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DRAFT FINAL INSTALLATION RESTORATION PROGRAM REMEDIAL INVESTIGATION  
FEASIBILITY STUDY STAGE 2 VOLUME 1 OF 9 NAS FORT WORTH TX  
4/1/1989  
RADIAN CORPORATION



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

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**ADMINISTRATIVE RECORD  
COVER SHEET**

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**INSTALLATION RESTORATION PROGRAM**

**RI/FS STAGE 2**

**DRAFT FINAL  
VOLUME 1: TECHNICAL REPORT**

**FOR**

**CARSWELL AFB, TEXAS**

**HEADQUARTERS STRATEGIC AIR COMMAND  
(HQ SAC/DE)  
OFFUTT AIR FORCE BASE, NEBRASKA 68113-5001**

**APRIL 1989**

**PREPARED BY**

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**USAF CONTRACT NO. F33615-87-D-4023, DELIVERY ORDER NO. 0004  
RADIAN CONTRACT NO. 227-005-04**

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PREFACE

Radian Corporation is the contractor for the Installation Restoration Program (IRP) Phase II, Stage 2 investigation at Carswell AFB, Texas. The work was performed under USAF Contract No. F33615-87-D-4023, Delivery Order 0004.

A hydrogeological investigation has been conducted at several landfills, fire department training areas, and fuels handling areas to further assess and define the extent of contamination confirmed in the Stage 1 investigation at Carswell AFB. Soil gas surveys were conducted at two locations to determine the extent of petroleum hydrocarbon vapors. Ground-water monitor wells were installed in alluvial materials to further define the limits of ground-water contamination. Soil samples were collected during drilling operations and with hand augers at selected sites and analyzed for a broad range of parameters. Water samples collected from the wells and a stream were analyzed for a wide spectrum of metals, inorganic compounds, and organic compounds. A baseline risk assessment of all sites was performed, and preliminary remedial action alternatives for each site were identified and evaluated.

Key Radian project personnel were:

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Radian would like to acknowledge the cooperation of the Carswell AFB Civil Engineering Staff. In particular, Radian acknowledges the assistance of Mr. Raj Sheth, Environmental Coordinator, and Sgt. Stanley Reinhartz.

The work reported herein was accomplished between December 1987 and September 1988. Mr. Karl W. Ratzlaff, Technical Services Division, USAF Occupational Environmental Health Laboratory (USAFOEHL/TS), was the Technical Monitor.

Approved: Nelson H. Lund  
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10-10-88

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EXECUTIVE SUMMARY

Introduction

The Department of Defense (DOD) is conducting a nationwide program to evaluate past waste disposal practices on DOD property, to control the migration of hazardous contaminants, and to control hazards that may result from these waste disposal practices. This program, the Installation Restoration Program (IRP), consists of several phases: a preliminary assessment (Phase I), an RI/FS (Phase II), screening of remedial alternatives, selection of a preferred alternative, and the design and implementation of the selected remedial action alternative. The United States Air Force is conducting an IRP investigation at Carswell AFB near Fort Worth, Texas. Radian Corporation has performed this RI/FS Stage 2 Field Evaluation under USAF Contract No. F33615-87-D-4023, Delivery Order 4. Authorization to proceed on this study was given on 24 September 1987. Field activities were performed from December 1987 to April 1988.

Purpose of the Investigation

The purpose of the RI/FS Stage 2 investigation was to determine the magnitude and extent of contamination identified in the RI/FS Stage 1 investigation (Radian, 1986), identify environmental consequences of migrating pollutants, and recommend additional investigations to identify the magnitude, extent and direction of movement of discovered contaminants. A baseline risk assessment and preliminary assessment of possible remedial alternatives was included in the Stage 2 investigation.

Site Descriptions

Carswell AFB is located six miles west of the center of Fort Worth in Tarrant County, Texas. The Weapons Storage Area (WSA) is five miles west

of Carswell AFB. Figure 1 illustrates the locations of Carswell AFB and the WSA in Tarrant County.

RI/FS Stage 2 work has focused on twelve sites at Carswell AFB (Figure 2) and on one site at the WSA west of the base (Figure 3). At Carswell AFB, these sites consist of landfills, fire training areas, industrial areas, and spill sites that were located in two main areas. One group of sites is near the flightline and another set of sites is concentrated in the east area of the base. These IRP sites and findings of the RI/FS Stage 1 investigation are described briefly in the following paragraphs.

Site 1, Landfill 1--Landfill 1 was reported to be the original base landfill and was operated during the 1940s. This site is located adjacent to the Trinity River levee at the same spot as the current Defense Reutilization and Marketing Office (DRMO) storage yard. Due to the time elapsed since this site was closed, no information was available concerning past waste disposal practices at this location.

Results of the Stage 1 study showed that ground water at Landfill 1 contains some elevated levels of oil and grease (ranging from not detected to 190 mg/L) and heavy metals, as well as some purgeable halocarbons in low concentrations. Ground water movement is toward the Trinity River, adjacent to the site.

Site 3, Landfill 3--Landfill 3 is located under the present runway, immediately south of the culvert carrying the flow of Farmers Branch. During the period from 1950 until 1952, Site 3 was used for burial of all types of wastes, but primarily construction rubble. During that period, the runway ended north of Farmers Branch, and a ravine present at this site was used as a fill area.

Results of the Stage 1 geophysical surveys at the site did not provide conclusive evidence of waste materials in the subsurface.

Flightline Sites (Landfills 4 and 5, Waste Burial Area)--Landfill 4 includes 10 acres of land east of the runway and was the main landfill during much of the history of Carswell AFB. At least six large pits, approximately 12 feet deep were filled with refuse which was burned and buried. Various materials suspected of being hazardous were reportedly disposed at this site, including drums of waste liquids, partially full paint cans, and cadmium batteries.

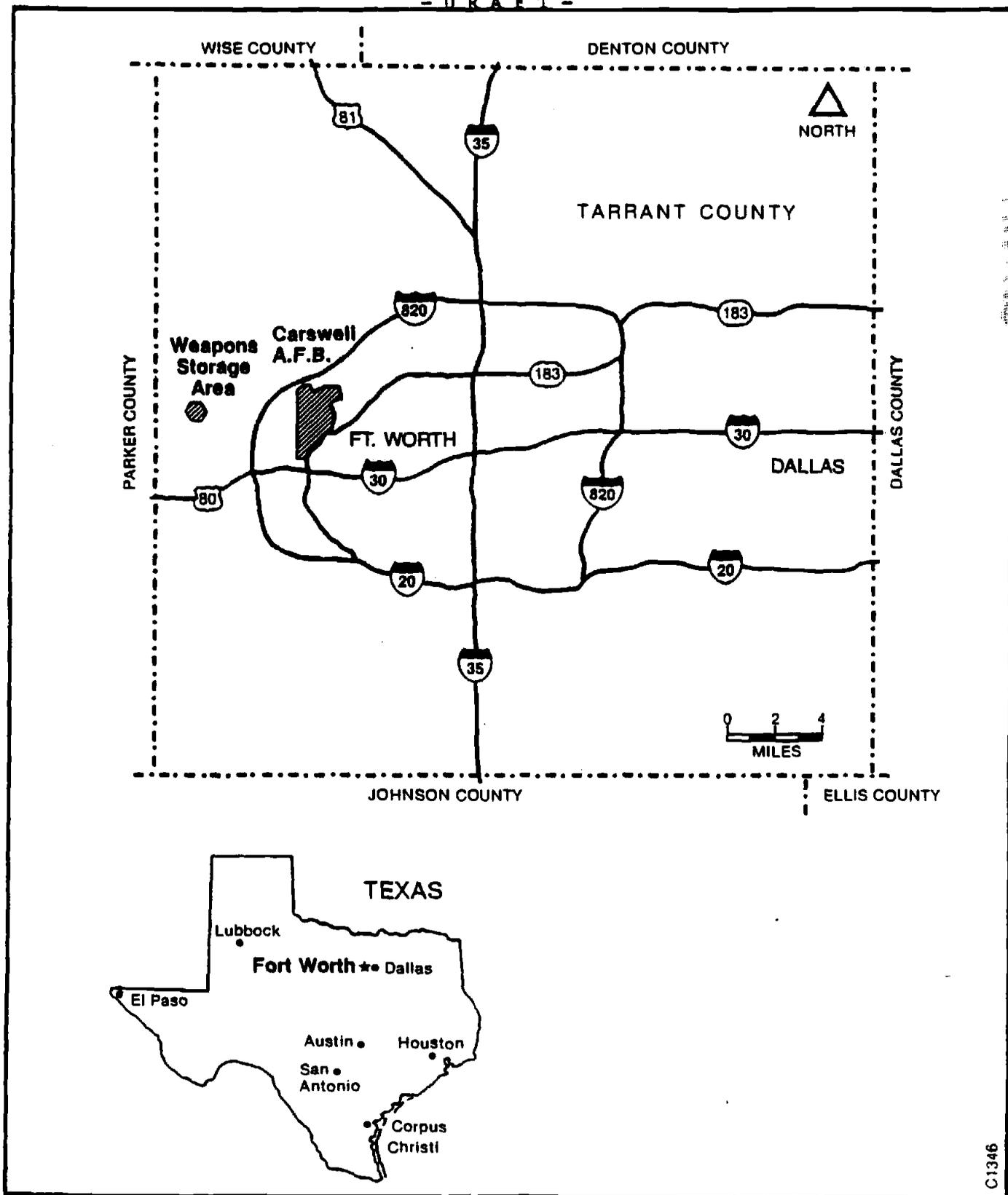


Figure 1. General Location of Carswell AFB and the Weapons Storage Area, Texas

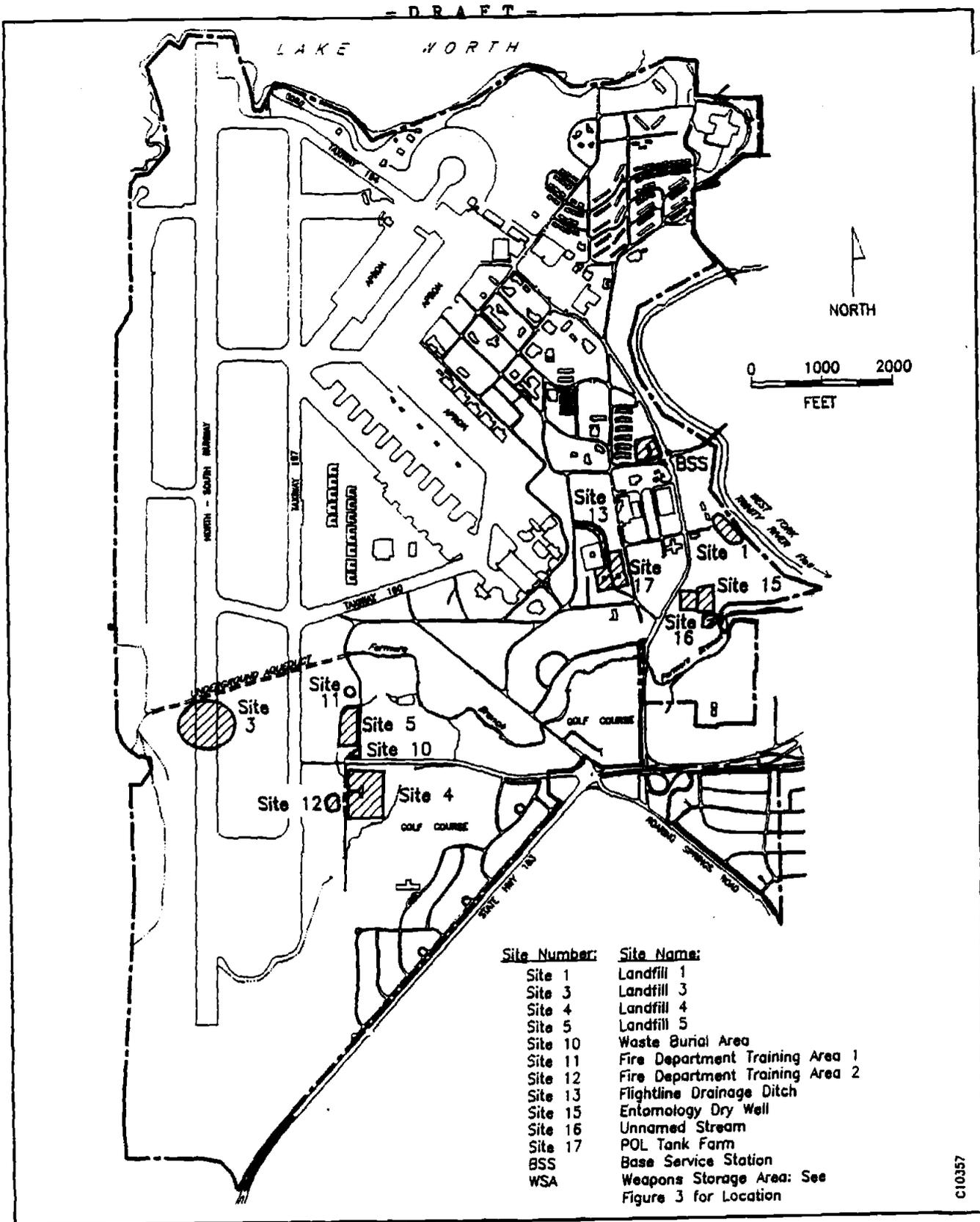


Figure 2. Location of IRP RI/FS Stage 2 Sites at Carswell AFB, Texas



Landfill 5 is located northwest of Landfill 4 and was constructed adjacent to a small tributary to Farmers Branch. The landfill site was constructed by building a clay berm adjacent to the creek and then filling the area behind the berm up to its existing level. This fill site received all types of flightline wastes and refuse, and was regularly burned prior to covering.

Site 10, located adjacent to and north of White Settlement Road, where it dead-ends at the taxiway, was used for burial of wastes during the 1960s. Various types of hazardous materials, including drums of cleaning solvents, leaded sludge, and possibly ordnance materials, were reported disposed of at this site.

Results of Stage 1 chemical analyses indicated that ground water in the vicinity of these sites was found to contain elevated levels of TCE. The occurrence of TCE was generally in the range of non-detectable to 5,000 ug/L in the affected areas both upgradient and downgradient of the landfills. Results of soil analyses also indicated TCE (range from none detected to 0.338 ug/g) contamination at some areas near these sites. Most of the contamination is centered east of these sites at the golf course, however, levels of TCE in the range of 10-3,280 ug/L were also discovered in the ground water upgradient of Landfill 5, 900 feet from the flightline.

Site 11. Fire Department Training Area 1--Site 11, north of Landfill 5, was the primary fire pit prior to 1963. The pit reportedly was adjacent to a small tributary to Farmers Branch, was gravel-lined, and had a low concrete curb around its perimeter. Waste oils and contaminated fuels were the primary flammable liquids used in the exercises.

During the Stage 1 study, low levels of TCE (range from none detected to 0.249 ug/g) were detected in one well at Site 11, located just north of Landfill 5. In addition, TCE (range from none detected to 0.257 ug/g) was also detected in soil from a hand-augered boring at the center of the site and at the upgradient well.

