not be addressed in the risk assessment for the Northern Lobe TCE Plume.
	Volatilization and fugitive dust emissions from surface soil.	Because risks due to contamination in the soils are being addressed through the RCRA closure process, the soil-to-air pathway will not be addressed in the risk assessment for the Northern Lobe TCE Plume.
Stormwater Runoff	Discharge to Lake Worth	Any contaminants discharged to Lake Worth would be substantially diluted and would commingle with contaminants from other sites and facilities adjacent to Lake Worth. For these reasons, this risk assessment will not consider exposure to surface water in Lake Worth.
	Discharge to Farmer's Branch Creek	Because risks associated with chemicals detected in Farmer's Branch Creek were evaluated in the risk assessment for the BRAC property, Farmer's Branch Creek will not be considered in the risk assessment for the Northern Lobe TCE Plume.
	Discharge to West Fort Trinity River	Dissolved contaminants will be diluted by the river when the stormwater runoff first mixes with the West Fork Trinity River. Within the river, the dissolved contaminants will be diluted by advection and dispersion as the contaminants are transported downstream. Dissolved contaminants may be removed from solution by sorption to sediment or by chemical precipitation. Contaminants associated with turbidity may settle out of solution and become sediment. These particles may be re-suspended and transported downstream during periods of high river flow. In addition, contaminants associated with the sediment may dissolve into the surface water. Contaminants may volatilize from the surface water to the ambient air. Because dispersion and dilution would quickly dilute air concentrations, the surface water-to-air pathway will not be evaluated in the risk assessment.

Because the Terrace Alluvium is a shallow, unconfined aquifer, volatile compounds may transfer out of solution and move vertically through the soil column. These volatiles may accumulate within basements of buildings that are located above the plume. Because the Paluxy Aquifer is a confined aquifer, the soil gas transport pathway does not apply to this deeper aquifer.

2.3.2 Soil

Contaminants present in the surface and subsurface soils may be leached into the deeper soil horizons by infiltrating precipitation. Eventually, these contaminants may leach into the Terrace Alluvium groundwater. As part of the RFI process for each SWMU and AOC, it is necessary to evaluate the soil-to-groundwater pathway and to ensure that this transport pathway does not pose a threat to groundwater quality. Because the RFI and closure process consider the risks associated with the soil-to-groundwater pathway for the contaminated soils at NAS Fort Worth JRB, this pathway will not be included in this risk assessment. In addition, the transfer of contaminants from the surface soil to air through volatilization and fugitive dust emissions will not be considered for the same reason.

2.3.3 Stormwater

Contaminants associated with the surface soil in the SWMUs and AOCs may dissolve into or be eroded by stormwater runoff. As described in Section 2.2.3, the stormwater on NAS Fort Worth JRB discharges into Lake Worth, Farmers Branch Creek, and the West Fork Trinity River. Soil particles carried by the stormwater runoff into Lake Worth will settle out of solution on to the lake bottom. Chemicals dissolved in the stormwater runoff that discharges to Lake Worth will be quickly diluted by the large volume of the lake. A polychlorinated biphenyl advisory was posted in August 2001 advising against consuming any fish caught in the lake. The U.S. Geological Survey (USGS) has conducted sediment, surface water and fish tissue sampling to assess water quality. Their research is on-going and a report will be published in the Fall 2002. Based on groundwater flow maps and contaminant isopleth maps (Figures 2.2 and 2.3), there is no evidence that the TCE, DCE or vinyl chloride plumes are discharging to Lake Worth. Since there is no connection between the plumes and the lake, and because the lake is being addressed by the USGS under a separate (and more comprehensive) investigation, this surface water body will not be addressed as part of this risk assessment.

The West Fork Trinity River flows along the eastern border of NAS Fort Worth JRB and serves as a groundwater discharge point for the Terrace Alluvium aquifer on NAS Fort Worth JRB. Contaminants in the stormwater runoff from NAS Fort Worth JRB may be transported into West Fork Trinity River either dissolved in solution or associated with eroded particles. The Terrace Alluvial groundwater may transport dissolved contaminants to the river through the groundwater seeps. Once within the West Fork Trinity River, dissolved contaminants may be moved downstream with the surface water flow. Contaminants associated with eroded particles may settle onto the river bottom in places of quiescent flow, and may then be re-suspended with the particles during periods of high flow. During this downstream transport, the concentration of dissolved contaminants will decrease through dilution and dispersion. The concentration in the sediment will also decrease because of differential settling by the particles to which a contaminant may have adsorbed. This risk assessment will use surface water, seep, and sediment data to evaluate the risks posed by contaminants that are present in the West Fork Trinity River.

Volatile contaminants entrained in the storm water runoff and discharged into the surface waters may volatilize into the ambient air. Dilution and dispersion will rapidly reduce the concentration of any airborne contaminants that volatilize from the stormwater runoff and the receiving surface water bodies. Therefore, this risk assessment will not consider volatilization from surface water to air.

2.4 EXPOSURE PATHWAY SCENARIOS

In this section, the specific routes by which a receptor may be exposed to contaminants is described. Because exposure to soil will be evaluated separately for each SWMU and AOC that is still under investigation, the soil exposure pathway scenarios will not be quantitatively evaluated in this risk assessment. For each land use timeframe, current and future, the exposure pathways are described below.

2.4.1 Current Exposure Pathway Scenarios

The groundwater exposure pathway under the current land use scenario does not include the use of groundwater as a potable water supply. Therefore, the only routes by which a receptor may be exposed to groundwater contaminants are inhalation of vapors from the soil gas, and contact with and inhalation of groundwater contaminants during excavation. These pathways apply only to the Terrace Alluvium. With respect to the Paluxy Aquifer, there is no complete groundwater pathway in the current land use scenario.

Recreational users may be exposed to surface water and sediment in the West Fork Trinity River during swimming. It is also assumed that recreational users may eat fish that they catch in the West Fork Trinity River. In addition, it is assumed that construction activities will not take place in the West Fork Trinity River adjacent to NAS Fort Worth JRB. Therefore, the only receptor that has the potential for exposure to contaminants in the West Fork Trinity River under the current land use scenario is the recreational user.

Maintenance workers may be exposed to stormwater in the stormwater collection system while performing routine maintenance activities. The stormwater collection system is being addressed under the RFI process for SWMU 54. Therefore, exposure to surface water and sediment by the maintenance worker will not be quantitatively evaluated in this risk assessment.

The exposure pathways and individual receptors under the current land use scenario are described below and summarized in Table 2.2.

Table 2.2
Potential Receptors and Exposure Pathways

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Groundwater	Indoor Air	Buildings on NAS Fort Worth JRB	Resident	Adult	Inhalation	On-site	Quant	There is base housing on NAS Fort Worth JRB
					Child	Inhalation	On-site	Quant	There is base housing on NAS Fort Worth JRB
				Industrial Worker	Adult	Inhalation	On-site	Quant	Site workers may be exposed to contaminants that accumulate in buildings
				Maintenance Worker	Adult	Inhalation	On-site	None	Because the maintenance worker's exposure would be less than that for the industrial worker, the maintenance worker will not be evaluated
				Site Visitor	Adult	Inhalation	On-site	Quant	Site visitors may be exposed to contaminants that accumulate in buildings
	Groundwater	Groundwater and Air	Excavation Trench or Pit	Construction Worker	Adult	Dermal Absorption	On-site	Quant	It is possible that groundwater may be encountered during construction work
						Inhalation	On-site	Quant	It is possible that groundwater may be encountered during construction work
	Sediment	Sediment	Sediment in the West Fork Trinity River	Recreational User	Child	Dermal Absorption	Off-site	Quant	Recreational users may wade in the West Fork Trinity River
						Ingestion	Off-site	Quant	Recreational users may wade in the West Fork Trinity River
					Adult	Dermal Absorption	Off-site	Quant	Recreational users may wade in the West Fork Trinity River
						Ingestion	Off-site	Quant	Recreational users may wade in the West Fork Trinity River
	Surface Water	Surface Water	Surface Water in the West Fork Trinity River	Recreational User	Child	Dermal Absorption	Off-site	Quant	Recreational users may wade in the West Fork Trinity River
						Ingestion	Off-site	Quant	Recreational users may wade in the West Fork Trinity River
					Adult	Dermal Absorption	Off-site	Quant	Recreational users may wade in the West Fork Trinity River
						Ingestion	Off-site	Quant	Recreational users may wade in the West Fork Trinity River
		Fish	Fish Caught in the West Fork Trinity River	Recreational User	Adult	Ingestion	Off-site	Quant	An adult recreational user may catch fish from the West Fork Trinity River and consume the fish
Future	Groundwater	Groundwater	Terrace Alluvium or Paluxy Aquifer groundwater	Resident	Adult	Dermal Absorption	On-site	Quant	Although unlikely, NAS Fort Worth JRB may install future drinking water wells to provide potable water onsite There is base housing on NAS Forth Worth JRB.
						Ingestion	On-site	Quant	Although unlikely, NAS Fort Worth JRB may install future drinking water wells to provide potable water onsite There is base housing on NAS Forth Worth JRB.
						Inhalation	On-site	Quant	Although unlikely, NAS Fort Worth JRB may install future drinking water wells to provide potable water onsite There is base housing on NAS Forth Worth JRB.
					Child	Dermal Absorption	On-site	Quant	Although unlikely, NAS Fort Worth JRB may install future drinking water wells to provide potable water onsite There is base housing on NAS Forth Worth JRB.
						Ingestion	On-site	Quant	Although unlikely, NAS Fort Worth JRB may install future drinking water wells to provide potable water onsite There is base housing on NAS Forth Worth JRB.
						Inhalation	On-site	Quant	Although unlikely, NAS Fort Worth JRB may install future drinking water wells to provide potable water onsite There is base housing on NAS Forth Worth JRB.
				Industrial Worker	Adult	Dermal Absorption	On-site	Quant	An industrial worker may be exposed to groundwater as a potable water source during the work day
						Ingestion	On-site	Quant	An industrial worker may be exposed to groundwater as a potable water source during the work day
				Maintenance Worker	Adult	Dermal Absorption	On-site	None	A maintenance worker may be exposed to groundwater as a potable water source during the work day Because that exposure would be similar to the exposure for an industrial worker, the maintenance worker will not be separately evaluated.