Site 12. Fire Department Training Area 2--Site 12 is located between the north-south taxiway and the radar facility. This site, with only slight modifications, has been used as a fire department training area since 1963. The fire ring is gravel-lined with a low earthen berm around its perimeter. In the past, a pit was present at the site to collect runoff from training exercised, but this pit has been filled.

Results of Stage 1 analyses at Site 12 indicated that the fire training activities have introduced significant amounts of halogenated and aromatic organic compounds into soil (range from none detected to 752 ug/g) and ground water (range from none detected to 362 ug/L). The highest levels of contamination occurred in the center of the site, where high levels of benzene, toluene, and ethyl benzene were detected (range from non detected to

752 ug/g, 134 ug/g and 110 ug/g, respectively) in soil. TCE also occurred in ground water downgradient (north and east) of the site, but in lower concentrations (range from none detected to 362 ug/L) than at Sites 4, 5, and 10. The operations at this site have also affected the quality of surface water draining the area. Water samples from a drainage ditch near the site had oil and grease (range from 1 to 84,000m g/L) and TOC (range 86 to 50,000 mg/L).

Site 13. Flightline Drainage Ditch--Site 13 is an unlined drainage ditch from Hailø Drive to where it intersects the POL tank farm, at which point it enters a concrete-lined channel. In addition to normal storm drainage, this ditch receives discharges from the aircraft washracks and the Fuel Systems Shop (Building 1048). Washrack wastes (PD-680, a cleaning solvent, and soap) can be discharged directly to the Facility 1190 oil/water separator, located adjacent to the flightline drainage ditch, or into the drainage ditch via an overflow pipe in the drain line between the washracks and the oil/water separator. Discharge to the oil/water separator or to the drainage ditch is controlled by a valve in the drain line just upstream of the separator.

Based on Stage 1 results, soils at the Flightline Drainage Ditch are contaminated with jet fuel, detergents, or both. It was observed that the distribution of contaminants is somewhat erratic, suggesting that contaminant mobility and infiltration are controlled by local variations in soil composition and texture.

Site 15. Entomology Dry Well--Site 15 is located immediately west of the old entomology shed (Building 1338), in the present Civil Engineering Compound, off Rogner Drive. A dry well at the site was used for disposal of insecticide rinsate between 1965 and 1981. The site is currently vacant; Building 1338 has been demolished and the site has been regraded. Building 1338 was used for the storage and mixing of insecticides including malathion, diazinon, dursban, and chlordane, and for storage and cleaning of spray equipment. Chlordane has been reported in samples taken from the well next to Building 1338, although no documented analytical results could be found during the records search to substantiate this report.

The Stage 1 study concluded that pesticides and herbicides from the former Entomology Building and Entomology Dry Well have not been released in significant quantities into the soil and water. Lindane and endrine were detected in one downgradient well, but at levels which were not quantitatively measurable.

Site 16. Unnamed Stream--Site 16 is a small tributary of Farmers Branch, located south of the old entomology shed, and near the confluence of Farmers Branch and the Trinity River. This small stream is the discharge from an oil/water separator located immediately south of the fenced civil engineering yard, and receives its perennial flow from ground water entering the separator. The separator is connected to a french underdrain system which was

reportedly installed due to a gasoline leak at the former base gasoline station. This separator has not been routinely cleaned for a number of years and reportedly contained hydrocarbon constituents.

Hydrocarbon fuels (gasoline or JP-4) were observed in the Stage 1 study (range of oil and grease was <1 to 7,100 mg/L, with high levels of aromatic compounds) in the ground water at Site 16. The source of the contamination is either a former gasoline station at the site or the POL Tank Farm. Results of analyses at the Unnamed Stream suggest that the oil/water separator does not always ensure that oil and grease are not released to the stream.

Site 17, POL Tank Farm--Site 17 is located on the eastern side of Carswell AFB, adjacent to Knight's Lake Road. In 1988, three aboveground tanks were located at this location; formerly, four additional tanks were also located here. During the early 1960s, fuels were discovered in the ground in this area, and also downgradient from site site in the direction of the former base gasoline station. A french drain system was installed downgradient from this area to collect fuels in the ground. The french drain discharges through the oil/water separator at Site 16.

During Stage 1, organic compounds were observed in the ground water (<1 to 31,000 mg/L) and soil (<1 to 1,300 ug/g) underlying the POL Tank Farm. The organic compounds are most likely fuel hydrocarbons from the storage and handling of fuels.

Weapons Storage Area (WSA)--The WSA is located about 6 miles west of Carswell AFB, just north of White Settlement Road. It has been reported that small quantities of waste cleaners and solvents have occasionally been disposed of on the ground behind the Inspection Shop.

In Stage 1, ground water from the potable supply well was found to contain total radium (8.5 pCi/L) in excess of federal standards for drinking water. In addition, analysis of soil west of the Inspection Shop site revealed the presence of TCE (range from none detected to 0.0619 ug/g).

#### Scope of the RI/FS Stage 2 Investigation

The RI/FS Stage 2 investigation included the performance of two soil gas surveys, drilling of boreholes and installation of monitor wells in alluvial (upper zone) material, collection of soil samples from boreholes and hand-auger holes, collection of sediment samples, and analysis of samples for a variety of inorganic and organic constituents. Table 1 summarizes the number of monitor wells, boreholes, and hand-auger holes completed at each

TABLE 1. SUMMARY OF IRP RI/FS STAGE 2 BOREHOLES, MONITOR WELLS,  
AND HAND AUGER BORINGS AT CARSWELL AFB, TEXAS

IRP Site	Description	Location Number	Boring Type	Depth <sup>2</sup>
1	Landfill 1	1E	MW	30
		1F	MW	33
3	Landfill 3	3A	BH	18
		3B	BH	21
		3C	BH	12
		3D	MW	15.5
		3E	BH	16
4	Landfill 4	4F	MW	35.5
		4G	MW	40
		4H	MW	29
5	Landfill 5	5D	MW	24
		5E	MW	40
		5F	MW	37
		5G	MW	29
		5H	MW	25.6
10	Waste Burial Area	10D	BH	29
		10E	BH	29
		10F	BH	29
12	Fire Department Training Area 2	12D	MW	36
		12E	MW	40
		12G	BH	17
		12H	BH	25
		12I	BH	25
		12J	BH	25
15	Entomology Dry Well	12K	BH	25
		15D	HA	1
		15E	HA	4
		15F	HA	4
		15G	HA	2
		15H	HA	1
		15I	HA	2
15J	HA	3		

(Continued)

<sup>1</sup>MW - Monitor well  
 BH - Borehole  
 HA - Hand auger hole  
<sup>2</sup>Feet below land surface

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TABLE 1. (Continued)

IRP Site	Description	Location Number	Boring Type <sup>1</sup>	Depth <sup>2</sup>
17	POL Tank Farm	17I	MW	20
		17J	MW	20.5
		17K	MW	18
		17L	MW	20.5
		17M	MW	16
BSS	Base Service Station	BSS-A	MW	11
		BSS-B	MW	10
		BSS-C	MW	12
		BSS-D	BH	6
WSA	Weapons Storage Area	WSA-D	HA	1
		WSA-E	HA	1
		WSA-F	HA	1
		WSA-G	HA	1
		WSA-H	HA	1
		WSA-I	HA	1
		WSA-J	HA	4
		WSA-K	HA	3

<sup>1</sup>MW - Monitor well  
BH - Borehole  
HA - Hand auger hole  
<sup>2</sup>Feet below land surface

site during the Stage 2 program. The number and parameter type of soil and water samples collected at each site during the Stage 2 program are summarized in Tables 2 and 3.

All data related to field activities and laboratory analyses performed for the Stage 2 investigation were incorporated into the IRP Information Management System (IRPIMS) database. These data are included in the text and appendices of this document and were provided to USAFOEHL in a Informal Technical Information Report after field activities were completed.

A baseline risk assessment was conducted to determine the potential carcinogenic risk associated with each Carswell AFB IRP site, characterize the potential for noncarcinogenic effects, and use the results to rank and prioritize sites for remedial action. The methodology used in the baseline risk assessment involved several sequential steps to derive the values and assumptions necessary to calculate exposure, dose, and risk. The steps included selecting and characterizing indicator chemicals, estimating contaminant release rates, evaluating exposure pathways, and developing exposure scenarios. These tasks produced inputs to a computerized risk assessment model, the Radian Risk Assessment Model (R-RAM), which calculated the pollutant-specific estimates of exposure, dose, and risk for direct and indirect routes of exposure. Exposure pathways which were not quantified were described qualitatively.

An additional activity of the Stage 2 investigation was the evaluation and screening of preliminary alternative remedial actions. Possible remedial actions were identified for each of the contaminated environmental media, including soil, ground water, and surface water. Next, a preliminary screening process was conducted to identify a comprehensive set of available control measure technologies and select those that were applicable to the IRP sites. These technologies were then evaluated according to effectiveness and ease of implementation. Finally, these technologies were combined into

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**TABLE 2. IRP RI/FS STAGE 2 SUMMARY OF SOIL AND SEDIMENT SAMPLE ANALYSES  
AT CARSWELL AFB, TEXAS**

Parameter	Method <sup>2</sup>	Site <sup>1</sup>											Total <sup>3</sup>				
		1	3	4	5	7	10	12	13	15	17	BSS		WSA			
Oil and Grease	E413.2	4	5	4	7	5	0	0	0	0	0	0	0	0	0	0	25
Petroleum Hydrocarbons	E418.1	0	0	0	0	5	20	11	0	6	5	0	47				
Metal Screen	SW6010	4	5	4	7	5	20	11	0	0	0	13	69				
Arsenic	SW7060	4	5	4	7	5	0	0	0	0	0	0	25				
Lead	SW7420	0	0	0	0	4	0	0	0	6	5	0	15				
Mercury	SW7471	4	5	4	7	5	0	11	0	0	0	0	36				
Selenium	SW7740	4	5	4	7	5	0	0	0	0	0	0	25				
Organochlorine Pesticides/PCBs	SW8080	0	0	0	0	7	0	0	8	0	0	0	15				
Volatile Organic Compounds	SW8240	4	5	4	7	6	21	12	0	7	5	14	87				
Semivolatile Organic Compounds	SW8270	4	5	4	7	5	20	11	0	0	0	13	71				
Chlorinated Phenoxy Herbicides	SW8150	0	0	0	0	7	0	0	8	0	0	0	15				
Organophosphorous Pesticides	SW8140	0	0	0	0	0	0	0	8	0	0	0	8				
EP Toxicity	CFR261	0	0	0	0	0	0	0	0	0	0	0	2				
Soil Moisture	D2216	4	5	4	7	5	20	0	8	6	5	13	77				

<sup>1</sup> Totals include all field QA/QC samples and second-column confirmation analyses associated with site.  
<sup>2</sup> Refer to text for complete description of test methods.  
<sup>3</sup> Total analyses include those of soil cuttings.

TABLE 3. SUMMARY OF IRP RI/FS STAGE 2 WATER SAMPLE ANALYSES AT GARSWELL AFB, TEXAS

Parameter	Method <sup>2</sup>	Site <sup>1</sup>											Total
		1	3	4	5	10	11	12	16	17	BSS		
Alkalinity	A403	6	1	11	11	5	2	5	4	7	5	57	
Specific Conductance	E120.1	12	1	18	18	6	2	10	8	10	6	91	
pH	E150.1	12	1	18	18	6	2	10	8	10	6	91	
Temperature	E170.1	12	1	18	18	6	2	10	8	10	6	91	
Fluoride	E340.2	13	2	22	22	8	4	12	9	13	0	105	
Chloride	E325.3	13	2	22	22	8	4	12	9	13	0	105	
Sulfate	E375.4	13	2	22	22	8	4	12	9	13	0	105	
Total Dissolved Solids	E160.1	12	2	20	20	7	4	10	9	11	7	103	
Orthophosphate	E365.1	13	2	22	22	8	4	12	9	13	0	105	
Nitrate	E353.1	13	2	22	22	8	4	12	9	13	0	105	
Metal Screen	E200.7	13	2	22	22	8	4	12	9	13	8	113	
Arsenic	E206.2	13	2	22	22	8	4	12	9	13	8	113	
Lead	E239.2	13	2	0	0	8	0	0	9	13	8	53	
Mercury	E245.1	13	2	22	22	8	4	12	9	13	8	113	
Selenium	E270.2	13	2	22	22	8	4	12	9	13	8	101	
Oil and Grease	E413.2	13	2	0	0	8	0	0	9	1	0	33	
Petroleum Hydrocarbons	E418.1	0	2	0	0	8	4	12	0	12	8	46	
Purgeable Halocarbons	E601	20	3	34	33	14	5	21	17	19	14	180	
Purgeable Aromatics	SM8020	21	3	34	33	14	5	21	17	19	14	181	
Phenols	E604	0	3	0	0	11	0	0	0	0	0	14	
Organochlorine Pesticides	E608	0	3	0	0	11	0	0	0	0	0	14	
Extractable Priority Pollutants	E625	3	2	4	2	0	2	2	0	2	0	17	
Chlorinated Phenox Acid Herbicides	A509B	0	3	0	0	11	0	0	0	0	0	14	

<sup>1</sup>Totals include all field QA/QC samples and second-column confirmation analyses associated with the site.  
<sup>2</sup>Refer to text for complete description of test methods.

Controlled & Restricted

1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052 2053 2054 2055 2056 2057 2058 2059 2060 2061 2062 2063 2064 2065 2066 2067 2068 2069 2070 2071 2072 2073 2074 2075 2076 2077 2078 2079 2080 2081 2082 2083 2084 2085 2086 2087 2088 2089 2090 2091 2092 2093 2094 2095 2096 2097 2098 2099 2100

site-specific alternatives to address the environmental conditions determined by the Stage 2 field and laboratory activities.

### Discussion of Results and Significance of Findings

#### Hydrogeology

The IRP RI/FS Stage 2 investigation conducted at Carswell AFB is the second study to define the nature and extent of contamination at the facility. The geologic setting and occurrence and character of the ground water have been previously described in the Stage 1 report, so that the emphasis of investigation has been to fill in gaps in the data.

In summary, Carswell AFB is underlain at the surface by alluvial and terrace deposits of gravel, sand, silt, and clay. These materials are underlain by limestone and shale bedrock that has been eroded to form an uneven surface, upon which the alluvium rests. The thickness of the alluvium, termed the upper zone, ranges from a few feet to more than 40 feet at the IRP sites. Ground water occurs in most locations of the upper zone, typically in sand or gravel deposits at the base of the upper zone in sharp contact with the bedrock. Ground-water flow is generally toward the nearest surface water body, usually Farmers Branch or the Trinity River. Previous studies have shown that the shallowest bedrock, the Goodland and Walnut Formations, is dry. The uppermost bedrock aquifer at Carswell AFB is the Paluxy aquifer, which is penetrated by two monitor wells at depths of approximately 70 feet below the land surface.

*which was in the 1st report*

#### Results and Significance of Chemical Analyses

To determine possible water quality effects on the local ground-water systems, concentrations of organic and inorganic compounds detected in ground-water samples were compared to various water quality criteria. These criteria, from federal drinking water regulations, standards,

and guidelines, include final and proposed Maximum Contaminant Levels (MCLs) and proposed Maximum Contaminant Level Goals (MCLGs) above zero (0), established by the EPA as part of national drinking water regulations. The MCLGs are nonenforceable health goals set, with an adequate margin of safety, at levels that would result in no known or anticipated adverse health effects. The MCLs are enforceable standards set at levels as close to the MCLGs as feasible.