Table 2.2
Potential Receptors and Exposure Pathways

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Future (cont'd)	Groundwater	Groundwater	Terrace Alluvium or Paluxy Aquifer groundwater	Maintenance Worker	Adult	Ingestion	On-site	None	A maintenance worker may be exposed to groundwater as a potable water source during the work day Because that exposure would be similar to the exposure for an industrial worker, the maintenance worker will not be separately evaluated
				Site Visitor	Adult	Dermal Absorption	On-site	Quant	Site visitors may be exposed to groundwater as a potable water source during their visit
						Ingestion	On-site	Quant	Site visitors may be exposed to groundwater as a potable water source during their visit
	Surface Water	Surface Water	West Fork Trinity River	Resident	Age-Adjusted	Dermal Absorption	Off-site	Quant	Although unlikely, surface water from the West Fork Trinity River may be used as future potable water supply
						Ingestion	Off-site	Quant	Although unlikely, surface water from the West Fork Trinity River may be used as a future potable water supply
						Inhalation	Off-site	Quant	Although unlikely, surface water from the West Fork Trinity River may be used as a future potable water supply
					Child	Dermal Absorption	Off-site	Quant	Although unlikely, surface water from the West Fork Trinity River may be used as a future potable water supply
						Ingestion	Off-site	Quant	Although unlikely, surface water from the West Fork Trinity River may be used as a future potable water supply
						Inhalation	Off-site	Quant	Although unlikely, surface water from the West Fork Trinity River may be used as a future potable water supply

Notes
Quant = Quantitative

- Onsite Resident: The child and adult onsite residents may inhale contaminants that have volatilized from the plume, risen through the soil column, and accumulated in the basement of a house. Because residents of military installations do not spend both childhood and adulthood on the same facility, the age-adjusted resident will not be used to evaluate carcinogenic risks. Instead, the adult resident and child resident will be used to evaluate both cancer and non-cancer effects.

- Industrial/Commercial Worker: The onsite industrial/commercial worker may inhale contaminants that have volatilized from the plume, risen through the soil column, and accumulated in the basement of an office building or store.

- Maintenance Worker: The onsite maintenance worker may inhale contaminants that have volatilized from the plume, risen through the soil column, and accumulated in the basement of an office building. Because maintenance workers spend part of the day outside, their exposure should be bounded by the industrial/commercial workers who spend the entire work day inside. Therefore, the maintenance worker's exposure to soil gas will not be evaluated separately.

- Construction Worker: The onsite construction worker may be exposed to shallow groundwater that is encountered during excavation of pits or trenches. Because it is assumed that the construction worker will work outside, the construction worker will not be exposed to soil gas that accumulates within basements.

- Site Visitor: The site visitor may be exposed to contaminants that have volatilized from the plume, risen through the soil column, and accumulated in the basement of an office building, store or onsite residence. Because the site visitor's exposure is bounded by the exposure for the onsite worker, the site visitor will not be evaluated separately unless the onsite worker scenario results in unacceptable levels of risk.

- Recreational User: The offsite recreational user may be exposed to surface water and sediment in the West Fork Trinity River during swimming. Although unlikely, it is possible that a recreational user may catch and eat fish from the West Fork Trinity River, this exposure pathway will also be considered.

2.4.2 Future Exposure Pathway Scenarios

In addition to the exposure pathways evaluated under the current land use scenario, the future exposure pathways will include the use of the Terrace Alluvium, the Paluxy Aquifer and the West Fork Trinity River as potable water sources.

The exposure pathways associated with these scenarios are described below and summarized in Table 2.2. All of the exposure pathways described in the previous section will be included in the future use scenarios. The description of these pathways will not be repeated in this section.

- Onsite Resident (adult and child): Through the use of groundwater on the site for drinking and bathing purposes, the child and adult resident may be exposed to contaminants in the groundwater through ingestion, dermal contact and inhalation (adult only, while showering). The risk assessment will evaluate the Terrace Alluvium and Paluxy Aquifer as separate potable water sources.

- Industrial/Commercial Worker: Through the use of the site groundwater for potable water, the industrial/commercial worker may be exposed to groundwater contaminants via ingestion and dermal contact. Because it is assumed that an industrial/commercial worker would not shower while on site, inhalation of volatiles from the groundwater will not be evaluated. The risk assessment will evaluate the Terrace Alluvium and Paluxy Aquifer as separate potable water sources.

- Maintenance Worker: Through the use of the site groundwater for potable water, the maintenance worker may be exposed to groundwater contaminants via ingestion and dermal contact. It is assumed that a maintenance worker would not shower while on site. Because of the similarity in the exposure conditions, it is assumed that the maintenance worker would have the same groundwater exposure as the industrial/commercial worker.

- Construction Worker: It is assumed that the construction worker would not consume potable water from the site, but would use a water cooler set up in a construction support trailer. Therefore, the future construction worker will be exposed to groundwater in the same manner as the current construction worker.

- Site Visitor (adult): Through the use of the site groundwater for potable water, the site visitor may be exposed to groundwater contaminants via ingestion and dermal contact. It is assumed that a site visitor would not shower while on site. As noted for the current exposure pathways, the site visitor's exposure will not be quantified unless the onsite worker is exposed to unacceptable levels of risk.

- Recreational User (child and adult): The offsite recreational user will not use potable water from the site. Therefore, the offsite recreational user will not be exposed to the site groundwater. The exposure pathways for the future and current recreational user are the same.

- Offsite Resident (lifetime and child): It is conservatively assumed that an offsite, future resident may use the West Fork Trinity River as a potable water source. The resident may be exposed to contaminants through ingestion, dermal contact while bathing or showering, and inhalation of volatiles while showering. The lifetime resident will be used to assess carcinogenic risks and the child resident will be used to evaluate non-cancer hazards.

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3.0 DATA COMPILATION

Only data validated to EPA Level III using the HydroGeoLogic 2002 Quality Assurance Project Plan (HydroGeoLogic, 2002d) will be used in this risk assessment.

3.1 GROUNDWATER

Data from Paluxy Aquifer samples and from Terrace Alluvium samples will comprise separate data sets. For every RFI and Site Investigation that has been conducted at the site, all installed monitoring wells (at least three per site) were sampled on 3 occasions spaced approximately two months apart for the full set of Appendix IX constituents were required by the RCRA Hazardous Waste Permit unless a subset was agreed on by the regulators based on operational history. In addition, a subset of the Appendix IX analyte list, comprised predominantly of volatile organic compounds (VOCs), is sampled and analyzed for a quarterly basis. For this subset of analytes, the October 2001 data will be used in the risk assessment. For the remaining analytes on the Appendix IX list, the most recent data available will be used.

3.2 WEST FORK TRINITY RIVER

Surface water and sediment in the West Fork Trinity River were sampled in February 2001. The locations of these samples are shown in Figure 3.1. This figure also shows the locations of samples collected from seeps adjacent to the West Fork Trinity River. The seep data and the surface water data will be pooled to determine the surface water exposure point concentrations under the current land use scenario.

For the future exposure scenarios, the TCE concentration in the surface water will be estimated from the modeling work performed by HydroGeoLogic (HydroGeoLogic 2002b). According to TNRCC guidance, the groundwater concentration with an appropriate dilution factor should be used as the exposure point concentration in a groundwater-to-surface water discharge situation (TNRCC, 2002). Because the groundwater monitoring wells close to the West Fork Trinity River are currently non-detect for TCE, it is proposed to use the modeling results to estimate the future TCE concentration in the surface water of the West Fork Trinity River. TNRCC guidance will be used to determine an appropriate dilution factor for the future TCE groundwater concentration. For all sediment analytes and all other surface water/ seep analytes, the existing data will be used for the future exposure pathway scenarios.

3.3 SOIL GAS

As described in Section 2.3, volatile compounds may volatilize from the groundwater and move through the soil and into basements above the plume. Until recently, an EPA approved approach to estimating the risk from the basement vapors was to model the movement of the volatile compounds from the groundwater through the soil and across the basement foundation using the Johnson and Ettinger model. A recent comparison of model results to indoor air quality data indicated that the model may underestimate indoor air concentrations by more than an order of magnitude. Therefore, for this risk assessment, actual indoor air quality data will be used.

The majority of buildings in the Fort Worth area are built on a slab. Due to greater distance to the groundwater and greater air changes, vapors have less potential to accumulate with slab construction than with basement construction. There are only two buildings with basements at NAS Fort Worth JRB. The air in both of these basements will be sampled using summa canisters. In addition, two buildings located above higher groundwater TCE concentrations, will be sampled for indoor air using the summa canisters. Prior to collection of the samples, the basements will be inspected to identify any potential contaminant source inside the room, such as stored solvents. The indoor air samples will be analyzed for 1,1-DCE, TCE, *cis*-1,2-DCE, and vinyl chloride.

4.0 DATA EVALUATION

This section describes how the data will be screened to identify COPCs and how the data will be analyzed to determine the exposure point concentration for each COPC.

Data may be classified as rejected (R), qualified as estimated (J or F), or qualified below detection limits (U). Rejected data will not be used in the risk assessment. J-qualified and F-qualified data represent estimated values but will be used in the risk assessment as if they were not qualified. Often, an analyte is detected in some but not all samples for a particular environmental medium. In this situation, it is not appropriate to assume that a non-detect result is equivalent to absence of that analyte in the sample. Therefore, a proxy concentration of one half the site-specific sample quantitation limit will be used for non-detect results for analytes found in other samples in the data set. This proxy concentration will be used in the statistical analyses for determining the representative concentration and/or the exposure point concentrations.

4.1 SCREENING PROCESS

The purpose of the screening process is to identify chemicals that likely resulted from site-related activities and that pose a potential threat to human health. The screening process for the ecological risk assessment is described separately in Section 8.0 of this document.

4.1.1 Comparison to Background Concentrations

The first step is to determine which chemicals likely resulted from prior land use activities at the site. This screening process is performed only on inorganic constituents. It is assumed that any organic analytes present resulted from human, even if not necessarily site-related, activities.

A facility-wide background study was performed several years ago by Jacobs Engineering (Jacobs, 1998). The representative concentration of each inorganic analyte detected in each dataset for this risk assessment will be compared against the results of the 1998 background study to determine if the site data are consistent with the facility-wide background. If a data set contains five or fewer samples, as in the case of sediment and indoor air data, the maximum detected concentration will be the representative concentration. If a dataset contains more than five samples, as in the case of the surface water/seep data, the representative concentration will be the 95 percent (%) upper confidence limit (UCL) of the expected concentration.

Because site investigation sampling schemes are often selected to focus on areas of known contamination, the data may not be normally distributed. It may be more appropriate to assume that the data are log normally distributed. The Shapiro-Wilkes test will be used to determine whether the data are more appropriately evaluated as a normal distribution or a lognormal distribution. Based on the results of the Shapiro-Wilkes test, the 95% UCL of the normal distribution or lognormal distribution will be calculated. For a given inorganic analyte, the 95% UCL for the site data will be compared to the 95% UCL for the facility-wide background data. If the 95% UCL for the site data is greater than the background 95% UCL, that analyte will be retained for further evaluation.

The equation that will be used to calculate the 95% UCL for the lognormal distribution is:

$$UCL = e^{\bar{x} + 0.5\left(s^2\right) + sH/\sqrt{n-1}}$$

where:

UCL	=	95% UCL
e	=	constant (base of the natural log, equal to 2.718)
$\bar{x}$	=	arithmetic mean of transformed data
s	=	standard deviation of the transformed data
H	=	H-statistic (Gilbert, 1987)
n	=	number of samples

The equation that will be used to calculate the 95% UCL for the normal distribution is:

$$UCL = \bar{x} + t(s/\sqrt{n})$$

where:

UCL	=	95% UCL
$\bar{x}$	=	arithmetic mean of the untransformed data
s	=	standard deviation of the untransformed data
t	=	Student-t statistic (Gilbert, 1987)
n	=	number of samples

The statistical methods described in this section are parametric procedures and are intended for use in cases where the percentage of non-detects in a particular data set is less than 50 percent. In the event that the percentage of non-detects for a particular chemical is greater than 50 percent, non-parametric procedures will be applied as appropriate. Procedures for evaluating and applying non-parametric statistics are described in the guidance document Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Addendum to Interim Final Guidance (EPA, 1992a).