In the absence of regulatory standards for some compounds, other human health criteria have been used for the interpretation of IRP data. Although these criteria do not now have the force of standards, they do provide a valid means of assessing the relative degree of contamination. Using human health criteria and standards is a stringent way to evaluate ground-water contamination at Carswell AFB. Since the upper zone is not used as a drinking water supply source, contaminants in-situ in this unit have neither human health nor environmental consequences. Ground water in the Paluxy Formation, however, issued directly as a drinking water source.

No guidelines exist concerning the maximum allowable or recommended pollutant concentrations in soils for protection of human health and the environment.

Tables 4 through 12 present the results of ground-water analyses for sites where applicable water quality criteria (i.e., MCLs) were exceeded in the IRP RI/FS Stage 2 program. The areas of subsurface contamination at Carswell AFB are focused at the Flightline Area sites, the POL Tank Farm, and the Base Service Station.

Figure 4 illustrates the plume of TCE in upper zone ground water at the Flightline Area sites. The extent of the TCE plume, associated with Landfills 4 and 5 and the Waste Burial Area, has not been completely defined upgradient (west) or downgradient (north and east) of these sites. Since shallow ground-water flow is generally west to east, the existence of TCE west of IRP sites indicates an additional upgradient TCE source not related to

**TABLE 4. COMPARISON OF WATER QUALITY<sup>1</sup> AT LANDFILL 1 (SITE 1), CARSWELL AFB, TEXAS  
WITH APPLICABLE WATER QUALITY CRITERIA**

Parameter	Criteria	Sampling Location <sup>2</sup>					
		IA	IB	IC	ID	IE	IF
<b>METALS<sup>2</sup></b>							
Arsenic	0.05			0.067	0.14	0.17	
Lead	0.05				0.18	0.29	
Barium	1.0				2.1	2.9	
Cadmium	0.01				0.012	0.021	
Chromium	0.05			0.075	0.051	0.33	0.50

- Notes: 1. All values in units of mg/L.  
 2. Maximum values reported exceeding criteria for either Jan-Feb 1988 or April 1988 sampling round.  
 3. Graphite AA analyses reported, if available.

(continued)

TABLE 5. COMPARISON OF WATER QUALITY<sup>1</sup> AT LANDFILL 3 (SITE 3), CARSWELL AFB, TEXAS WITH APPLICABLE WATER QUALITY CRITERIA

Parameter	Criteria	Sampling Location <sup>2</sup> 3D
METALS (mg/L)		
Chromium	0.05	0.13

- Notes: 1. All values in units of mg/L.  
2. Maximum values reported exceeding criteria for either Jan-Feb 1988 or April 1988 sampling round.

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TABLE 6. COMPARISON OF WATER QUALITY<sup>1</sup> AT LANDFILL 4 (SITE 4), CARSWELL AFB, TEXAS WITH APPLICABLE WATER QUALITY CRITERIA

Parameter	Criteria	Sampling Location <sup>2</sup>											
		P2	4A	4B	4C	4D	4E	4F	4G	4H			
<b>METALS<sup>3</sup></b>													
Arsenic	0.05		0.056		0.056								
Lead	0.05		0.16		0.056								0.061
Barium	1.0				0.24								0.11
Cadmium	0.01				1.9								1.2
Chromium	0.05		0.21		0.02								0.025
Selenium	0.01			0.014	0.24		0.059						0.44
<b>PURGEABLE HALOCARBONS</b>													
Trichloroethene	0.005				0.027	3.3	4.2	4.2	4.2	2.5			3.3
Vinyl Chloride	0.001				0.0038								
<b>PURGEABLE AROMATICS</b>													
Benzene	0.005				0.019								0.28

- Notes: 1. All values in units of mg/L.  
 2. Maximum values reported exceeding criteria for either Jan-Feb 1988 or April 1988 sampling round.  
 3. Graphite AA analyses reported, if available.

TABLE 7. COMPARISON OF WATER QUALITY<sup>1</sup> AT LANDFILL 5 (SITE 5); CARSWELL AFB, TEXAS  
WITH APPLICABLE WATER QUALITY CRITERIA

Parameter	Criteria	Sampling Location <sup>2</sup>								
		5A	5B	5C	5D	5E	5F	5G	5H	
<b>METALS<sup>3</sup></b>										
Arsenic	0.05				0.055	0.061	0.068	0.068	0.056	
Lead	0.05	0.08		0.06	0.068	0.066	0.18	0.09	0.09	0.09
Barium	1.0						1.0			
Cadmium	0.01		0.06							
Chromium	0.05	0.12		0.06	0.15	0.17	0.23	0.11	0.12	
<b>PURGEABLE HALOCARBONS</b>										
Trichloroethene	0.005	3.2		2.7	0.17	0.91	3.8	1.2	2.8	
Vinyl Chloride	0.001		0.11							
<b>PURGEABLE AROMATICS</b>										
Benzene	0.005								0.22	

Notes: 1. All values in units of mg/L.  
2. Maximum values reported exceeding criteria for either Jan-Feb 1988 or April 1988 sampling round.  
3. Graphite AA analyses reported, if available.

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TABLE 8. COMPARISON OF WATER QUALITY<sup>1</sup> AT WASTE BURIAL AREA (SITE 10), CARSWELL AFB, TEXAS WITH APPLICABLE WATER QUALITY CRITERIA

Parameter	Sampling Location <sup>2</sup>	
	10A	10B
<b>METALS<sup>3</sup></b>		
Arsenic		
Lead	0.1	
Barium	1.1	
Chromium	0.098	0.066
		0.052
<b>PURGEABLE HALOCARBONS</b>		
Trichloroethene	3.4	11
		2.1

- Notes: 1. All values in units of mg/L.  
 2. Maximum values reported exceeding criteria for either Jan-Feb 1988 or April 1988 sampling round.  
 3. Graphite AA analyses reported, if available.

TABLE 9. COMPARISON OF WATER QUALITY<sup>1</sup> AT FDTA 1 (SITE 11), CARSWELL AFB, TEXAS WITH APPLICABLE WATER QUALITY CRITERIA

Parameter	Criteria	Sampling Location <sup>2</sup>	
		11A	11B
<b>METALS<sup>3</sup> (mg/L)</b>			
Arsenic	0.05		0.096
Lead	0.05		0.10
Chromium	0.05		0.053

- Notes:
1. All values in units of mg/L.
  2. Maximum values reported exceeding criteria for either Jan-Feb 1988 or April 1988 sampling round.
  3. Graphite AA analyses reported, if available.

TABLE 10. COMPARISON OF WATER QUALITY<sup>1</sup> AT FDTA 2 (SITE 12), CARSWELL AFB, TEXAS  
WITH APPLICABLE WATER QUALITY CRITERIA

Parameter	Criteria	Sampling Location <sup>2</sup>				
		12A	12B	12C	12D	
<b>METALS<sup>3</sup></b>						
Arsenic	0.05	1.0	0.051	0.074	0.054	0.061
Lead	0.05	0.06	0.066	0.05	0.27	
Cadmium	0.01			0.011	0.015	
Chromium	0.05	0.1	0.22	0.23	0.35	0.31
<b>PURGEABLE HALOCARBONS</b>						
Trichloroethene	0.005		0.11		0.055	
Vinyl Chloride	0.001			0.018		0.0034

- Notes: 1. All values in units of mg/L.  
 2. Maximum values reported exceeding criteria for either Jan-Feb 1988 or April 1988 sampling round.  
 3. Graphite AA analyses reported, if available.

TABLE 11. COMPARISON OF WATER QUALITY<sup>1</sup> AT POL TANK FARM (SITE 17), CARSWELL AFB, TEXAS WITH APPLICABLE WATER QUALITY CRITERIA

Parameter	Criteria	Sampling Location <sup>2</sup>				
		17I	17J	17K	17L	
<b>METALS<sup>3</sup></b>						
Arsenic	0.05	0.13	0.072	0.11	0.068	0.12
Lead	0.05	0.40	0.1	0.30	0.39	0.56
Barium	1.0	2.2	1.2	2.0	1.2	1.7
Cadmium	0.01	0.015	0.01	0.12	0.031	0.02
Chromium	0.05		0.25	0.31	0.23	0.56
<b>PURGEABLE AROMATICS</b>						
Benzene	0.005	0.054				11.0

- Notes: 1. All values in units of mg/L.  
 2. Maximum values reported exceeding criteria for either Jan-Feb 1988 or April 1988 sampling round.  
 3. Graphite AA analyses reported, if available.

0.11

0.11

TABLE 12. COMPARISON OF WATER QUALITY<sup>1</sup> AT BASE SERVICE STATION (SITE BSS), CARSWELL AFB, TEXAS WITH APPLICABLE WATER QUALITY CRITERIA

Parameter	Criteria	Sampling location <sup>2</sup>		
		BSS-A	BSS-B	BSS-C
<b>METALS<sup>3</sup></b>				
Arsenic	0.05			
Lead	0.05	0.18	0.22	0.45
Chromium	0.05	0.058	0.14	0.068
				0.12
<b>PURGEABLE AROMATICS</b>				
Benzene	0.005		4.4	0.037

- Notes:
1. All values in units of mg/L.
  2. Maximum values reported exceeding criteria for either Jan-Feb 1988 or April 1988 sampling round.
  3. Graphite AA analyses reported, if available.

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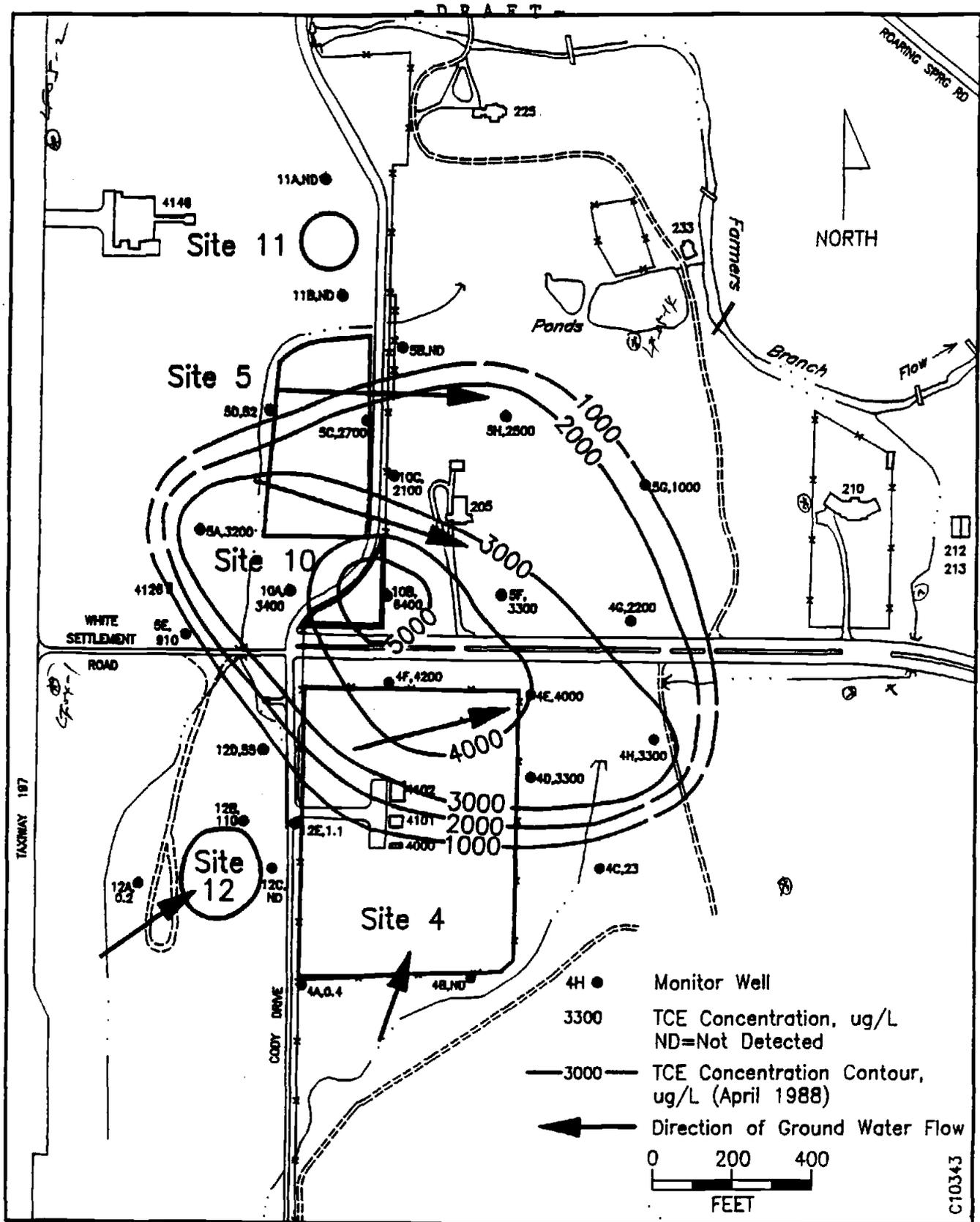


Figure 4. Extent of TCE in Ground Water of the Upper Zone, Flightline Area, Carswell AFB, Texas

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See P. 257

current IRP sites. Field evidence and further review of Carswell AFB records suggests that TCE may be attributable to an additional fire training area, near Bldg. 4126. Other possibilities, including TCE in shallow ground water documented east of AF Plant 4, may require further consideration.

At the POL Tank Farm, purgeable aromatic hydrocarbons have been detected in two areas, as shown on Figure 5. The areas of hydrocarbon contamination in ground water are also revealed by results of the soil gas survey, which identified similar areas with hydrocarbon vapors in the subsurface. The contamination is associated with fuels storage and handling facilities at Site 17.

Soil gas survey results for the Base Service Station are illustrated in Figure 6. The areas of the soil gas plumes also coincided with concentrations of aromatic hydrocarbons detected in shallow ground water. The area of greatest aromatic hydrocarbon concentrations in ground water coincides with the soil gas plume located just north of the service station at the underground gasoline storage tanks (well BSS-B).

Results of the Baseline Risk Assessment

Table 13 summarizes the results of the baseline risk assessments for each site and provides a qualitative basis for determining a priority for remedial actions. IRP sites may be grouped as follows:

1. Sites which have no significant impact (NSI on Table 13) on human health. No further action is necessary unless impacts on wildlife can be substantiated.
2. Sites which have a low or moderate potential for impact on human health. Remedial action is appropriate.
3. Sites which have a high potential impact on human health or which pose an immediate and direct health hazard. Swift remedial action is required.