4.1.2 Comparison to Risk-Based Screening Concentrations

This next step applies to both organic and inorganic analytes. This screening process is based on the acknowledgement that, frequently, a fraction of the analytes present contribute negligibly to the overall risk associated with the site. To reduce the number of calculations that would be required if every detected analyte were carried through the risk assessment, EPA Region 6 developed risk-based screening concentrations (RBCs). The data are compared against these RBCs to identify the analytes that have the potential to contribute to an unacceptable level of risk.

The RBC screen includes the following steps:

- The maximum concentration is identified for each chemical detected in each medium.
- The maximum concentration is compared to the Region 6 Media-Specific Screening Criteria (EPA, 2000), also known as a RBC.
- If a specific chemical exceeds the RBC for that exposure medium, the chemical is retained for the risk assessment for all routes of exposure involving that medium.
- If a specific chemical does not exceed its RBC for a particular exposure medium, the chemical is eliminated from the COPC list for that medium.

In accordance with EPA guidance (EPA, 1989), the detection frequency of each analyte will be considered in the screening process. Unless an analyte is a Class A carcinogen, chemicals that are detected infrequently (i.e., in less than 5 percent of 20 or more samples) at less than five times the reporting limit will be eliminated from the COPC list. Any detected Class A carcinogens will be retained as a COPC.

In addition, surface water concentrations will be compared to TNRCC screening criteria for non-sustainable fisheries (TNRCC, 2000). This comparison will be used to determine the need for a more quantitative evaluation of this pathway.

4.2 EXPOSURE POINT CONCENTRATION

The exposure point concentration is the concentration of a COPC in an exposure medium that may be contacted by a real or hypothetical receptor. All exposure point concentrations for the current land use scenarios will be based on data. For the future land use scenarios, some of the exposure point concentrations will be estimated from groundwater modeling while the majority of the exposure point concentrations will be based on data. The sections below describe in detail how the exposure point concentrations will be determined.

4.2.1 Exposure Point Concentrations - Current Land Use Scenario

4.2.1.1 Surface Water and Sediment

For the surface water and sediment exposure pathways, the exposure point concentration will be the representative concentration calculated as described in Section 4.1.1. The seep data will be pooled with the surface water data for calculation of the exposure point concentration. This single point estimate approach will be used because the potential area of exposure is relatively small.

4.2.1.2 Groundwater

Within the Terrace Alluvium, the groundwater concentration varies by a couple of orders of magnitude across the installation. To provide a more comprehensive description of how the risk changes across the site and how much of the site is associated with a particular level of risk, single exposure point concentrations for the Terrace Alluvium groundwater will not be used. Instead, the concentrations at each of the selected wells in the Terrace Alluvium will be used as the exposure point concentrations at that location. The associated risks will be calculated and the risks across the site will be contoured as isopleths.

The Paluxy Aquifer is not a complete exposure pathway under the current land use scenario. Therefore, no exposure point concentration for the Paluxy Aquifer is required for the evaluation of risks to current receptors.

4.2.1.3 Soil Gas

Because only four indoor air samples will be collected, the maximum concentration detected will be the exposure point concentration.

4.2.2 Exposure Point Concentrations – Future Land Use Scenario

HydroGeoLogic modeled the movement of TCE in the Terrace Alluvium groundwater plume. This modeling effort is summarized in HydroGeoLogic 2002b. The purpose of the modeling was to estimate when the TCE plume would discharge into the West Fork Trinity River and the TCE concentrations at the point of discharge over time. Assuming a continuing source term, the modeling predicts that the TCE will reach the West Fork Trinity River in approximately 5 years, and the maximum concentration at the point of discharge is estimated to be 50 micrograms per liter (μg/L). The modeling also predicts that, after 5 years, the TCE plume will retreat such that the 10 μg/L contour line intersects the West Fork Trinity River. The model estimates that this concentration would remain stable for approximately 20 years.

For future exposures to surface water, it is assumed that the future receptor would begin exposure at the time the TCE plume intersects the West Fork Trinity River. The TCE concentration expected to reach the West Fork Trinity River will be combined with an appropriate dilution factor to yield the surface water exposure point concentration. The dilution factor accounts for the mixing of the groundwater seepage with the surface water flow. The expected decrease in TCE concentration with time will also be factored into the exposure point concentration. For example, if a receptor is assumed to be exposed to the surface water for 30 years, then the exposure point concentration for the first 5 years will be based on 50 μg/L of TCE in the groundwater. The exposure concentration for the next 20 years will be based on 10 μg/L of TCE in the groundwater. For all other analytes included in the future surface water exposure pathways, the exposure point concentrations will be the same as described for the current land use scenarios.

For future exposures to groundwater in the Terrace Alluvium, the contour lines predicted by the modeling results, assuming a constant source term, will be used to generate risk isopleths as described in Section 4.2.1.2. The contours associated with the 10 year timeframe will be used for the risk calculations. This timeframe represents a reasonable midpoint in the expected TCE values to occur over time across the installation. For the other analytes to be quantitatively evaluated for the groundwater exposure scenarios, the exposure point concentrations will be the same as those for the current land use exposure scenarios.

For future exposures to the Paluxy Aquifer, a representative concentration will be calculated as described in Section 4.1.1. A single point estimate will be used for the Paluxy Aquifer because, due to the limited hydraulic connection between the Paluxy Aquifer and the Terrace Alluvium, it is unlikely that concentrations within the Paluxy Aquifer will vary substantially across the installation.

The exposure point concentrations for the soil gas and sediment exposure pathways will be the same as described for the current land use scenarios.

734 40

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5.0 HUMAN INTAKE ASSUMPTIONS AND EXPOSURE QUANTIFICATION

This section describes methods that will be used to estimate contaminant intake by each receptor through each exposure pathway identified in Section 2. For each scenario, the exposure parameters will be selected to estimate the reasonable maximal exposure (RME) expected to occur at the site (EPA, 1989). If the RME concentration is determined to be below the appropriate threshold, then it is likely that all other lesser exposure concentrations at the site will also be below levels of concern. Exposure parameters that will be used to estimate the RME are provided in Table 5.1 for groundwater, Table 5.2 soil gas exposure pathways, Table 5.3 for surface water exposure pathways, Table 5.4 for exposure to sediment, and Table 5.5 for ingestion of fish caught in the West Fork Trinity River.

5.1 GROUNDWATER AND SURFACE WATER INGESTION

It is assumed that future onsite and offsite residents may use either the groundwater in the Terrace Alluvium and Paluxy Aquifer or the surface water in the West Fork Trinity River as a potable water source. A receptor can ingest water by drinking it or through using household water for cooking. An estimate of intake from ingesting water is calculated as follows (EPA, 1989):

$$I_w = \frac{C_w \cdot IR \cdot FI \cdot ED \cdot EF}{BW \cdot AT}$$

where:

I_w	=	intake of contaminant from drinking water (mg/kg/day)
C_w	=	concentration of contaminant in water (mg/L)
IR	=	ingestion rate (L/day)
FI	=	fraction ingested from contaminated source (unitless)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time (days); for noncarcinogens, AT equals [(ED)(365 days/ year)]; for chemical carcinogens, AT equals [(70 years)(365 days/year)]

5.2 DERMAL CONTACT WITH WATER

Residents may take in COPCs via dermal contact through bathing and showering. Recreational users of the West Fork Trinity River may absorb COPCs while wading. Construction workers may be dermally exposed to COPCs in groundwater while working in excavation pits that intersect the groundwater table. The amount of a chemical taken into the body upon exposure

Table 5.1
Exposure Parameters, Groundwater Pathway

Exposure Parameters	Adult Resident	Child Resident	Industrial Worker	Site Visitor	Construction Worker
Ingestion of Groundwater					
IR (L/day)	2 [a]	1 [b]	2 [a]	2 [a]	--
FI (unitless)	1	1	0.5 [c]	0.5 [c]	--
EF (days/year)	350 [d]	350 [d]	250 [d]	10 [c]	--
ED (years)	9 [b,c]	6 [d]	25 [d]	5 [c]	--
BW (kg)	70 [d]	15 [d]	70 [d]	70 [d]	--
AT-Noncancer (days)	3,285 [a]	2,190 [a]	9,125 [a]	1,825 [a]	--
AT - cancer (days)	25,550 [a]	25,550 [a]	25,550 [a]	25,550 [a]	--
Inhalation of Volatiles					
IR (m3/day)	15 [b]	8.3 [b]	--	--	13 [b,c]
EF (days/year)	350 [d]	350 [d]	--	--	40 [c]
ED (years)	9 [b,c]	6 [d]	--	--	1 [c]
OF	0.68 [b]	0.68 [b]	--	--	NA
BW (kg)	70 [d]	15 [d]	--	--	70 [d]
AT-Noncancer (days)	3,285 [a]	2,190 [a]	--	--	365 [a]
AT - cancer (days)	25,550 [a]	25,550 [a]	--	--	25,550 [a]
Dermal Contact					
SA (cm2)	20,000 [b]	6,500 [b]	840 [b]	840 [b]	2,000 [b]
EF (days/year)	350 [d]	350 [d]	250 [d]	10 [c]	40 [c]
ED (years)	9 [b,c]	6 [d]	25 [d]	5 [c]	1 [c]
BW (kg)	70 [d]	15 [d]	70 [d]	70 [d]	70 [d]
AT-Noncancer (days)	3,285 [a]	2,190 [a]	9,125 [a]	1,825 [a]	365 [a]
AT - cancer (days)	25,550 [a]	25,550 [a]	25,550 [a]	25,550 [a]	25,550 [a]
Kp (cm/hour)	chemical specific value [e]	chemical specific value [e]	chemical specific value [e]	chemical specific value [e]	chemical specific value [e]
B (unitless)	chemical specific value [e]	chemical specific value [e]	chemical specific value [e]	chemical specific value [e]	chemical specific value [e]
ET (hours)	0.2 [b]	0.3 [b]	0.1 [c]	0.1 [c]	4 [c]
t* (hours)	chemical specific value [e]	chemical specific value [e]	chemical specific value [e]	chemical specific value [e]	chemical specific value [e]

[a] = Risk Assessment Guidance for Superfund, Volume 1 Human Health Evaluation Manual (Part A), EPA/540/1-89/002, December 1989

[b] = Exposure Factors Handbook, EPA/600/P-95/002Fa, 1997a.

[c] = Best Professional Judgment

It is assumed that the industrial worker and site visitor would consume half of the default daily intake for drinking water while on site.

It is assumed that a site visitor would spend ten days, or two business weeks, on site for a given year.