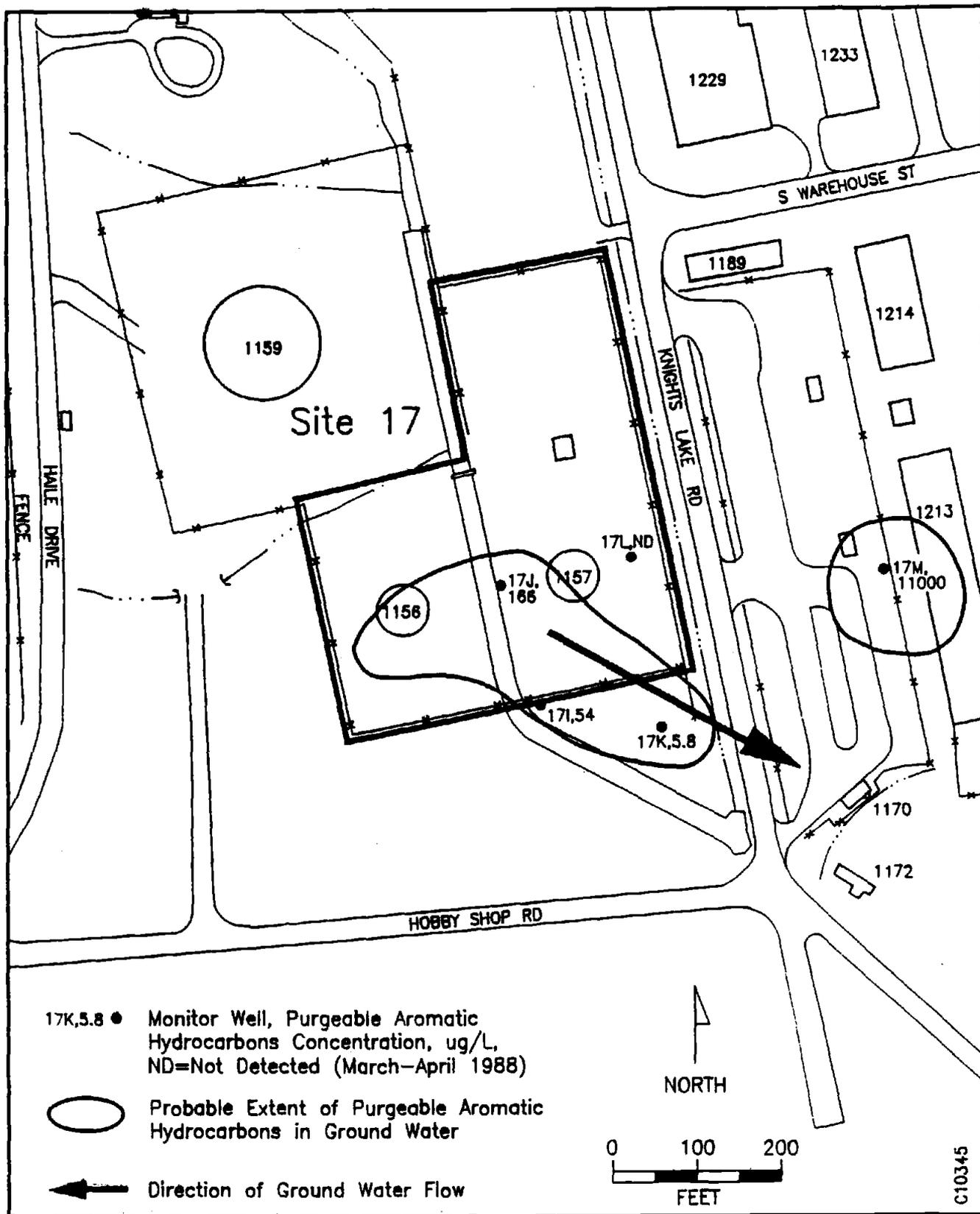


Figure 5. Extent of Purgeable Aromatic Hydrocarbons in Ground Water of the Upper Zone, POL Tank Farm, Carswell AFB, Texas



Considering the results of the field program and the baseline risk assessment, the following sites may be placed into the group indicating no further action is necessary:

<u>Site</u>	<u>Rationale</u>
Landfill 3 (Site 3)	Little evidence of disposal actions, no soil contamination, some metals in ground water above MCLs, little or no opportunity for exposure.
FDTA 1 (Site 11)	No soil or ground-water contamination, little opportunity for exposure.

Landfill 4 (Site 4) and the Waste Burial Area (Site 10) are also shown on Table 13 to have no significant impact in terms of risk assessment. The risk assessment focused on possible exposures due to contaminants, which were judged to be minimal at the sites themselves. However, since both of these sites are underlain by, but not necessarily contributing to, the plume of TCE in ground water at the Flightline Area, these sites are considered to be in the second group.

Sites in the second group, indicating a low to moderate health risk, and appropriate for remedial actions are listed below. The preliminary risk assessment ranking number indicates the relative priority of action, with a rank of 1 indicating the greatest need for action.

<u>Site</u>	<u>Preliminary Ranking</u>
FDTA 2 (Site 12)	1
Unnamed Stream (Site 16)	2*
Base Service Station (Site BSS)	3*
Entomology Dry Well (Site 15)	3*
Landfill 1 (Site 1)	3*
Flightline Drainage Ditch (Site 13)	3*
Weapons Storage Area (Site WSA)	4
POL Tank Farm (Site 17)	5
Landfill 5 (Site 5)	6*
Landfill 4 (Site 4)	7*
Waste Burial Area (Site 10)	7*

\*Equivalent ranking, based on magnitude of contaminant concentrations which might reach sensitive receptors.

TABLE 13. SUMMARY OF IRP RI/FIS STAGE 2 SITE RANKING BASED ON  
BASELINE RISK ASSESSMENT AT CARSWELL AFB, TEXAS

Human Exposure Pathway <sup>1</sup>	Sites																
	1	2	3	4	5	10	11	12	13	15	16	17	BSS	MSA			
Inhalation of Ambient Air	3x10 <sup>-11</sup> (M)	4x10 <sup>-11</sup> (N)	4x10 <sup>-11</sup> (N)	4x10 <sup>-9</sup> (M)	1x10 <sup>-8</sup> (L)	3x10 <sup>-8</sup> (M)	0	5x10 <sup>-8</sup> (L)	7x10 <sup>-10</sup> (M)	0	1x10 <sup>-6</sup> (L)	5x10 <sup>-6</sup> (L)	2x10 <sup>-9</sup> (M)	N			
Ingestion of Drinking Water	X	X	X	X	X	X	X	1x10 <sup>-10</sup> (M)	X	X	X	X	X	N			
Ingestion of Fruits and Vegetables	X	X	X	X	X	X	X	5x10 <sup>-8</sup> (L)	X	X	X	X	X	N			
Ingestion of Meat and Dairy Products	N	N	N	N	N	N	N	1x10 <sup>-14</sup> (M)	N	N	N	N	N	L			
Ingestion of Fish	L	N	N	N	N	N	N	2x10 <sup>-9</sup> (M)	L	L	L	N	L	N			
Ingestion of Soil	X	X	X	X	X	X	X	6x10 <sup>-9</sup> (M)	X	X	X	X	X	X			
Ingestion of Mother's Milk	N	N	N	N	N	N	N	4x10 <sup>-11</sup> (M)	N	N	N	N	N	N			
Skin Contact with Soil/ Surface Dust	X	X	X	X	X	X	X	2x10 <sup>-9</sup> (M)	X	X	X	X	X	X			
Skin Contact with Drinking Water (e.g., Bathing)	X	X	X	X	X	X	X	N	X	X	X	X	X	N			
Skin Contact with Surface Water (e.g., Swimming)	L	N	N	N	N	N	N	N	L	L	L	N	L	N			

D R A M T

(Continued)

TABLE 13. (Continued)

Human Exposure Pathway <sup>1</sup>	Sites																MSA
	1	3	4	5	10	11	12	13	15	16	17	BSS					
Inhalation of Vapors from Drinking Water (i.e., During Shower)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Inhalation of Vapors Close to Surface Water Source	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Ranking <sup>2</sup>	3*	NSI	NSI	6	NSI	NSI	1	3*	3*	2	5	3*	4				

Notes: 1. Cancer risks assigned to maximally exposed individual as follows: X = no potential risk, N = negligible potential risk ( $< 10^{-6}$ ), L = low potential risk ( $10^{-6} \leq L < 10^{-4}$ ), M = moderate potential risk ( $10^{-6} \leq M < 10^{-4}$ ), H = high potential risk ( $\geq 10^{-4}$ ).

2. NSI = no significant impact. Asterisk (\*) indicates tie ranking, based on magnitude of contaminant concentrations which might reach West Fork Trinity River.

APPENDIX B

Preliminary Alternative Remedial Actions

Alternatives were considered for further IRP activities at each site investigated in the RI/FS Stage 2 study. The types of alternatives considered for each site include continued monitoring, additional field investigations, no further action, and applicable contaminant control technologies.

The applicable control technologies identified and evaluated for soil contaminants include institutional actions, containment, removal, treatment, disposal, and subsurface vapor control. For ground water, applicable control technologies consist of institutional actions, containment, extraction/recovery, treatment, vapor control, and discharge. Technologies for surface water remedial actions also include diversion/collection, in addition to the technologies identified for ground water.

Recommendations

According to Air Force criteria, each site has been assigned to one of the following IRP categories:

Category 1--Sites where no further action is required.

Category 2--Site requiring additional IRP effort to:

1. Determine the mobility, toxicity, and volume of detected contaminants;
2. Evaluate human health and environmental risks associated with each contaminant; and
3. Conduct the detailed evaluation of remedial alternatives.

Category 3--Sites where the feasibility study process has been completed.

Sites investigated during the Stage 2 program fall into either Category 1 or Category 2. No sites were eligible for inclusion into Category 3, since only the first phase of the feasibility study process was completed and remedial alternatives were not selected. Table 14 summarizes the recommendations for further action based on the RI/FS Stage 2 investigation at Carswell AFB. Technical rationale supporting the recommendations are also in Table 14.

Category 1 Sites

Results of the Stage 2 investigation indicate that there are two sites where no further action is necessary at this time. These sites are:

- Landfill 3 (Site 3); and
- Fire Department Training Area 1 (Site 11).

Category 2 Sites

Category 2 sites are defined as sites requiring additional monitoring, effort to quantify or further assess the extent of contamination, and/or detailed evaluation of remedial alternatives. The sites or groups of sites listed as Category 2 sites are:

- Landfill 1 (Site 1);
- Landfills 4, 5, Waste Burial Area (Sites 4, 5, and 10);
- Fire Department Training Area 2 (Site 12);
- Flightline Drainage Ditch (Site 13);
- Entomology Dry Well (Site 15);
- Unnamed Stream (Site 16);
- POL Tank Farm (Site 17);
- Base Service Station (Site BSS); and
- the Weapons Storage Area (Site WSA).

TABLE 14. SUMMARY OF RECOMMENDED ACTIONS FOR IRP SITES AT CARSWELL AFB, TEXAS

Site(s)	Preliminary <sup>1</sup> Ranking	Recommended Action	Rationale <sup>2</sup>
1	3*	<ul style="list-style-type: none"> <li>• Continue monitoring of existing wells.</li> <li>• Proceed with detailed evaluation and selection of remedial alternative.</li> </ul>	<ul style="list-style-type: none"> <li>• Limited contamination of ground-water by metals.</li> <li>• Low potential for human exposure to contaminants.</li> <li>• Site is adequately characterized.</li> </ul>
3	NR	<ul style="list-style-type: none"> <li>• Continued monitoring of existing well.</li> <li>• No further action (besides monitoring).</li> </ul>	<ul style="list-style-type: none"> <li>• Some metals above MCLs, otherwise no evidence of contamination.</li> <li>• Low potential for human exposure to site.</li> </ul>
4, 5, 10	6-7*	<ul style="list-style-type: none"> <li>• Install additional monitor wells.</li> <li>• Continue monitoring of all wells.</li> <li>• Collect surface water samples at Farmers Branch and golf course ponds.</li> <li>• Conduct aquifer pumping test(s).</li> <li>• Proceed with detailed evaluation and selection of remedial alternatives.</li> </ul>	<ul style="list-style-type: none"> <li>• Extent of TCE plume in upper zone groundwater needs to be defined.</li> <li>• Possible connection between surface water and ground water should be investigated.</li> <li>• Aquifer characteristics need to be defined to support possible long-term remedial actions.</li> </ul>

(Continued)

TABLE 14. (Continued)

Site(s)	Preliminary <sup>1</sup> Ranking	Recommended Action	Rationale <sup>2</sup>
11	NR	<ul style="list-style-type: none"> <li>• Continued monitoring of existing wells.</li> <li>• No further action (besides monitoring).</li> </ul>	<ul style="list-style-type: none"> <li>• No contamination of ground water (except 1 well with metals above MCL). Monitoring is necessary to ensure that limit of TCE is evaluated.</li> </ul>
12	1	<ul style="list-style-type: none"> <li>• Carswell AFB should proceed with installation of concrete liner at FDTA 2, including removal of near-surface contaminated soil.</li> <li>• Continued monitoring of existing wells.</li> <li>• Proceed with detailed evaluation and selection of remedial alternative to mitigate contaminants at depth.</li> </ul>	<ul style="list-style-type: none"> <li>• Site is adequately characterized.</li> <li>• Low potential for human exposure to contaminants.</li> <li>• Existing conditions at site lead to uncontrolled releases of contaminants to soil, surface water.</li> <li>• Contaminants observed in ground water, but not closely related to TCE plume at Sites 4, 5, and 10.</li> <li>• Soil contaminants and vapors at depth may require mitigation to prevent additional contamination of ground water.</li> </ul>

(Continued)

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TABLE 14. (Continued)

Site(s)	Preliminary <sup>1</sup> Ranking	Recommended Action	Rationale <sup>2</sup>
13	3*	<ul style="list-style-type: none"> <li>Remove sediment and contaminated soil from ditch before remedial action implemented.</li> <li>Proceed with detailed evaluation and selection of remedial alternative.</li> </ul>	<ul style="list-style-type: none"> <li>Existing contaminants in ditch represent possible continued degradation of surface-water quality.</li> <li>Site is adequately characterized, ready for remedial action.</li> </ul>
15	3*	<ul style="list-style-type: none"> <li>Continued monitoring of existing wells.</li> <li>Proceed with detailed evaluation and selection of remedial alternative.</li> </ul>	<ul style="list-style-type: none"> <li>Site is adequately characterized, ready for remedial action.</li> <li>Pesticides and herbicides in surface soil are potential contaminants shallow ground water.</li> </ul>
16	2	<ul style="list-style-type: none"> <li>Install monitor wells at the old gasoline station.</li> <li>Continued monitoring of the unnamed stream.</li> <li>Proceed with detailed evaluation and selection of remedial alternative.</li> </ul>	<ul style="list-style-type: none"> <li>Stage 1 data and presence of aromatic hydrocarbon compounds in stream indicate upgradient ground water contamination.</li> </ul>

(Continued)

TABLE 14. (Continued)

Site(s)	Preliminary <sup>1</sup> Ranking	Recommended Action	Rationale <sup>2</sup>
17	5	<ul style="list-style-type: none"> <li>• Install additional monitor wells.</li> <li>• Continued monitoring of wells and inspection of wells for liquid hydrocarbon product.</li> <li>• Proceed with detailed evaluation and selection of remedial alternative.</li> </ul>	<ul style="list-style-type: none"> <li>• Limit of petroleum hydrocarbon contamination in ground water is not completely determined.</li> </ul>
BSS	3*	<ul style="list-style-type: none"> <li>• Continued monitoring of all wells.</li> <li>• Proceed with detailed evaluation and selection of remedial alternatives.</li> </ul>	<ul style="list-style-type: none"> <li>• Ground water contains petroleum hydrocarbons in limited areas.</li> <li>• Site is characterized adequately to support additional feasibility study.</li> </ul>
WSA	4	<ul style="list-style-type: none"> <li>• No further field investigation.</li> <li>• Proceed with detailed evaluation and selection of remedial alternatives for TCE in surface soil.</li> </ul>	<ul style="list-style-type: none"> <li>• Site is adequately characterized. Small amounts of TCE exist in surface soil.</li> </ul>

Note: 1. Preliminary ranking based on qualitative risk assessment: 1 = greatest need for action, NR = not ranked (no further action necessary). Asterisk indicates tie in ranking.  
 2. See Chapter 6 for specific data and rationale concerning recommended actions.

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facilities) and provide the information to EPA. To ensure compliance with these hazardous waste regulations, the Department of Defense developed the IRP.

In 1980, Congress enacted the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), also known as Superfund. This act sets forth responsibility for the identification and cleanup of contaminated sites within the United States and its possessions. This Superfund Act also designated EPA as the policy and enforcement agency.

Also in 1980, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) was issued to provide response guidance and a process by which to report contaminant releases, identify and quantify contamination, and select appropriate remedial actions. The NCP describes the responsibility of the Federal government, state governments, and parties responsible for the release.

In 1981, President Reagan signed Executive Order 12316, which delegated the role as lead agency to various Federal agencies [DOD, U.S. Department of Energy (DOE)] to conduct investigations and implement cleanup when they are the sole or co-contributor to contamination on or off their properties.

The IRP predated CERCLA and was initiated by DOD to carry out its role as lead agency to identify potentially contaminated sites, investigate these sites, and evaluate and select appropriate remedial actions. The IRP was organized into the following four phases:

- Phase I Records Searches;
- Phase II Confirmation and Quantification Studies;
- Phase III Technology Development; and
- Phase IV Remedial Action Plans and Implementation.

Phase I Records Searches were installation-wide studies that identified and assessed past disposal sites. File material, site visits, and interviews provided the information for these initial assessments. These assessments considered whether or not each site posed hazards to public health or to the environment. If a site presented little or no apparent hazard, it did not proceed to subsequent phases. If a site presented an imminent threat to public health, an emergency response, which was considered a Phase IV action, was taken. If sampling and evaluation to confirm the suspected hazard was required, Phase II studies were initiated. Sites identified in Phase I were rated by the USAF's Hazard Assessment Rating Methodology (HARM), a system that ranked the site for its potential hazards to the public and/or environmental resources.

CH<sub>2</sub>M-Hill was retained by the U.S. Air Force Strategic Air Command (SAC) to conduct the Phase I investigation at Carswell Air Force Base (CAFB), Texas. The final records search was published in February 1984 (CH<sub>2</sub>M-Hill, 1984).

Phase II Confirmation and Quantification Studies confirmed the presence or absence of contamination, determined the extent and degree of contamination, and provided the basis for selecting the appropriate type of remedial action. During this phase, groundwater, surface water, soil and sediment samples are collected and analyzed. Geologic profiles are typically defined by drilling. The Phase II Stage I survey was conducted by Radian Corporation; the Final report was completed in October 1986 (Radian, 1986).

If the Phase II studies revealed no contamination that threatened human health or the environment, then the results were documented and no further action was taken on the site. Phase II sampling at some sites may not detect enough contamination to justify costly remediation projects, but the development of future threats was still a possibility. The approach used for such sites is generally additional monitoring, which included continued site surveillance by a program of water, soil, or sediment analysis. Sites which are shown to be a threat typically proceeded to Phase IV.

Phase III Technology Development efforts may not be undertaken for every site but are intended to improve site investigation and cleanup technology through research, development, and testing. Phase III may be initiated for sites that could not be controlled with proven technology or for sites that were suitable for evaluating new technologies, such as in-place degradation of organic materials (such as JP-4) through the use of naturally occurring soil bacteria.

Phase IV usually is conducted in two stages. Phase IVA Remedial Action Plans (RAPs) documented the development, evaluation, and selection of alternatives to control the hazards posed by a waste disposal site. Selection of the best alternative is based on engineering feasibility, cost, environmental effects, public health effects, and compliance with regulatory requirements. Phase IVB is implementation of the selected alternative and normally included design, construction, and management methods (non-structural control measures). Long-term monitoring was often performed in association with site cleanup to ensure compliance with contaminant standards or achievement of cleanup goals.

In October 1986, President Reagan signed into law the Superfund Amendments and Reauthorization Act (SARA) of 1986. This law extends the requirements of CERCLA but modifies CERCLA with respect to the goals of cleanup and the process leading to the selection of a remedy. Under SARA, technologies that provide permanent removal or destruction of a contaminant are preferable to action which only contains or isolates the contaminant. SARA also provides for greater interaction with the public and state agencies and extends EPA's role in evaluation of the health risks associated with the contamination. Under SARA, early determination of the applicable or relevant and appropriate requirements (ARARs) is required, and consideration of potential remediation alternatives should be considered at the initiation of a remedial investigation/feasibility study (RI/FS).

In November 1986, in response to SARA and in consideration of various EPA interim guidance, USAF modified the IRP to provide for a RI/FS program. To accomplish this, the IRP was expanded to incorporate elements of Phases II and IV. The intent is to conduct the RI/FS in parallel instead of serial fashion. The program is now oriented to include ARAR determinations, identification and screening of technologies, and development of alternatives. It may include multiple field activities and pilot studies prior to the detailed final analysis of alternatives.

In order to develop the necessary data base to complete the detailed final analysis of alternatives, multiple field efforts may be required during the RI/FS process. These multiple field efforts are conducted in stages. The Stage 1 field effort was completed in 1985 (Radian, 1986).

In July 1987, President Reagan signed Executive Order 12580, which replaced EO 12316. This order delegated responsibility to conduct site investigations and cleanups at Federal facilities to the Secretaries of various agencies. This order defined relationships between various Federal and state agencies and provided EPA with the role as facilitator in dispute resolutions.

#### 1.1.2 Program Objectives

The objective of the current IRP is to develop and select appropriate and cost-effective solutions to remediate contamination resulting from USAF operations, which pose an existing or potential risk to human health or the environment. This objective is met through a well-defined and technically sound approach in accordance with CERCLA, NCP, and SARA. The solutions that are developed should provide the level of protection necessary to protect public health and the environment, meet the requirements of ARARs, and be technically feasible to implement at the site.

In order to meet this overall objective, several other program objectives must be met:

1. A defensible database must be developed through good field practice and rigorous analytical procedures.
2. A quality assurance/quality control (QA/QC) program must be developed and implemented to assure the production of meaningful and defensible data.
3. A site and laboratory safety program must be developed and followed to protect the health of personnel and prevent the release of any contaminants.
4. A rigorous procedure must be utilized to identify, evaluate, and select appropriate solutions.
5. Data gaps must be identified, and appropriate additional or supplemental studies must be recommended and executed during the course of performing the program. This includes additional field and/or analytical data collection as well as the evaluation of candidate technologies.
6. The program must be conducted in compliance with appropriate Federal regulations and available guidance.
7. The public and regulatory agency must be provided information regarding the nature of the contamination, the effects upon the community, the progress of the program, and the preferred remedial alternative and its impacts.

1.1.3 Program Organization

The current IRP consists of several steps, including a preliminary assessment, followed by a RI/FS program (or a no-action recommendation) screening of remedial alternatives, selection of a preferred alternative, and the design and implementation of the selected remedial action alternative.

In the preliminary assessment, a survey of a base or site is conducted to determine if past operations or disposal practices may have resulted in a potential release of contamination. This process includes a records search to document what potential contaminants were used, stored, and disposed and where such activities were conducted. If a release is suspected, an initial sampling and analytical program is recommended to confirm the presence of and identify target contaminants.

This preliminary assessment phase has been completed by USAF, resulting in a determination of bases and sites on bases for which either a RI/FS program is recommended or there is no evidence of contamination and no further actions are required.

The purpose of the RI/FS is to systematically:

1. Identify and prioritize contamination sources with respect to hazard,
2. Determine the nature and extent of contamination or conclude that no significant adverse impact exists,
3. Plan and conduct field activities that will support the selection and eventual design of appropriate remedial actions,
4. Determine the risk and pathways of the identified contamination to various human and environmental receptors, and
5. Develop appropriate remedial alternatives.

The RI/FS program involves a preliminary sampling and analysis effort leading to the development of alternatives. If necessary, a more detailed sampling and analysis effort will be conducted to delineate contamination and quantify pathways to aid in the selection of alternatives.

The RI/FS of the IRP encompasses several key elements necessary to select an appropriate remedial action. These include:

1. Determination of the Federal and state ARARs.
2. Development of the data quality objectives (DQOs) necessary to be consistent with the ARARs and achievable with acceptable field and analytical procedures.
3. Performance of a response field investigation of the impacted media along with collection of sufficient hydrogeologic information to assess contamination movement and pathways and to support development of potential alternatives. The field investigation may be conducted in one or more efforts depending on the results of the initial field work. This phase is described in CERCLA and NCP as the Remedial Investigation (RI).
4. Determination of the hazards by quantifiably evaluating the impact on receptors through the pathways of surface water, groundwater, biota, and air. This incorporates the exposure and risk assessment as required under CERCLA, NCP and SARA and defined in the Superfund Public Health Evaluation Manual.
5. Determination of those sites where the results of the field investigation and risk assessment indicate no significant threat to human health or welfare or the environment, and a preparation of a Decision Paper identifying and necessary control measures or no need for further action.
6. Development of a set of potential alternatives consisting of appropriate technologies that can remove the contamination or control its migration. These alternatives should provide a range of reduction of the mobility, toxicity, or volume (MTV) associated with the contamination and meet or exceed the ARARs.





**Residential Documents**

**Executive Orders**

- |          |   |
|----------|---|
| EO 12088 | Federal Compliance with Pollution Control Standards (13 October 1978) |
| EO 12580 | Superfund Implementation (23 January 1987)                            |

**U.S. Environmental Protection Agency**

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|------------------|--|
| EPA-330/9-51-002 | MEIC Manual for Groundwater/Subsurface Investigations of Hazardous Waste Sites |
|                  | Superfund Exposure Assessment Manual (January 1986)                            |
| EPA-600/4-79-020 | Methods for Chemical Analysis of Water and Wastes (1983)                       |
| SW-846           | Test Methods for Evaluating Solid Waste, Third Edition (1986)                  |

**American Public Health Association (APHA, AWWA, & WPCF)**

- Standard Methods for the Examination of Water and Wastes (16th Edition)

**American Society for Testing and Materials**

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|-------------------------------|--|
| D-1452                        | Soil Investigation and Sampling by Auger Boring              |
| D-1586                        | Penetration Test and Split-Barrel Sampling of Soils          |
| D-2487                        | Unified Soil Classification System                           |
| D-2488                        | Recommended Practices for Visual-Manual Description of Soils |
| Annual Book of ASTM Standards | Section 11, Water and Environmental Technology               |

**Handbooks**

**U.S. Environmental Protection Agency**

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|------------------|--|
| EPA-540/G-85-002 | Guidance on Remedial Investigations under CERCLA |
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EPA-540/G-85-003

Guidance on Feasibility Studies under  
CERCLA

Analytical Chemistry

Vol. 55, Pages 2210  
2218, December 83

Principles of Environmental Analysis

For a base-specific investigation, IRP documents that report the findings of preliminary assessment or initial RI/FS (Phase I) activities are the primary source documents for conducting continuing investigations. The principal documents for the Carswell AFB IRP RI/FS (Stage 2) investigations were:

- CH2M-Hill, Installation Restoration Phase I Records Search for Carswell AFB, Texas, February 1984; and
- Radian Corporation, Installation Restoration Program Phase II - Confirmation/ Quantification, Stage 1 - Final Report, Carswell AFB, Texas, October 1986.

#### 1.1.5 RI/FS Study Objectives

The primary objective of the Carswell AFB IRP RI/FS (Phase II Stage 2) work (hereafter referred to as Stage 2) has been to integrate past and present remedial investigations of the sites at the base in order to provide information needed to conduct feasibility studies. Of principal concern was determining which sites pose a threat to human health or the environment and which sites do not. To meet the objectives of the Stage 2 program for the Carswell AFB IRP, the following tasks were performed:

- Previous Phase I and Phase II Stage 1 work was reviewed and assessed with regard to its adequacy for use in the current effort;

- Procedural and administrative plans were prepared to control the quality and flow of information collected during Stage 2;
- Follow-on field investigations were conducted at incompletely characterized sites;
- Pathway characterization studies were conducted;
- Alternative remedial technologies were identified and screened;
- Applicable or relevant and appropriate requirements (ARARs) were defined and an approach for public health evaluation was developed;
- Sites were evaluated and prioritized according to the extent and magnitude of the threats posed to human health or the environment; and
- Appropriate remedial alternatives were identified and screened.

1.2 Duration of the Carswell AFB IRP

The Phase I (Initial Assessment/Records Search) study to identify waste handling procedures and disposal practices was completed in 1984 (CH2M-Hill, 1984). Later in 1984, the Phase II Stage 1 program began in an effort to determine the magnitude and extent of contamination, if any, resulting from sites identified during the Phase I investigation. The final report for the Phase II Stage 1 investigation was issued in 1986 (Radian, 1986).

Authorization to proceed on the RI/FS Stage 2 work was given on 25 September 1987. Field activities began in December 1987 were completed in April 1988. The field work consisted of:

- Soil gas surveys;
- Coring and sampling of near-surface soil at various locations;
- Installation of upper zone monitor wells;
- Performance of slug tests;
- Sampling of surface water; and
- Sampling of ground water from monitor wells.

### 1.3 Historical Waste Handling Practices

Carswell AFB was established in 1942 in Tarrant County, Texas at a location approximately 6 miles west of downtown Fort Worth (Figure 1.3-1). Historical waste management practices at Carswell AFB were discussed in the Phase I report (CH2M-Hill, 1984) and are summarized in the following paragraphs.

Wastes have been generated and disposed of at Carswell AFB since the beginning of industrial operation in 1942. Major industrial operations at Carswell AFB include: maintenance of jet engines, aerospace ground equipment (AGE), fuel systems, weapon systems, and pneudraulic systems; maintenance of general and special purpose vehicles; aircraft corrosion control; and non-destructive inspection (NDI) activities. All of these operations generate wastes--primarily oils, lubricants, recoverable fuels, spent solvents, and cleaners.