This ED represents the 50th percentile of exposure duration for a resident. Because individuals in the military tend to be moved to different facilities every 3 to 4 years, use of the 50th percentile resident exposure duration is adequately conservative to ensure protection of health for an adult, onsite, resident receptor.

It is assumed that a site visitor would visit NAS Fort Worth JRB over the course of five years.

This rate was calculated by multiplying the upper percentile hourly inhalation rate for outdoor workers by the number of hours the construction worker is expected to be in a trench or excavation each day (4 hours).

It is assumed that a construction job at NAS Fort Worth JRB would not involve more than 8 weeks of excavation.

It is assumed that a construction job at NAS Fort Worth JRB would not be longer than one year.

It is assumed that the length of time the industrial worker and site visitor would wash hands while on site is half of the standard shower duration.

It is assumed that a construction worker would spend half of each work day, 4 hours, in a trench or excavation.

[d] = Risk Assessment Guidance for Superfund, Volume 1 Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03, 1991c.

[e] = Dermal Exposure Assessment: Principles and Applications, Interim Report, EPA/60/8-91/011B, January 1992b.

Table 5.2
Exposure Parameters, Soil Gas Pathway

Exposure Parameters	Adult Resident	Child Resident	Industrial Worker	Site Visitor
Inhalation				
IR (m3/day)	15[a]	8.3[a]	8[a]	8[a]
EF (days/year)	350[b]	350[b]	250[b]	10[c]
ED (years)	9[a,c]	6[b]	25[b]	5[c]
OF	0.68[a]	0.68[a]	NA	NA
BW (kg)	70[b]	15[b]	70[b]	70[b]
AT-Noncancer (days)	3,285[d]	2,190[d]	9,125[d]	1,825[d]
AT – cancer (days)	25,550[d]	25,550[d]	25,550[d]	25,550[d]

[a] = Exposure Factors Handbook, EPA/600/P-95/002Fa, 1997a.
The industrial worker and site visitor inhalation rates were calculated by multiplying the average hourly inhalation rate for an adult at light activity by the number of hours in the work day.

[b] = Risk Assessment Guidance for Superfund, Volume 1 Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03, 1991c.

[c] = Best Professional Judgment
It is assumed that a site visitor would spend ten days, or two business weeks, on site for a given year.
This ED represents the 50[th] percentile of exposure duration for a resident. Because individuals in the military tend to be moved to different facilities every 3 to 4 years, use of the 50[th] percentile resident exposure duration is adequately conservative to ensure protection of health for an adult, onsite, resident receptor.
It is assumed that a site visitor would visit NAS Fort Worth JRB over the course of five years.

[d] = Risk Assessment Guidance for Superfund, Volume 1 Human Health Evaluation Manual (Part A), EPA/540/1-89/002, December 1989.

Table 5.3
Exposure Parameters, Surface Water Pathway

Parameter	Age-Adjusted Resident[a]	Child Resident	Adult Recreational User	Child Recreational User
Ingestion				
IR (L/day)	1.8[b]	1[b]	0.05[b]	0.05[b]
FI (unitless)	1	1	1	1
EF (days/year)	350[c]	350[c]	12[d]	12[d]
ED (years)	30[d]	6[c]	10[e]	6[e]
BW (kg)	59[c]	15[c]	70[c]	15[c]
AT-Noncancer (days)	--	2,190[b]	3,650[b]	2,190[b]
AT - cancer (days)	25,550[b]	--	25,550[b]	25,550[b]
Inhalation of Volatiles				
IR (m3/day)	14[d]	8.3[d]	--	--
EF (days/year)	350[c]	350[c]	--	--
ED (years)	30[d]	6[c]	--	--
OF	0.68[d]	0.68[d]		
BW (kg)	59[c]	15[c]	--	--
AT-Noncancer (days)	--	2,190[b]	--	--
AT - cancer (days)	25,550[b]	--	--	--
Dermal Contact				
SA (cm2)	20,000[d]	6,500[d]	6,200[d]	3,500[d]
EF (days/year)	350[c]	350[c]	12[d]	12[d]
ED (years)	30[d]	6[c]	10[e]	6[e]
BW (kg)	59[c]	15[c]	70[c]	15[c]
AT-Noncancer (days)	--	2,190[b]	3,650[b]	2,190[b]
AT - cancer (days)	25,550[b]	--	25,550[b]	25,550[b]
Kp (cm/hour)	chemical specific value[f]	chemical specific value[f]	chemical specific value[f]	chemical specific value[f]
B (unitless)	chemical specific value[f]	chemical specific value[f]	chemical specific value[f]	chemical specific value[f]
ET (hours)	0.2[d]	0.3[d]	1[d]	1[d]
t* (hours)	chemical specific value[f]	chemical specific value[f]	chemical specific value[f]	chemical specific value[f]

[a] = The age-adjusted resident is used to assess carcinogenic risk, while the child resident is used to assess non-cancer hazard. The intake rate values for the age-adjusted resident are calculated by performing a weighted average of the adult contribution (24 years) and the child contribution (6 years).

[b] = Risk Assessment Guidance for Superfund, Volume 1 Human Health Evaluation Manual (Part A), EPA/540/1-89/002, December 1989.

[c] = Risk Assessment Guidance for Superfund, Volume 1 Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285 6-03, 1991c.

[d] = Exposure Factors Handbook, EPA/600/P-95/002Fa, 1997a
The skin surface area is the hands, feet, lower legs and forearms for the adult recreational user, and hands, feet, arms and legs for the child recreational user.
The exposure frequency for the recreational user is the recommended exposure frequency for swimming.
The exposure time for the recreational user is the recommended exposure time for swimming

[e] = Best Professional Judgment
It is assumed that the adult recreational user would visit the West Fork Trinity River for 10 years, and the child exposure duration would be 6 years.

[f] = Dermal Exposure Assessment: Principles and Applications, Interim Report, EPA/60/8-91/011B, January 1992b.

Table 5.4
Exposure Parameters, Sediment Pathway

Parameter	Adult Recreational User	Child Recreational User
Ingestion		
IR (mg/day)	5[a]	10[a]
FI (unitless)	1	1
EF (days/year)	12[a]	12[a]
ED (years)	10[b]	6[b]
BW (kg)	70[c]	15[c]
AT-Noncancer (days)	3,650[d]	2,190[d]
AT – cancer (days)	25,550[d]	25,550[d]
Dermal Contact		
SA (cm^2)	6,200[a]	3,500[a]
SSAF (mg/cm^2)	0.31[a]	22[a]
Dabs (unitless)	chemical specific value[e]	chemical specific value[e]
EF (days/year)	12[a]	12[a]
ED (years)	10[b]	6[b]
BW (kg)	70[c]	15[c]
AT-Noncancer (days)	3,650[d]	2,190[d]
AT – cancer (days)	25,550[d]	25,550[d]

[a] = Exposure Factors Handbook, EPA/600/P-95/002Fa, 1997a. It is assumed that the sediment ingestion rate is one tenth of the mean soil ingestion rate.
The exposure frequency for the recreational user is the recommended exposure frequency for swimming.
The skin surface area is the hands, feet, lower legs and forearms for the adult, and hands, feet, arms and legs for the child.
The soil-to-skin adherence factor for adults is based on reed gatherers, and for children is based on kids-in-mud-no.2. The specific adherence factors for each portion of the anatomy included in the surface area were combined as a weighted average to yield an overall adherence factor.

[b] = Best Professional Judgment. It is assumed that the adult recreational user would visit the West Fork Trinity River for 10 years, and the child exposure duration would be 6 years.

[c] = Risk Assessment Guidance for Superfund, Volume 1 Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03, 1991c.

[d] = Risk Assessment Guidance for Superfund, Volume 1 Human Health Evaluation Manual (Part A), EPA/540/1-89/002, December 1989.

[e] = Dermal Exposure Assessment: Principles and Applications, Interim Report, EPA/60/8-91/011B, January 1992b.

Table 5.5
Exposure Parameters, Fish Ingestion

Parameter	Adult Recreational Fisher
IR_{fish} (g/day)	25[a]
EF (days/year)	12[b]
ED (years)	10[b]
BW (kg)	70[c]
AT-Noncancer (days)	3,650[d]
AT - cancer (days)	25,550[d]

[a] = Exposure Factors Handbook, EPA/600/P-95/002Fa, 1997a. Value is for recreational freshwater anglers.
[b] = same value as used for the adult recreational user, since it is assumed that the adult recreational user will also catch and consume fish from the West Fork Trinity River.
[c] = Risk Assessment Guidance for Superfund, Volume 1 Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03, 1991c.
[d] = Risk Assessment Guidance for Superfund, Volume 1 Human Health Evaluation Manual (Part A), EPA/540/1-89/002, December 1989.

via dermal contact is referred to as an absorbed dose. In accordance with guidance provided by EPA (1989, 1991b, and 1992b), the absorbed dose is calculated using the following equation:

$$I_w = \frac{D_{event} \cdot SA \cdot EF \cdot ED}{BW \cdot AT}$$

where:

I_w	=	intake through skin from showering or wading (mg/kg/day)
D_{event}	=	absorbed dose per event (mg/cm^2-event)
SA	=	skin surface area (cm^2)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time (days); for noncarcinogens, AT equals [(ED) (365 days/ year)]; for chemical carcinogens, AT equals [(70 years) (365 days/year)]

For organic compounds, D_{event} can be calculated as:

$$D_{event} = (C_w)(2)(K_p)(CF)[(6)(\tau)(ET)/\pi]^{+0.5} \text{ if } ET < t^*,$$

or

$$D_{event} = (C_w)(K_p)(CF)[(ET) + (2)(\tau)(1+3B)]/(1+B) \text{ if } ET > t^*$$

where:

C_w	=	concentration of constituent in water (mg/L)
K_p	=	chemical specific permeability constant (cm/hour)
τ	=	chemical specific lag time (hour)
B	=	chemical specific partitioning coefficient (unitless)
ET	=	exposure time (hours)
π	=	Pi (3.14)
t^*	=	time to equilibrium conditions (hours), chemical specific
CF	=	conversion factor (0.001 L/cm^3)

The chemical specific parameters will be obtained from Table 5-8 of Dermal Exposure Assessment: Principles and Applications (USEPA, 1992b). If the values are not available in this table, they will be calculated in accordance with the referenced guidance document.

For inorganic compounds, it is recommended that D_{event} be estimated using the following steady-state model (USEPA, 1992b):

$$D_{event} = (C_w)(K_p)(ET)$$

with the parameters as previously defined. Unless a chemical specific value for an inorganic compound is available, a default value for the K_p of 0.001 cm/hour will be used (USEPA 1992b).