Practices for past and present industrial waste disposal are summarized below:

- 1942-1970: The majority of waste oils, recovered fuels, spent solvents, and cleaners were burned at the fire department training areas during practice exercises. Some waste oils and spent solvents were disposed of through contractor removal, while some waste paints (contaminated with thinners and solvents), waste oils, and PD-680 (a cleaning solvent) are

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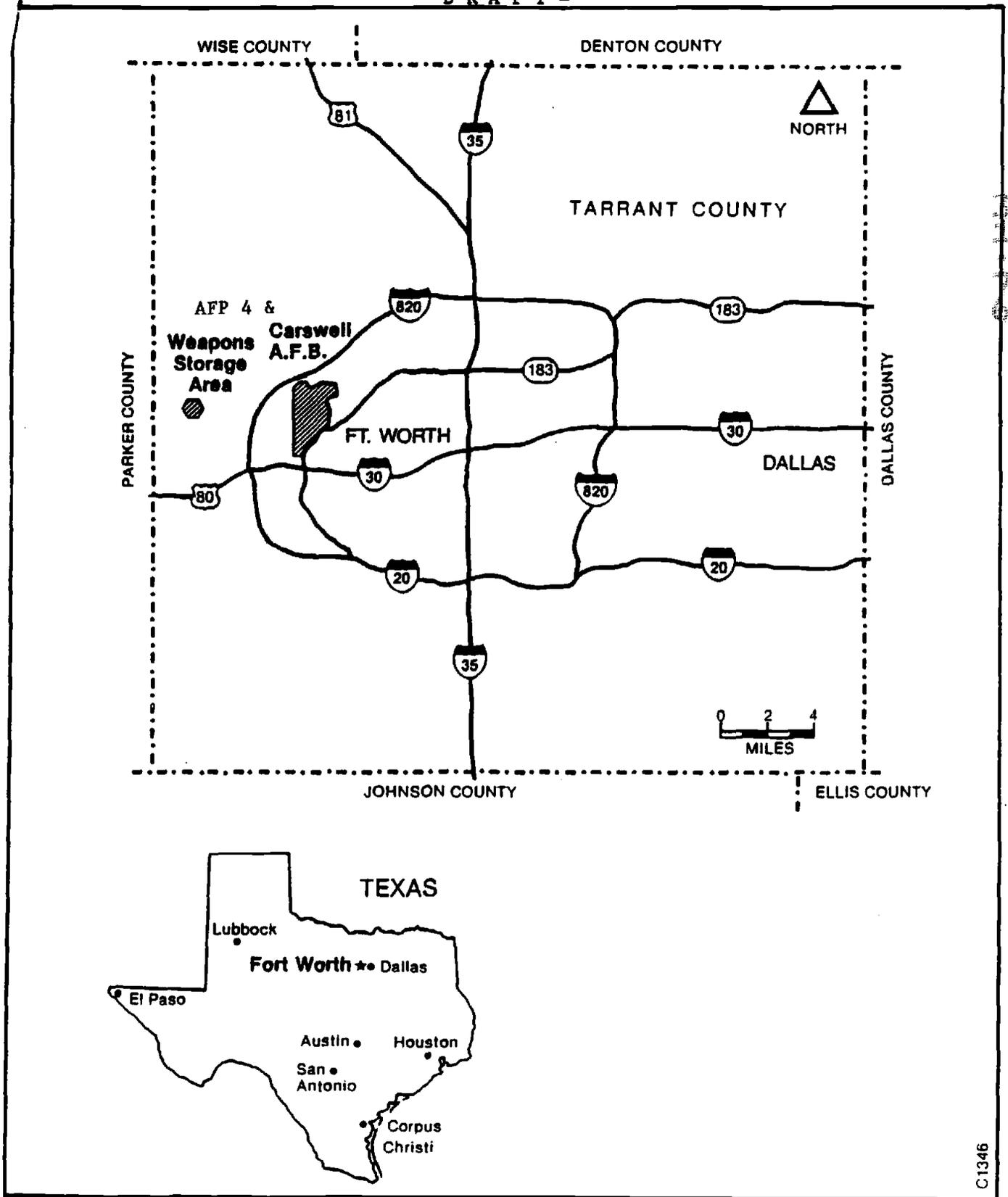


Figure 1.3-1. Regional Setting of Carswell AFB, Texas

suspected of having been disposed of in the base landfills. Some waste oils, recovered fuels, spent solvents, and cleaners were also discharged to sanitary and storm sewers. These discharges occurred primarily at the washracks. In 1955, an oil/water separator (Facility 1190) was installed to recover waste materials discharged from the washracks. Materials from the oil/water separators were pumped out and disposed of through contractor removal. Discharge from the oil/water separator was, and still is, pumped into the sanitary sewers.

- 1971-1975: During this period, most waste oils, spent solvents, and cleaners were disposed of by contractor removal. A private contractor would pump the materials from oil/water separators and from 55-gallon drums and bowlers. Recovered JP-4 was still stored at the fire department training area and burned in practice exercises. Recovered JP-4 was also reused in AGE operations. Some waste paints (contaminated with thinners and solvents), waste oils, and PD-680 are suspected of having been disposed of in the base landfills. Some waste oils, solvents, and cleaners were discharged into sanitary drains, primarily occurring at the washracks that discharge to the Facility 1190 oil/water separator. This oil/water separator was routinely pumped out by a private contractor and the recovered materials removed from the base by the contractor.
- 1976-1982: The majority of waste oils, spent solvents and cleaners were disposed of by service contract either directly or through the Defense Reutilization and Marketing Office (DRMO). Recovered JP-4 was stored at the fire department training area and burned during practice exercises. Recovered JP-4 was also used in AGE operations. PD-680 used at the washracks was discharged to the Facility 1190 oil/water separator which discharges to the sanitary sewers.

- 1983-Present: Waste oils, solvents, and cleaners have been collected in 55-gallon drums and temporarily (less than 90 days) stored at 12 hazardous waste accumulation points located throughout the flightline area of the base. They are subsequently disposed of by contractor removal through DRMO. Recovered JP-4 fuel is stored at the fire department training area for subsequent burning in practice exercises or is reused in AGE operations. Removal of waste oils and PD-680 (Type II) from oil/water separators is also handled by an off-base contractor through DRMO.

#### 1.4 Description of IRP Sites

The preliminary assessment (CH<sub>2</sub>M-Hill, 1984) identified 17 disposal and spill sites at Carswell AFB and 5 sites at the Weapons Storage Area (WSA) located west of Carswell AFB. Several of these sites were determined not to have significant potential for adverse environmental consequences. The potential environmental consequences of the remaining 14 sites were evaluated using the U.S. Air Force Hazard Assessment Rating Methodology (HARM). This evaluation, performed by CH2M-Hill, took into account such factors as potential receptors of contamination, the nature of the waste, potential pathways for contaminant migration, and efforts to contain any potential contamination.

The RI/FS Stage 2 at Carswell AFB has focused on 12 sites located on the base (Figure 1.4-1), and 1 site located at the WSA (Figure 1.4-2). Plate 1 illustrates the locations and details of all Stage 2 sites at Carswell AFB and the WSA. These sites consist of landfills, fire department training areas, industrial areas, spill sites, and a gasoline service station. One group of sites is near the flightline and another group of sites is concentrated near the main gate at the east side of the base. The IRP sites, except for the Base Service Station, were prioritized according to their HARM rating, as shown in Table 1.4-1. The Base Service Station was not included in

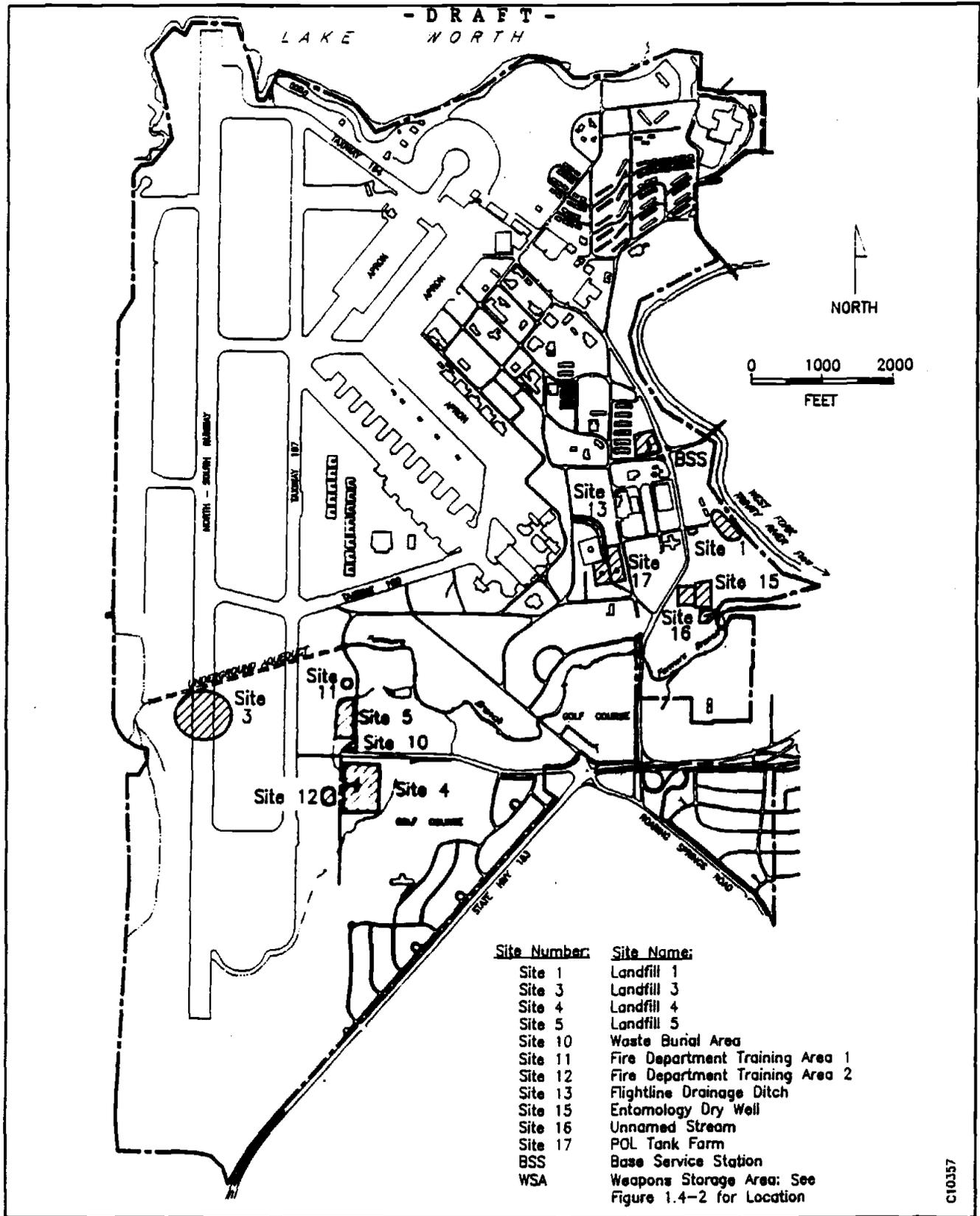
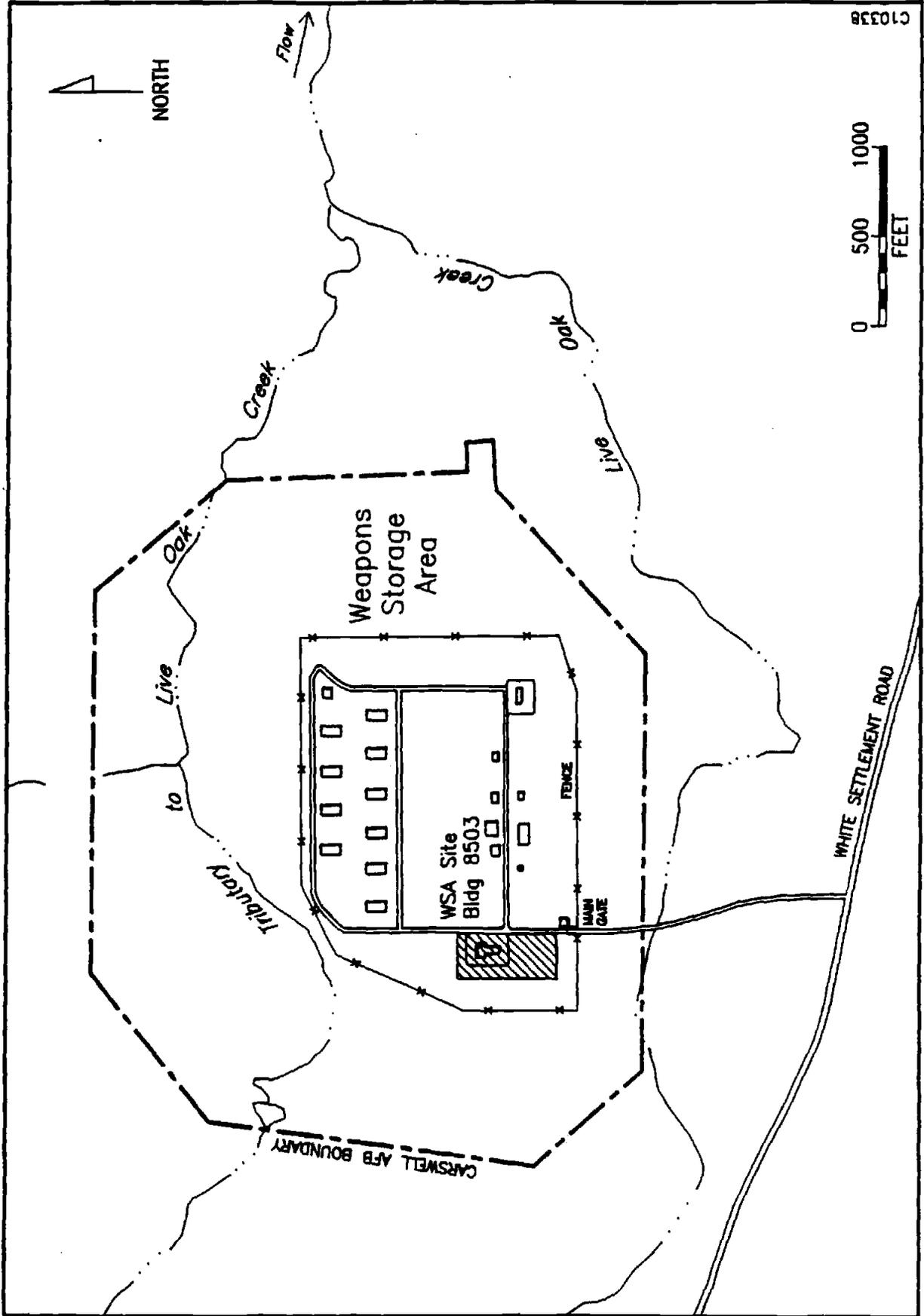


Figure 1.4-1. Location of RI/FS Stage 2 Sites, Carswell AFB, Texas



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Figure 1.4-2. Location of the Weapons Storage Area Site, Carswell AFB, Texas

TABLE 1.4-1. PHASE I PRIORITIZED SITE LISTING, CARSWELL AFB, TEXAS

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On-Base Facilities:

1. Site 13, Flightline Drainage Ditch
2. Site 12, Fire Department Training Area 2
3. Site 17, POL Tank Farm
4. Site 10, Waste Burial Area
5. Site 16, Unnamed Stream
6. Site 15, Entomology Dry Well
7. Site 1, Landfill 1
8. Site 4, Landfill 4
9. Site 5, Landfill 5
10. Site 11, Fire Department Training Area 1
11. Site 3, Landfill 3

Off-Base Facilities:

Inspection Shops at the Weapons Storage Area

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Source: CH2M-Hill, 1984.

the HARM rating because it was designated as an IRP site after the RI/FS Stage I investigation was completed. The descriptions and general features of each Stage 2 site are discussed below in order of their HARM rankings.

1.4.1 Flightline Drainage Ditch (Site 13)

This site consists of a drainage ditch located east of Haile Drive, directly east of the main aircraft washrack and Hangers 1048 and 1049. This ditch receives run-off from the flightline area via a three-foot concrete drainage conduit located underneath Haile Drive. This ditch is unlined from its beginning at Haile Drive to its intersection with the POL Tank Farm, where the ditch becomes concrete-lined. The ditch enters a storm sewer at the intersection of Knights Lake Road and Hobby Shop Road. Where the sewer meets Farmers Branch near the base main gate, the flow is diverted by underground pipeline to the NPDES outfall (outfall 0004) at Jennings Drive.

In addition to receiving normal storm runoff, the flightline drainage ditch receives discharge from the aircraft washracks and from the Fuel Systems Shop. Washrack wastes are discharged to an oil/water separator adjacent to the ditch; however, a valve in the drain line from the washracks to the separator can be opened, allowing discharge to bypass the separator and flow directly into the flightline drainage ditch.

1.4.2 Fire Department Training Area 2 (Site 12)

Site 12 is located between the north-south taxiway and the radar facility. This site, with only slight modifications, has been used as a fire department training area since 1963. The fire ring is gravel-lined with a low earthen berm around its perimeter. In the past, a pit was present at the site to collect runoff from training exercises, but this pit has been filled.

Two tanks located at the site have been used for storage of flammable liquids prior to training exercises. An 8,500-gallon aboveground tank is used to store clean or contaminated fuels, which are delivered to the ring

100-100

100-100

100-100

100-100

via a pump and various pipes. An underground tank of approximately 9,500 gallons has been used for storage of waste oils and solvents from the flight-line shops. Although normal disposition of the underground tank contents has been to off-base contractors, it is possible that contents of this tank have also been used for training exercises in the past.

1.4.3 POL Tank Farm (Site 17)

The POL Tank Farm is located along Knight's Lake Road, near the Carswell AFB main gate. Currently, the site consists of three aboveground tanks. Three additional tanks were formerly located at this site, but have been dismantled. During the early 1960s, fuels were discovered in the ground in this area, and also downgradient from this site. A french drain system was installed downgradient from this area to collect fuels in the ground. The french drain discharged through the oil/water separator at Site 16 (Section 1.4.5). At that same time, the leaking underground POL pipes were reportedly located and replaced. No additional loss of POL to the ground is suspected to have occurred in this area since 1965. The french drain system is still continuing to collect POL as evidenced by the results of the Unnamed Stream observed during the site visit.

1.4.4 Waste Burial Area (Site 10)

Site 10, located adjacent to and north of White Settlement Road, where it dead-ends at the taxiway, was used for burial of wastes during the 1960s. Various types of hazardous materials, including drums of cleaning solvents, leaded sludge, and possibly ordnance materials, were reported disposed of at this site. Reportedly, these materials were buried in a natural impermeable clay strata. The site is currently identified by several signs reporting the presence of buried tetraethyl lead sludge.

1.4.5 Unnamed Stream (Site 16)

The Unnamed Stream is a small tributary of Farmers Branch that emerges from an underground oil/water separator (Facility 38). This small stream and separator are located south of the new communications building (Bldg. No. 1337) and immediately south of the fenced civil engineering storage yard. The oil/water separator is connected to a french underdrain system which was reportedly built in 1965 to capture hydrocarbon contaminants leaking from the POL Tank Farm into sewer pipes. The Unnamed Stream receives perennial flow from ground water entering the french drain and separator.

1.4.6 Entomology Dry Well (Site 15)

Site 15 is located immediately west of the space occupied by the entomology shed (Bldg. 1338) before its removal in 1981. Site 15 now occupies a graded, partially paved lot in the vicinity of the new communications building (Bldg. No. 1337). Building No. 1338 was used for the storage and mixing of insecticides and for the storage and cleaning of spray equipment. A dry well at the site was used for the disposal of insecticide rinsate between 1965 and 1981. Due to the dismantling of entomology shed facilities and grading of the site, the location of the former dry well has not been determined.

1.4.7 Landfill 1 (Site 1)

Landfill 1 was reported to be the original base landfill and was operated during the 1940s. This site is located adjacent to the Trinity River levee at the same spot as the current Defense Reutilization and Marketing Office (DRMO) storage yard. Due to the time elapsed since this site was closed, no information was available concerning past waste disposal practices at this location.

1.4.8 Landfill 4 (Site 4)

Landfill 4 was operated from approximately 1956 until 1975. This site, which includes 10 acres of land east of the runway and is currently the location of the radar site, was the main landfill during much of the history of Carswell AFB. All base refuse was buried here and burning was a regular practice. At least six large pits, approximately 12 feet deep were filled with refuse which was burned and buried. Various materials suspected of being hazardous were reportedly disposed at this site, including drums of waste liquids, partially full paint cans, and cadmium batteries. Written records indicate that routine disposal of waste paints, thinners, and strippers; oil containing adsorbent materials; PD-680 (a safety cleaning solvent) and oils may have been practiced at this location.

1.4.9 Landfill 5 (Site 5)

Landfill 5 was reportedly used between 1963 and 1975. This site is located northwest of Landfill 4 and was constructed adjacent to a small tributary to Farmers Branch. The landfill site was constructed by building a clay berm adjacent to the creek and then filling the area behind the berm up to its existing level. This fill site received all types of flightline wastes and refuse, and was regularly burned prior to covering.

1.4.10 Fire Department Training Area 1 (Site 11)

Site 11 was located near Landfill 5. This training area was the primary fire pit prior to 1963. The pit reportedly was adjacent to a small tributary to Farmers Branch, was gravel-lined, and had a low concrete curb around its perimeter. Several fire training exercises are reported to have taken place at this site each month, with waste oils and contaminated fuels being the primary flammable liquids used in the exercises. Small quantities of solvents are also reported to have been used in these exercises.

1.4.11 Landfill 3 (Site 3)

Landfill 3 is located under the present runway, immediately south of the culvert that carries the flow of Farmers Branch. The landfill occupied a ravine that was present when the runway ended north of Farmers Branch. Landfill 3 was used between 1950 and 1952 for the burial of all types of waste, but primarily construction rubble.

1.4.12 Base Service Station (BSS)

The Base Service Station (BSS) is located on the northwest corner of Rogner Dr. and Jennings Dr. Gasoline is stored in several underground tanks located north of the pump islands. Drainage from the BSS is to culverts adjacent to Rogner Dr. The BSS has been in operation for less than 20 years, having replaced the gasoline station formerly located near the main gate and Site 15.

1.4.13 Weapons Storage Area (WSA)

The WSA is the only off-base facility included in the Phase II study. The area is located approximately five miles west of Carswell AFB, north of White Settlement Road. The facility is on 247 acres of fee-owned land and is surrounded by an additional 264 acres of easement. The land in the WSA consists of unimproved pasture heavily grazed by beef cattle and of natural oak woodlands populated by white-tail deer and coyotes. The WSA is located between two forks of Live Oak Creek, which flows east to its discharge point of Lake Worth. Elevations in the area range from 720 to 800 feet MSL.

The WSA facility was built in 1956. The site includes two munitions inspection shops, 16 ordnance storage buildings, one entry-control building, an emergency power plant, an Explosive Ordnance Disposal (EOD) range, a radioactive waste disposal facility, a water storage tank, and two water wells.

It has been reported that waste cleaners and solvents (suspected paint thinners and trichloroethene) have occasionally been disposed of on the ground behind the Inspection Shop. Quantities were estimated to be 5 to 10 gallons per year.

### 1.5 Summary of Contaminants at IRP Sites

The RI/FS Stage 1 investigation (Radian, 1986) documented the presence of organic contamination, mostly trichloroethylene (TCE), in the upper zone soil and ground water at several sites. Concentrations of heavy metals were typically at background levels. Low levels of organic compounds were detected in small tributaries of Farmers Branch in the vicinity of several sites at the flightline. Appendix H contains the results of soil and water analyses from the RI/FS Stage 1 investigation. The following paragraphs briefly summarize the results of preliminary assessment and RI/FS Stage 1 studies at each site. These sites are again listed in priority according to their HARM rankings.

#### 1.5.1 Flightline Drainage Ditch (Site 13)

Field activities during the preliminary assessment identified aircraft soap entering the flightline drainage ditch, petroleum products on the water surface in the ditch, and the presence of a dark zone of fuel or oil saturation along banks of the ditch. Discharge into the flightline drainage ditch from the aircraft washracks include PD-680 (cleaning solvent) and JP-4 jet fuel from the Fuel Systems Shop.

RI/FS Stage 1 sampling confirmed that soils at the Flightline Drainage Ditch are contaminated with jet fuel, detergents, or both. It was observed that the distribution of contaminants is somewhat erratic, suggesting that contaminant mobility and infiltration are controlled by local variations in soil composition and texture.

1.5.2 Fire Department Training Area 2 (Site 12)

Results of the RI/FS Stage 1 analyses at Site 12 indicated that halogenated and aromatic organic compounds were present in the soil (at concentrations ranging from not detected to 752 ug/g) and in the ground water (at concentrations ranging from not detected to 362 ug/L). The highest levels of contamination occurred in the center of the site, where benzene, toluene, and ethyl benzene were detected in the soil (at concentrations ranging from not detected to 752 ug/g, 134 ug/g, and 110 ug/g, respectively). TCE also occurred in ground water downgradient (north and east) of the site, but in lower concentrations (ranging from not detected to 362 ug/L). The operations at this site have also affected the quality of surface water draining the area. Water samples from a drainage ditch near the site had oil and grease (at concentrations ranging from 1 to 84,000 mg/L) and total organic carbons (at concentrations ranging from 86 to 50,000 mg/L).

1.5.3 POL Tank Farm (Site 17)

During the Stage 1 investigation, organic compounds observed in the ground water (at concentrations ranging from less than 1 to 31,000 mg/L) and soil (at concentrations ranging from less than 1 to 1,300 ug/g) were most likely fuel hydrocarbons. These hydrocarbons originated from the storage and handling of fuels. During the Stage 1 ground-water sampling program, a petroleum odor was noticed along with an oily film in the ground water. One water sample from a borehole suggested that organic solvents (based on total organic halogen levels) may have been present in the ground water.

1.5.4 Waste Burial Area (Site 10)

Ground water at this site contains elevated levels of TCE in 3 monitor wells. During the RI/FS Stage 1 investigation, the occurrence of TCE was generally in the range of 1,870 to 5,000 ug/L.

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1.5.5 Unnamed Stream (Site 16)

RI/FS Stage 1 sampling occurred at the Unnamed Stream and the former gasoline station locations. Hydrocarbon fuels (gasoline or JP-4) were detected in the ground water at the site of the former base gasoline station (now removed). Concentrations of oil and grease ranged from less than 1 mg/L to 7,100 mg/L, with high levels of aromatic compounds.

During the preliminary assessment and RI/FS Stage 1 investigations the Unnamed Stream had a petroleum odor, an oily sheen, and extensive growths of reddishbrown, iron-reducing bacteria. Also, analyses completed on the stream by the base Bioenvironmental Engineer in 1983 revealed trace levels of TCE.

1.5.6 Entomology Dry Well (Site 15)

Based on sampling and analysis of soil and ground water from 3 Stage 1 wells, pesticides and herbicides from the former Entomology Building and Entomology Dry Well have not been released in significant quantities into the soil and water. Lindane and endrine were detected in one downgradient well, but at levels which were not quantitatively measurable.

1.5.7 Landfill 1 (Site 1)

Ground water at Landfill 1 contained some elevated levels of oil and grease (at concentrations ranging from not detected to 190 mg/L) and heavy metals, as well as some purgeable halocarbons in low concentrations. Ground-water movement is toward the Trinity River, adjacent to the site.

1.5.8 Landfill 4 (Site 4)

Ground water at Site 4 was found to contain elevated levels of TCE. The occurrence of TCE was generally in the range of not-detected (at upgradient wells south of the site) to 4,290 ug/L (downgradient east of the site).

Most of the ground-water contamination observed was located east of Site 4 at the base golf course. No ground-water contaminants were detected in the Paluxy aquifer.

1.5.9 Landfill 5 (Site 5)

The principal contaminant at Landfill 5 was TCE, which occurred in the ground water ranging from not-detected to 3,280 ug/L. Levels of TCE above federal standards were also discovered in the ground water upgradient of Landfill 5 near the flightline. No ground-water contaminants were detected in the Paluxy aquifer.

1.5.10 Fire Department Training Area 1 (Site 11)

Low levels of TCE were detected in soils collected during the installation of one monitor well (at concentrations ranging from not detected to 0.249 ug/g) . In addition, TCE was also detected in soil samples from hand-augered borings taken at the center of the site and at an upgradient well (at concentrations ranging from not detected to 0.2 to 57 ug/g).

1.5.11 Landfill 3 (Site 3)

A geophysical survey conducted during the RI/FS Stage 1 investigation did not yield conclusive evidence of waste material in the subsurface. Direct sampling of soil or water was not performed in the Stage 1 investigation.

1.5.12 Weapons Storage Area (WSA)

The preliminary assessment identified the inspection shop site, specifically the ground behind Building 8503, as having occasionally been the site of dumping of waste cleaners and solvents (paint thinners). An estimated 5 to 10 gallons of waste per year were disposed on the ground behind Building

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8503. The analysis of soil samples collected west of the Inspection Shop site revealed the presence of TCE (at concentrations ranging from not detected to 0.0619 ug/g).

Ground water from the potable supply well was found to contain total radium (8.5 pCi/L) in excess of federal standards for drinking water.

1.6 Investigation Personnel

The Carswell AFB RI/FS Stage 2 investigation was conducted by staff from the Austin, Herndon (VA), Los Angeles, Irvine (CA), and Houston offices of Radian Corporation. Francis J. Smith (Sept 87 - June 88) and Nelson H. Lund (June 88 - present) served as contract IRP Contract Managers, and William L. Boettner served as IRP Program Manager. These individuals were responsible for the contractual administration of the program. The overall technical program was directed by Lawrence N. French.

Table 1-2 identifies the Radian staff responsible for the completion of the Carswell AFB investigation. The table also lists the subcontractors who provided support to the program. Appendix J contains the resumes of the key Radian staff involved in the RI/FS Stage 2 investigation.