5.3 INHALATION OF VOLATILES RELEASED FROM POTABLE WATER

If the potable water source contains volatile COPCs, then the intake by the resident from inhalation of the volatilized compounds from showering and other household uses of water will be evaluated using the Andelman model (EPA, 1991a):

$$I_w = \frac{(C_w)(K)(IR_i)(EF)(ED)(OF)}{(BW)(AT)}$$

where:

I_w	=	intake of volatile in water from inhalation (mg/kg/day)
C_w	=	concentration of contaminant in water (mg/L)
K	=	volatilization factor (0.5 L/m^3)
IR_i	=	inhalation rate (m^3/day)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
OF	=	occupancy factor (unitless)
BW	=	body weight (kg)
AT	=	averaging time (days); for noncarcinogens, AT equals [(ED) (365 days/ year)]; for chemical carcinogens, AT equals [(70 years) (365 days/year)]

This exposure pathway will only be evaluated for organic chemicals with a Henry's Law constant greater than 1 x 10^{-5} and with a molecular weight of 200 g /mole or less (EPA, 1991a). The occupancy factor accounts for the fact that the resident does not spend the entire day, on average, in the house. Because the inhalation rate is the daily rate, the occupancy factor reduces this rate by the fraction of time spent inside the house.

5.4 INHALATION OF VOLATILES IN AN EXCAVATION

In order to estimate the intake by a construction worker through the inhalation of contaminants volatilized from the groundwater during excavation activities, the Construction Trench model developed by Virginia Department of Environmental Quality will be used (VDEQ, 2002). This model relies on mass transfer coefficients to estimate the transport of volatile COPCs from the groundwater into a trench. For the purposes of this risk assessment, it is assumed that the trench will intersect the groundwater and that there will be no contribution from the soil.

After estimating the airborne concentration in the construction trench, the following equation will be used to estimate COPC intake by the construction worker:

$$I_a = (C_a)(IR_i)(EF)(ED)/[(BW)(AT)]$$

where:

I_a	=	intake of volatile in the trench from inhalation (mg/kg/day)
C_a	=	concentration of contaminant in air (mg/m^3)
IR_i	=	inhalation rate (m^3/day)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time (days); for noncarcinogens, AT equals [(ED) (365 days/ year)]; for chemical carcinogens, AT equals [(70 years) (365 days/year)]

5.5 INHALATION OF INDOOR AIR

The following equation will be used to estimate intake from the inhalation of COPCs in indoor air:

$$I_a = (C_a)(IR_i)(EF)(ED)(OF)/[(BW)(AT)]$$

where:

I_a	=	intake of volatile in the basement from inhalation (mg/kg/day)
C_a	=	concentration of contaminant in air (mg/m^3)
IR_i	=	inhalation rate (m^3/day)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
OF	=	Indoor occupancy factor (residents only)
BW	=	body weight (kg)
AT	=	averaging time (days); for noncarcinogens, AT equals [(ED) (365 days/ year)]; for chemical carcinogens, AT equals [(70 years) (365 days/year)]

The occupancy factor accounts for the fact that the resident does not spend the entire day, on average, in the house. Because the inhalation rate is the daily rate, the occupancy factor reduces this rate by the fraction of time spent inside the house. The fact that industrial workers do not spend the entire day in the office is accounted for in the determination of their inhalation rate.

5.6 INGESTION OF SEDIMENT

The estimation of intake of contaminants in sediment is determined using the concentration in sediment at the location of interest.

$$I_s = \frac{C_s \cdot IR \cdot CF \cdot FI \cdot EF \cdot ED}{BW \cdot AT}$$

where:

I_s	=	intake from sediment (mg/kg-day)
C_s	=	concentration of contaminant in sediment (mg/kg)
IR	=	ingestion rate (g/day)
CF	=	conversion factor (10^{-3} kg/g)
FI	=	fraction ingested from contaminated source (unitless)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time (days); for noncarcinogens, AT equals [(ED) (365 days/year)]; for chemical carcinogens, AT equals [(70 years) (365 days/year)]

5.7 DERMAL CONTACT WITH SEDIMENT

The estimation of intake of organic contaminants in sediment via absorption through the skin is determined using the concentration in sediment at the location evaluated (EPA, 1991b).

$$AB_s = \frac{C_s \cdot CF \cdot SA \cdot AF \cdot ABS \cdot EF \cdot ET \cdot ED}{BW \cdot AT \cdot TC}$$

where:

AB_s	=	amount of constituent absorbed during contact with sediment (mg/kg-day)
C_s	=	concentration of constituent in sediment (mg/kg)
SA	=	skin surface area available for contact (cm^2/event)
AF	=	skin adherence factor (mg/cm^2)
ABS	=	absorption factor (unitless), chemical specific
CF	=	conversion factor (10^{-6} kg/mg)
EF	=	exposure frequency (events/year)
ET	=	event time (hours/day)
TC	=	time conversion (24 hours/day)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time (days); for noncarcinogens, AT equals [(ED) (365 days/year)]; for chemical carcinogens, AT equals [(70 years) (365 days/year)]

5.8 INGESTION OF FISH

If the screening indicates that the ingestion of fish caught from the West Fork Trinity River pose a threat to human health, a chemical specific bioconcentration factor (BCF) will be used to estimate the COPC concentration in the fish tissue. If a BCF derived from experimental data cannot be found for a given COPC, the BCF will be estimated based on the octanol/water partition coefficient of the COPC. This latter equation will be obtained from a review of the available literature. Then, the intake of COPC from consumption of the fish will be calculated as follows:

$$I_{fish} = (C_{fish})(IR_{fish})(CF)(EF)(ED)/[(BW)(AT)]$$

where:

I_{fish}	=	intake from fish (mg/kg-day)
C_{fish}	=	concentration of contaminant in fish tissue (mg/kg)
CF	=	conversion factor (kg/0.001 g)
IR_{fish}	=	ingestion rate of fish (g/day)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time (days); for noncarcinogens, AT equals [(ED) (365 days/year)]; for chemical carcinogens, AT equals [(70 years) (365 days/year)]

734 52

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6.0 TOXICITY ASSESSMENT

The toxicity assessment presents the toxicity values that will be used to generate estimates of potential health risks associated with chemical exposure. In addition, the specific organs on which non-cancer hazards may act will be identified. Depending on the chemical and the amount of toxicological data available, a COPC may be characterized by a reference dose (RfD) and/or a cancer slope factor (CSF). The RfD quantifies the threshold value below which a dose of a given chemical is expected to exert no observable effect. The RfD is used in the estimation of non-cancer hazards, the evaluation of which is based on the assumption that there is a level of chemical intake that will result in no toxic effect. For carcinogens, the CSF is a measure of a given chemical's potency with respect to cancer induction.

EPA's Integrated Risk Information System (IRIS) and Health Effects Assessment Summary Tables (HEAST) databases, and National Center for Environmental Assessment (NCEA) publications will be searched for toxicity values of the COPCs. If information is not available from these sources, toxicity values from the EPA Region 6 Media-Specific Screening Criteria tables will be used. If information is not available from any of the preceding sources, EPA Region 6 risk assessors will be consulted.

Oral toxicity values will be adjusted from administered to absorbed doses for evaluating dermal exposure. If no chemical specific factors are available, default values of 80% for VOCs and 20% for metals will be used.

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7.0 RISK CHARACTERIZATION

The purpose of the risk characterization step is to integrate the exposure and toxicity assessments to generate quantitative expressions of cancer risk and noncancer hazard. The risk characterization is performed in accordance with EPA risk assessment guidelines (EPA, 1989). To characterize potential noncarcinogenic effects, comparisons are made between projected intakes of chemicals and toxicity values. To characterize potential carcinogenic effects, probabilities that an individual will develop cancer over a lifetime of exposure are estimated from projected intakes and chemical-specific dose-response information.

Risk characterization serves as the bridge between risk assessment and risk management and is, therefore, a key step in the ultimate site decision-making process. This step summarizes risk assessment information for the risk manager to consider with other factors important for decision-making such as economics, technical feasibility, and regulatory context. The following sections provide separate discussions for carcinogenic and noncarcinogenic effects because the methodology differs for these two modes of chemical toxicity. In addition to providing methods for calculating risk estimates, this section provides information for the interpretation of results with regard to the uncertainty associated with the estimates (EPA, 1989).

7.1 CARCINOGENIC RISK ESTIMATES

Cancer risk will be compared to a target risk range of $1x10^{-6}$ to $1x10^{-4}$. Total cancer risk from all exposures can be summed:

$$Total\ Cancer\ Risk = \Sigma\ Cancer\ Risk_i$$

where:

Total Cancer Risk	=	Total lifetime cancer risk from exposures to all chemicals (unitless)
Cancer $Risk_i$	=	Lifetime cancer risk from exposures to chemical contaminant *i* (*i*=1...n) (unitless)

Cancer risk from exposures to chemical contaminants can be estimated using the equation:

$$Cancer\ Risk_i = I_i^* \ CSF_i$$

where:

Cancer $Risk_i$	=	lifetime cancer risk (unitless) from chemical contaminant *i* (*i*=1...n)
I_i	=	total daily intake of contaminant *i* (*i*=1...n) from indirect exposures (mg/kg/day)

CSF_i	=	cancer slope factor ([mg/kg/day]$^{-1}$) for chemical contaminant i (i=1...n)

7.2 NONCANCER HAZARD ESTIMATES

The hazard index (HI) will be used to evaluate noncancer risk for any given target organ. The target HI is 1. The Hazard Quotient (HQ) is used to evaluate noncancer toxicity of individual chemical contaminants. The HQ represents the ratio of the dose received by the exposed individual to the dose that is associated with no adverse effects, i.e. the threshold or RfD. HQs that affect the same target organ (i.e., liver, kidney, etc.) are summed to obtain a HI for an individual target organ. The HI can be estimated using the equation:

$$HI = \Sigma HQ_i$$

where:

HI	=	hazard index (unitless)
HQ_i	=	hazard quotient for chemical i (i=1...n) (unitless)

The HQ for exposures to chemical contaminants which have noncancer health effects can be estimated using the equation below:

$$HQ_i = \frac{I_i}{RfD_i}$$

where:

HQ_i	=	hazard quotient for chemical i (i=1...n) (unitless)
I_i	=	total daily intake from exposures to chemical contaminant i (i=1...n) (mg/kg/day)
RfD_i	=	reference dose for chemical i (i=1...n) (mg/kg/day)

7.3 DEVELOPMENT OF RISK MAPS

In order to generate risk maps (i.e., risk isopleth maps), it is necessary to calculate an estimate of risk for every location on the site map. This can be accomplished by calculating a unit risk value (risk per mg/L) for each COPC and multiplying that value by every concentration value at each point in a concentration plume map for the same COPC. These risk estimates will be contoured in the same manner as the concentration contours. A similar procedure will be followed for noncarcinogens using unit HI values.

Carcinogenic risk and non-cancer hazard isopleth maps will be created for:

1) Exposure to groundwater by a construction worker (current and future); and

2) Exposure to the Terrace Alluvium groundwater by future onsite adult and child residents, and onsite workers.

For each exposure pathway, maps will be developed to show the results for the COPCs that contribute the most to the health risk and to show the sum of carcinogenic risk and non-cancer hazards for all COPCs evaluated within that pathway.

7.4 UNCERTAINTY ASSESSMENT

Calculated risk estimates are subject to varying degrees of uncertainty from a variety of sources. Areas of uncertainty in a risk assessment can be categorized as: 1) generic or methodological, and 2) site-specific. Methodological uncertainties are those that are inherent to the methods or procedures used for risk assessments, that is, policy decisions made to reflect the EPA's desire to error on the side of conservatism. Site-specific areas of uncertainty are those characteristics of the site or the investigation of the site that could result in over- or underestimates of risk. The assessment of uncertainty will be qualitative. The most significant sources of uncertainty in the risk assessment will be itemized and qualitatively evaluated for their potential to contribute to either the over- or underestimation of risk.

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8.0 ECOLOGICAL RISK ASSESSMENT

A quantitative assessment of potential ecological risks associated with COPCs in the surface water and sediment will be performed as part of risk assessment. The State of Texas has recently published ecological risk assessment guidance (TNRCC, 2000). This guidance applies to sites regulated within the TNRCC Remediation Division. Although this site is regulated under CERCLA, the TNRCC guidance will be used as the primary guidance document for the ERA because this guidance mirrors the EPA's Ecological Risk Assessment Guidance for Superfund (EPA, 1997b).

The TNRCC ERA methodology is a tiered approach to assessing ecological risk. Tier 1 is an exclusion criteria checklist. If the site does not meet the exclusion criteria, a Tier 2, screening-level ERA, will be conducted. The Tier 2 assessment will include:

1) A comparison of detected constituent concentrations for non-bioaccumulative COPCs to established ecological benchmarks.

2) The identification of communities and major feeding guilds and their representative species which are supported by habitats at the site.

3) The development of a conceptual model that depicts the movement of COPCs through media to communities and the feeding guides.

4) A discussion of COPC fate and transport and toxicological profiles.

5) The preparation of a list of input data which includes values from the literature (e.g., exposure factors, intake equations, no-observed-adverse-effect-level (NOAEL) and lowest-observed-adverse-effect-level (LOAEL) values references) and reasonably conservative exposure assumptions, and the calculation of the total exposure to selected ecological receptors from each COPC not eliminated according to item number 1.

6) The utilization of an ecological hazard quotient methodology to compare exposures to NOAELs in order to eliminate COPCs that pose no unacceptable risk (i.e., NOAEL hazard quotient less than 1). If all COPCs are eliminated at this point, the ecological risk assessment process ends. Otherwise, the process continues.

7) The utilization of less conservative assumptions for exposure for re-calculating the hazard quotients. If all COPCs are eliminated at this point, the ecological risk assessment process ends. Otherwise, the process continues.

8) The development of an uncertainty analysis that discusses the major areas of uncertainty associated with the screening level ecological risk assessment. If all COPCs are eliminated at this point, the ecological risk assessment process ends. Otherwise, the process continues.

9) The calculation of medium-specific protective concentration levels (PCLs) bounded by NOAELs and LOAELs for those COPCs which are not eliminated as a result of the hazard quotient exercises or the uncertainty analysis.

10) Development of recommendations for managing ecological risk at the site based on final PCLs. Recommendations can also be made for proceeding with a Tier 3 evaluation.

Due to similarity in site conditions, if a Tier 2 screening level ERA is required, it will be performed in the same manner as the ERA for the Southern Lobe TCE Plume (HydroGeoLogic, 2001a). The same ecological receptors, including the bald eagle added to the Southern Lobe TCE Plume ERA as a result of TNRCC comments, will be evaluated if required. In addition, the same intake equations and parameter values will also be used.

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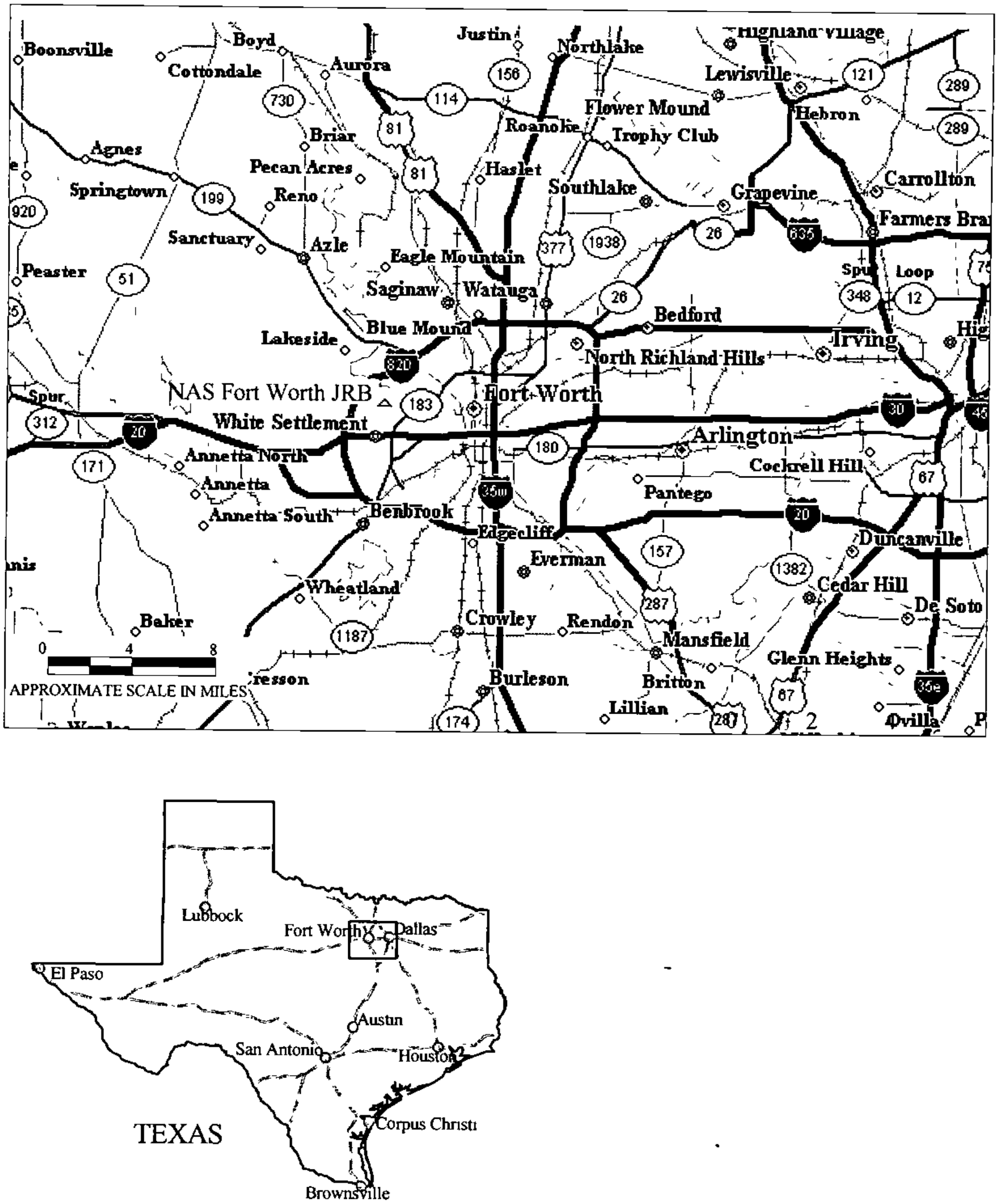

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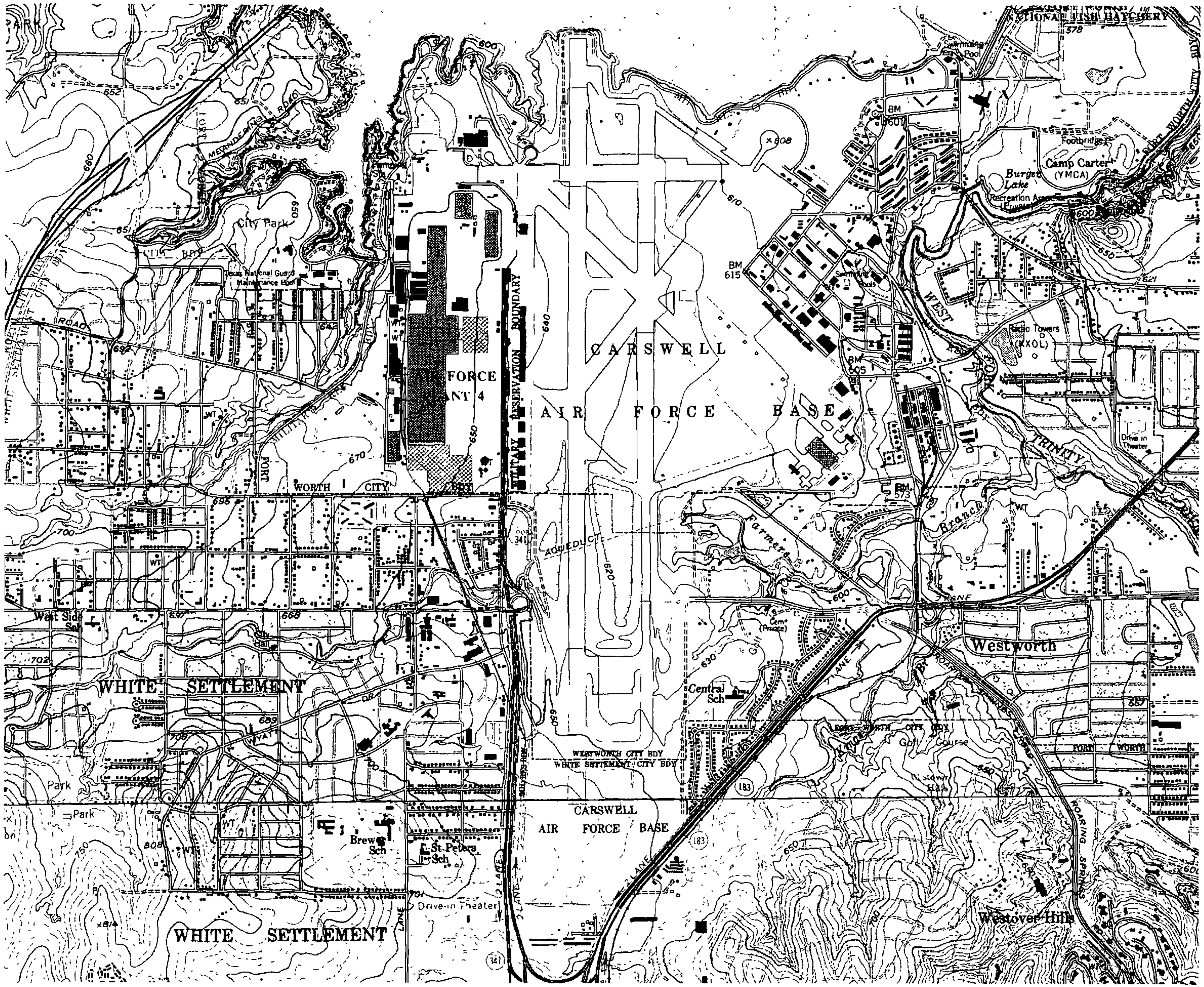
Figure 1.1

Site Location Map
NAS Fort Worth JRB, Texas



HydroGeoLogic, Inc
RAAD Northern and Central Lobes of the TCE Plume
NAS Fort Worth JRB, Texas

Figure 1.2

NAS Fort Worth JRB
Regional Topographic Map

U.S. Air Force Center for Environmental Excellence

Legend

Site Location

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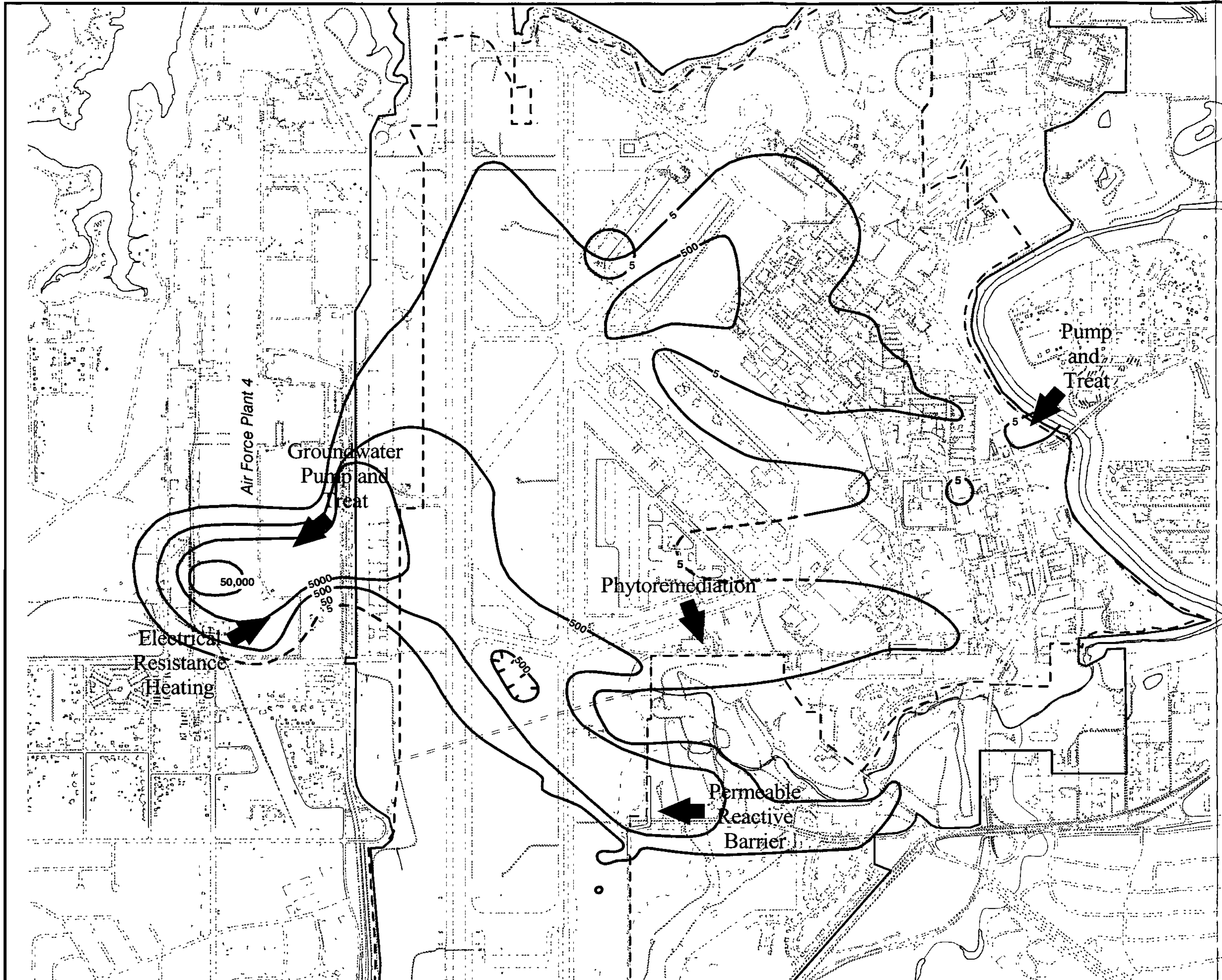

HydroGeoLogic, Inc
RAAD Northern and Central Lobes of the TCE Plume
NAS Fort Worth JRB, Texas

Figure 1.3
Current Remediation Strategy
Air Force Plant 4 and the
NAS Fort Worth JRB

U.S. Air Force Center for
Environmental Excellence

Legend

- NAS Fort Worth JRB (Carswell Field)
- Former Carswell Air Force Base
- 50 TCE Concentration Contour (μg/L)
- 5 Benzene Concentration Contour (μg/L)

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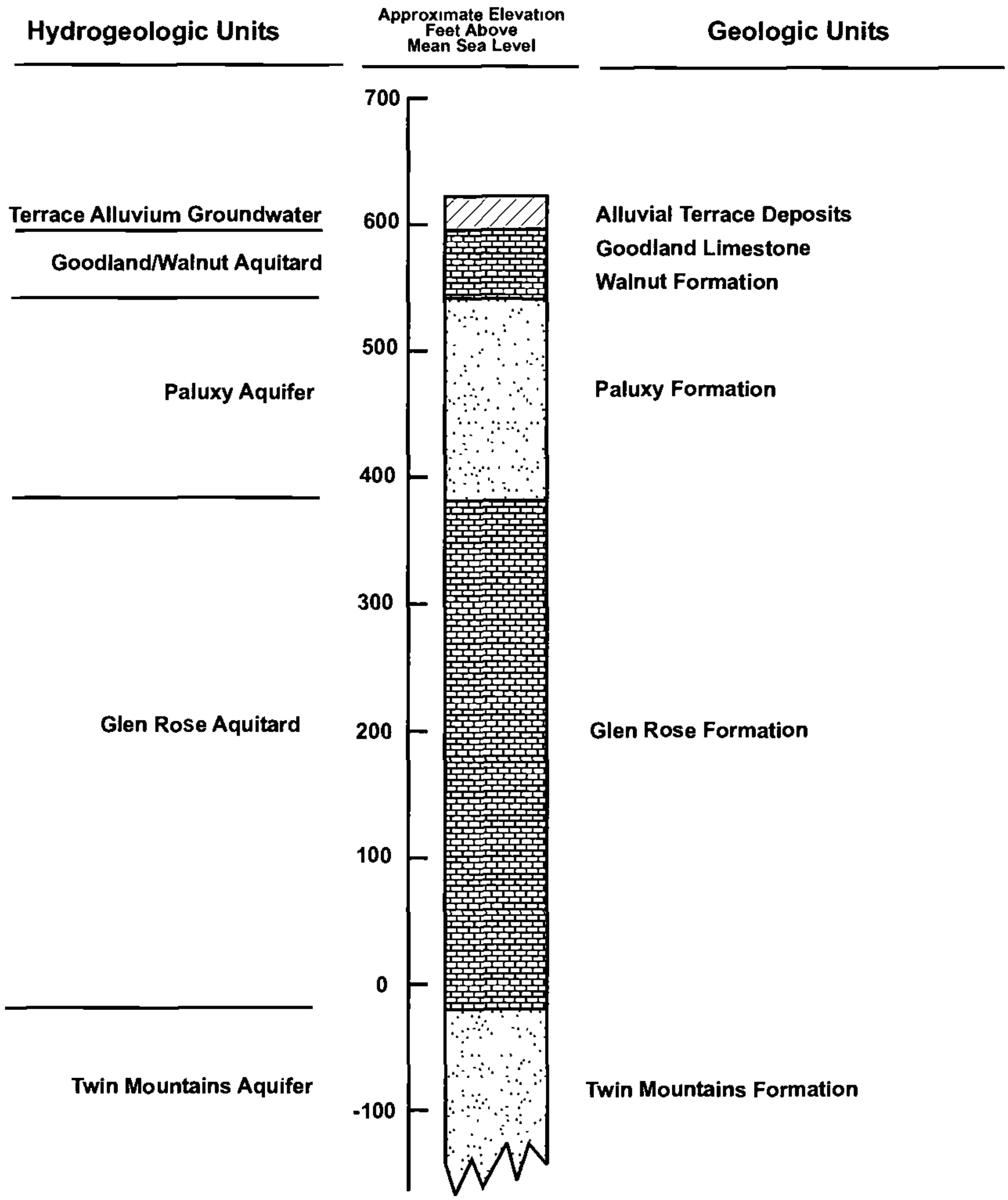

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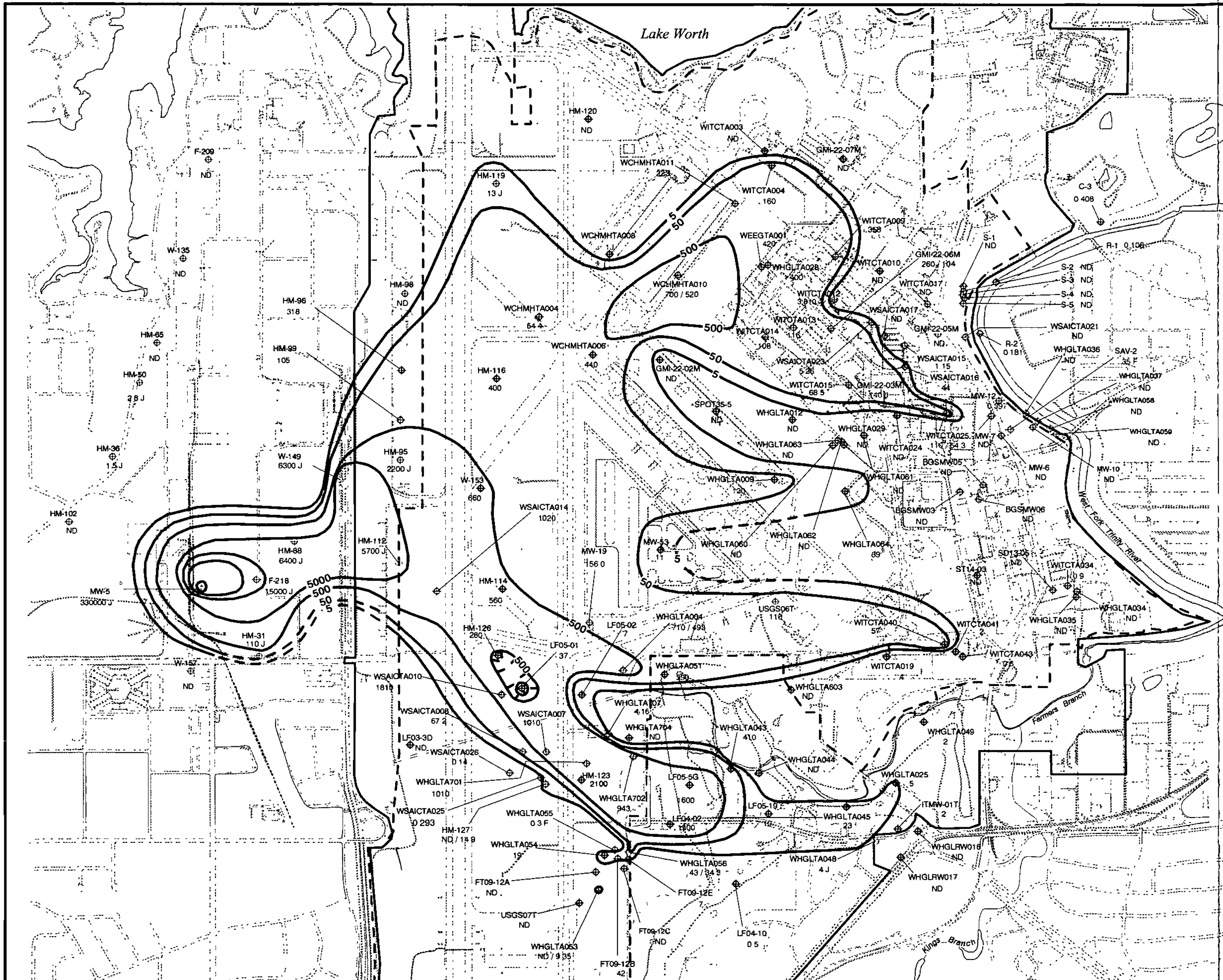
Map Source Radian, 1989

Figure 2.1
Stratigraphic Column
Correlating Hydrogeologic Units
and Geologic Units



HydroGeoLogic, Inc
RAAD Northern and Central Lobes of the TCE Plume
NAS Fort Worth JRB, Texas

Figure 2.2
TCE Concentrations
Terrace Alluvium
April 2002

U.S. Air Force Center for Environmental Excellence

Legend

- NAS Fort Worth JRB (Carswell Field)
- Former Carswell Air Force Base
- 50 — TCE Concentration Contour (µg/L)
- Permeable Reactive Barrier Location
- LF05-01 / 34 — NAS Fort Worth JRB Basewide Sampling Well / TCE Concentration (µg/L)
- BGSMW03 / ND — Monitoring well data collected as part of other investigations during October - November 2001* / TCE Concentration (µg/L)
- HM-119 / 13J — AFP 4 Semi-Annual Monitoring Well / TCE Concentration (µg/L)
- HM-119 / 0 181 — SAIC Monitoring Well / TCE Concentration (µg/L)

Note * Not validated data

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

F = The analyte was positively identified, but the associated value is below the PQL

J = The analyte was positively identified, but the quantitation is an estimation

ND / 9.36 TCE Concentrations (µg/L) sampled by HGL and SAIC on different occasions HGL / SAIC

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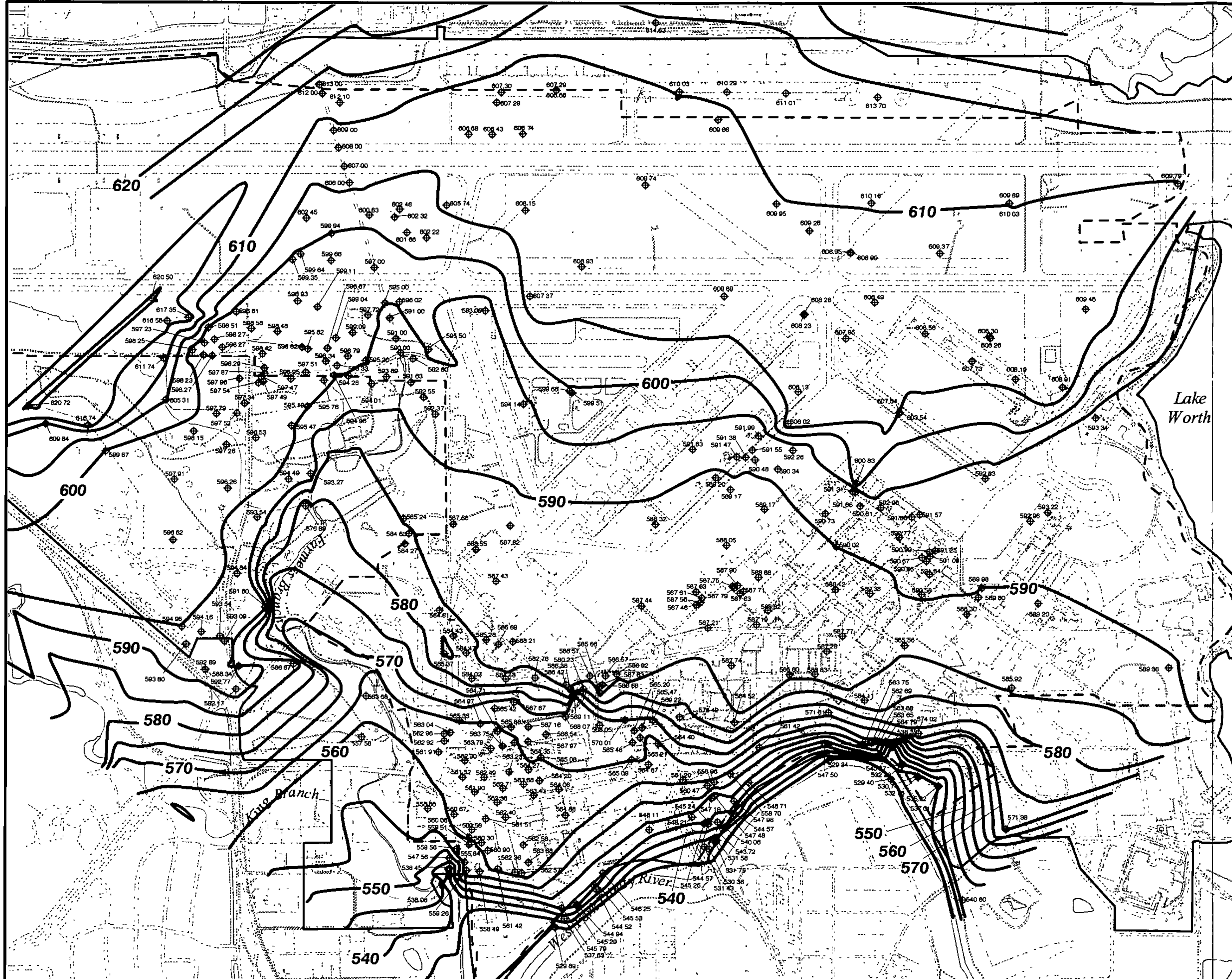

HydroGeoLogic, Inc
RAAD Northern and Central Lobes of the TCE Plume
NAS Fort Worth JRB, Texas

Figure 2.3

Water Level Elevations
Terrace Alluvium
October 2001

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

608 99 Groundwater Elevation (ft msl)

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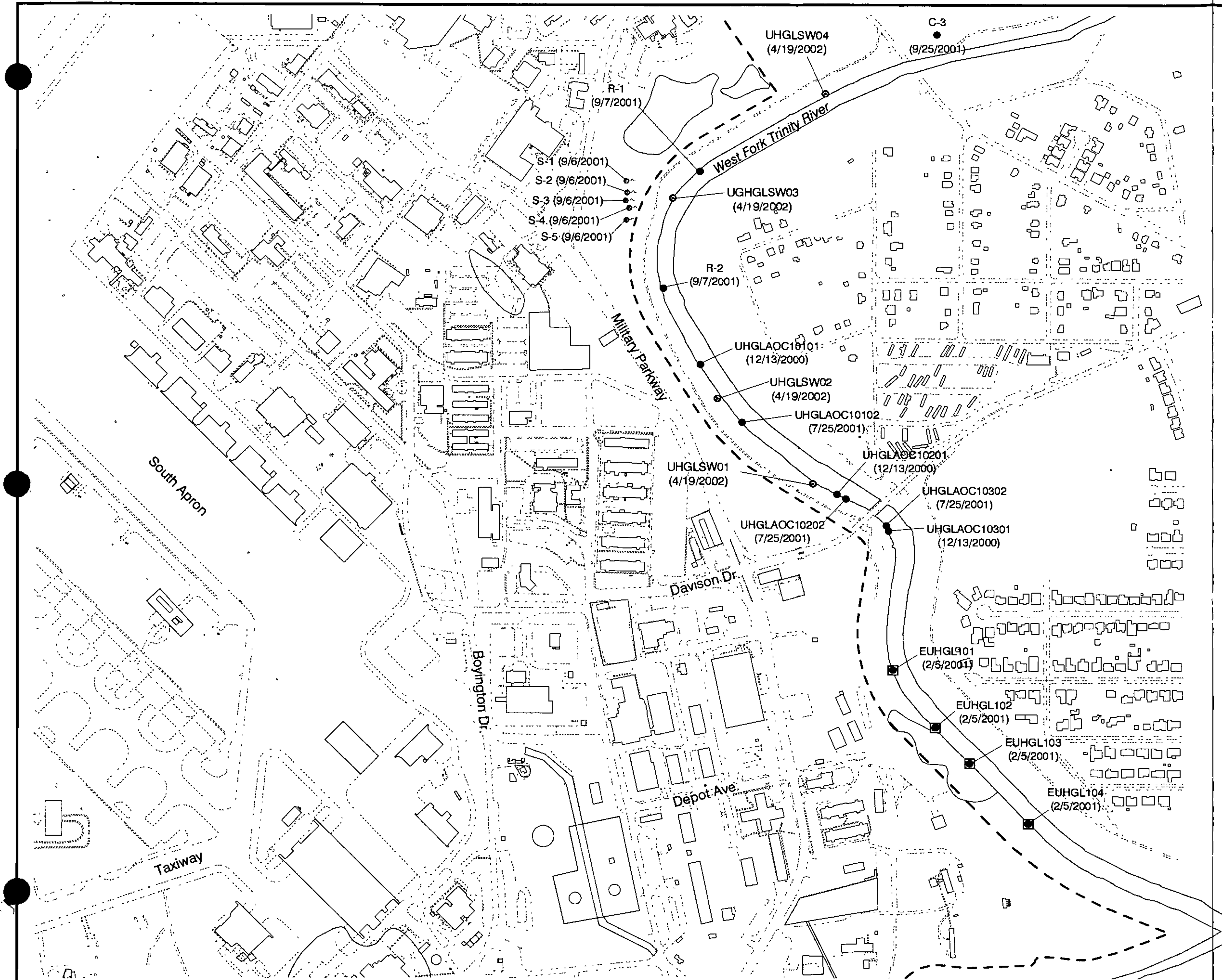

HydroGeoLogic, Inc
RAAD Northern and Central Lobes of the TCE Plume
NAS Fort Worth JRB, Texas

Figure 3.1
Surface Water and Sediment Sampling Locations

U.S. Air Force Center for Environmental Excellence

Legend

- NAS Fort Worth JRB (Carswell Field)
- Solid Waste Management Unit
- Area of Concern
- Building/Structure
- UHGLAOC10101 — Surface Water Sample Location
- UGHGLSW01 — 2002 GSAP Surface Water Sample Location
- S-1 — Seep Sample Location
- EUHGL104 — Sediment Sample Location

Note Date shown is most recent sampling date.

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FINAL PAGE

ADMINISTRATIVE RECORD

FINAL PAGE