TABLE 1-2. CARSWELL AFB IRP RI/FS STAGE 2 STUDY TEAM

Individual	Function/Role
N.H. Lund F.J. Smith	IRP Contract Managers
W.L. Boettner	IRP Program Manager
L.N. French	Project Director/Delivery Order Manager
G.J. Childs	Soil gas surveys, monitor well installation, soil sampling
W.G. McIntyre	Soil sampling, slug tests, water sampling
S.A. Smith S.A. Langevin M.J. Thompson	Qualitative risk assessment
K.B. Alsup	Feasibility study
R.P. Petrossian G.S. Shaw M.A. Powers	Water sampling
S.E. Fain	Data evaluation
G.L. Patton	Database development, QA/QC
D.J. Radin M.A. Underwood D.F. Baldwin	Database development
J.P. Rossi	Cartography, technical illustrations
B.N. Netherton W.G. Hamer J. Embree	Technical review and editing
<b><u>Subcontractors:</u></b>	
McClelland Engineers	Soil gas study
ATEC Associates	Monitor well installation and soil sampling
Brittian & Crawford	Well location and elevation surveying

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## 2.0 ENVIRONMENTAL SETTING

The following discussion of the Carswell AFB environmental setting is derived primarily from the IRP preliminary assessment report (CH2M-Hill, 1984). In addition to the information supplied from that report, available literature was also used, along with the general findings of this study, and information supplied by the USAF.

### 2.1 Geographic Setting

Carswell AFB is located in north-central Texas in Tarrant County, six miles west of downtown Fort Worth (Figure 2.1-1). The base is bordered by Lake Worth to the north, the West Fork of the Trinity River and the community of Westworth to the east and southeast, the community of White Settlement to the south and southwest and Air Force (AF) Plant 4 to the west. One off-base facility, the Weapons Storage Area (WSA), is included in this study. The WSA location, five miles west of Carswell AFB on White Settlement Road, is also shown in Figure 2.1-1.

#### 2.1.1 Physiography

The majority of Carswell AFB is located within the Grand Prairie section of the Central Lowlands Physiographic Province. This area is characterized by broad terrace surfaces sloping gently eastward, interrupted by westward-facing escarpments. The topography of the base is fairly flat except for areas near Farmers Branch and the Trinity River. The land is typically grass covered and treeless, except for isolated stands of upland timber. The northwestern part of Carswell AFB is within the Western Cross Timbers Physiographic Province that is characterized by rolling topography and a heavy growth of post and blackjack oaks. Elevations on the base range from a high of approximately 690 feet above mean sea level (MSL) at the southwest corner of the base to a low of approximately 550 feet MSL at the east side of the base.

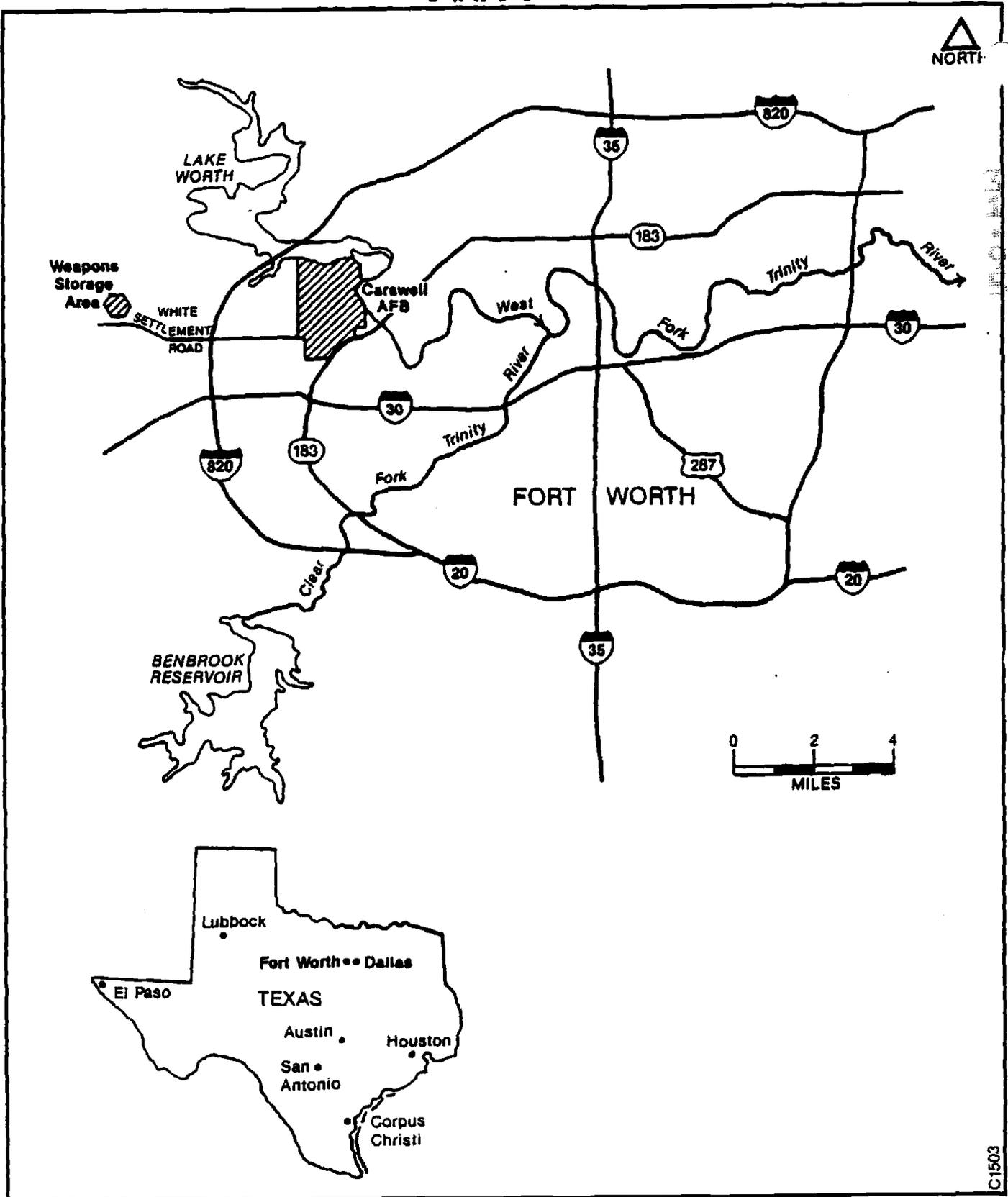


Figure 2.1-1. Regional Setting of Carswell AFB, Texas

2.1.2 Cultural Geography

Land Use

Carswell AFB is surrounded by residential, commercial, recreational, and industrial types of land use. Residential land use occupies areas to the southwest, southeast, and east of the base. Commercial property (shopping mall) lies to the south and recreational property (Lake Worth) is north of the base. AF Plant 4 is an industrial facility located directly west of Carswell AFB.

Demographics

In 1984, the City of Fort Worth had a population of 414,562 and a population density of 1,617 people per square mile. The smaller suburbs of Fort Worth adjacent to Carswell AFB had 1980 population estimates as follows:

White Settlement	-	13,508
Westworth	-	3,651
River Oaks	-	6,890

The total work force at Carswell AFB is approximately 6,100, which includes about 1,000 civilian personnel.

2.2 Geology

2.2.1 Geologic Setting

A geologic section showing the rock formations beneath Carswell AFB is presented in Figure 2.2-1. Descriptions and properties of units pertinent to this study are summarized in Table 2.2-1. From youngest to oldest, the geologic units of interest to Carswell AFB are as follows: 1) Quaternary Alluvium, 2) Cretaceous Goodland Limestone, 3) Cretaceous Walnut Formation, 4)

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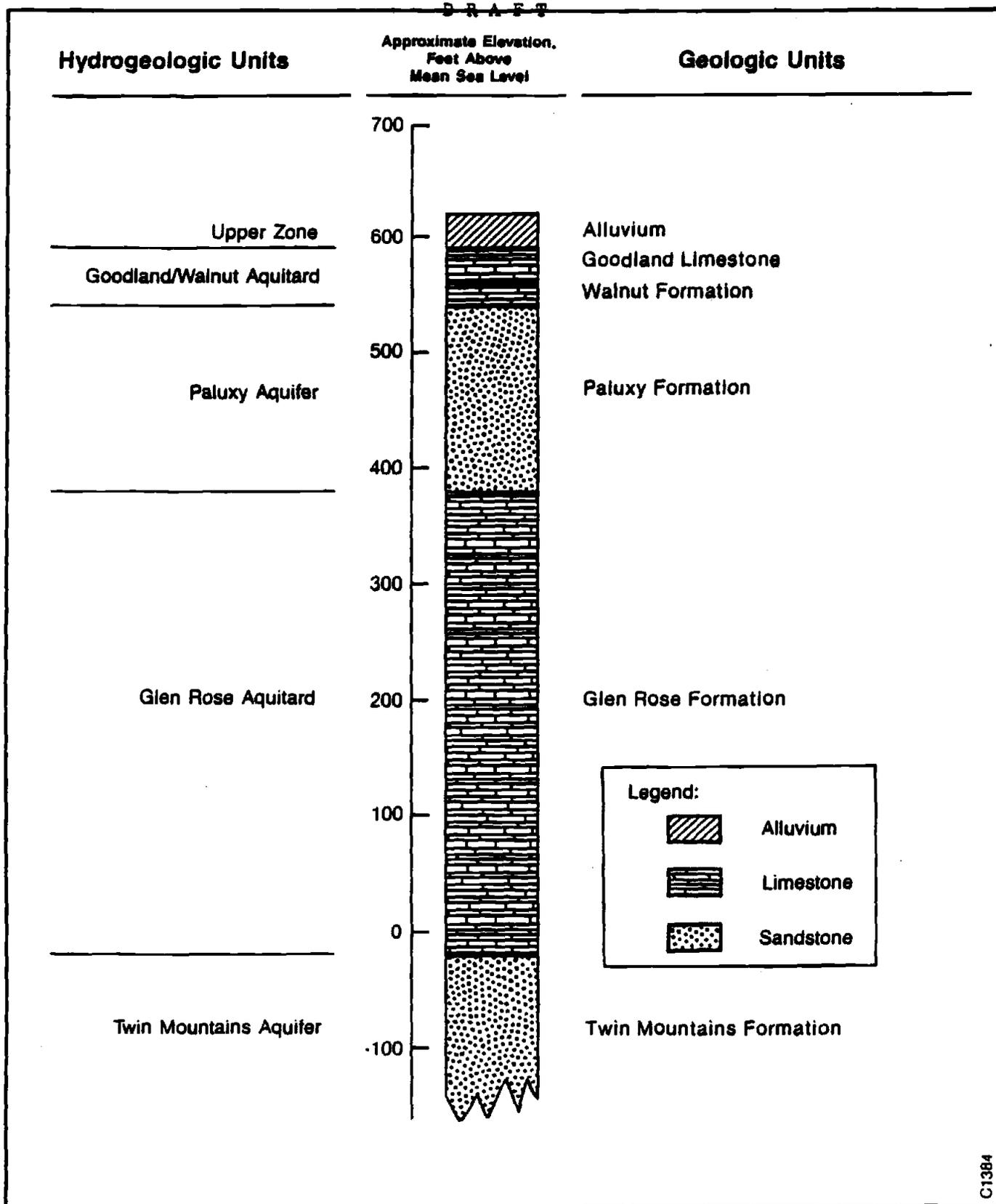


Figure 2.2-1. Stratigraphic Column at Carswell AFB, Texas

**TABLE 2.2-1. GEOLOGIC FORMATIONS IN THE VICINITY OF CARSWELL AFB, TEXAS**

System	Series and Group	Formation and Number	Thickness (ft)	Character of Rocks	Topographic Expression	Water-Bearing Properties		
Quaternary	Recent and Pleistocene Alluvium		0-65	Sandy gravel, clay, and silt.	Terraces and flood-plain deposits.	Soil to moderate yields. Water unsatisfactory for use unless treated.		
		Cretaceous	Comanche Series	Fredericksburg Group	0-25	Impure limestone and marl, which is blue when fresh and straw-colored when weathered. Fossiliferous with distinctive markings.	Soils topography produced by lower limestone unit. Upper part forms steps separating the Bush Creek from Fort Worth limestone.	Soil to moderate yields. Water unsatisfactory for use unless treated.
					0-25	Blue and brownish-yellow marl. Thin limestone and mudstone flags.	Grassy slope separating creeps of Goodland and Bush Creek formations.	Soil to moderate yields. Water unsatisfactory for use unless treated.
					0-125	Darkly-brown fossiliferous limestone, and blue to yellowish brown marl.	Prominent glacial-tilt escarpment along stream.	Soil to moderate yields. Water unsatisfactory for use unless treated.
					0-25	Soil argillaceous fossiliferous clay and limestone, sandy clay, and black shale.	Few conspicuous escarpment and waterfalls in western Green Timbers belt.	Not known to yield water to wells in Tarrant County.
Cretaceous	Comanche Series	Trinity Group	140-185	Fire-grained sand, shale, sandy shale, lignite and pyrite.	Sandy soil, hummocky topography, locally covered with silt.	Source of supply for such households, molar clinics, and some industries.		
			250-450	Fire-grained limestone, shale, marl, and concretion.	Not exposed in Tarrant County.	Soils yield small supplies to wells in Fort Worth and western Tarrant County. Water too highly mineralized east of Fort Worth.		
			250-450	Thin Monticello Formation (formerly Travis Peak formation)	Not exposed in Tarrant County.	Principal aquifer in Tarrant County. Yields large supplies for municipal and industrial purposes. Water in upper beds east of Fort Worth may be highly mineralized.		
Pennsylvanian	Undifferentiated		8,000-7,000	MAJOR UNCONFORMITY Gray, sandy shale, light quartzitic sandstone, black limestone. Probably represents Birnie formation.	Not exposed in Tarrant County.	Not tested. Probably would not yield fresh water.		

Source: E. A. Leggat.

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Cretaceous Paluxy Formation, 5) Cretaceous Glen Rose Formation, and 6) Cretaceous Twin Mountains Formation. The occurrence of these units on base is shown on a geologic map, Figure 2.2-2.

Carswell AFB is located on the relatively stable Texas craton, west of the faults that lie along the Ouachita Structural Belt. No major faults or fracture zones have been mapped near the base. The regional dip of the rocks beneath Carswell AFB is between 35 and 40 feet per mile in an easterly to southeasterly direction. The stratigraphic and structural relationships of the uppermost geologic units at Carswell AFB are illustrated in Figure 2.2-3, which shows a cross-section from the flightline eastward to the Trinity River.

The majority of the base is covered by alluvium deposited by the Trinity River during flood stages. The alluvium is composed of gravel, sand, silt, and clay of varying thicknesses and lateral extents. The Goodland Limestone is exposed on the southern portion of the base, south of White Settlement Road. The Goodland is a chalky-white, fossiliferous limestone and marl. A small area exposing the Walnut and Paluxy Formations occurs in the northwestern corner of the base along the shores of Lake Worth. The Walnut Formation is a shell-agglomerate limestone with varying amounts of clay and shale. The Paluxy Formation is primarily a fine- to coarse-grained sand with minor amounts of clay, sandy clay, pyrite, lignite, and shale. Neither the fine-grained Glen Rose Limestone, nor the sandstones of the Twin Mountains Formation are exposed at Carswell AFB, though these formations are important in understanding the hydrogeology of the Carswell area.

### 2.2.2 Bedrock Geology

#### Stratigraphy

Beneath the upper zone alluvium are the Cretaceous-age Goodland and Walnut Formations. Both formations consist of interbedded, fossiliferous, hard limestone and calcareous shale. The rock is fractured and there is

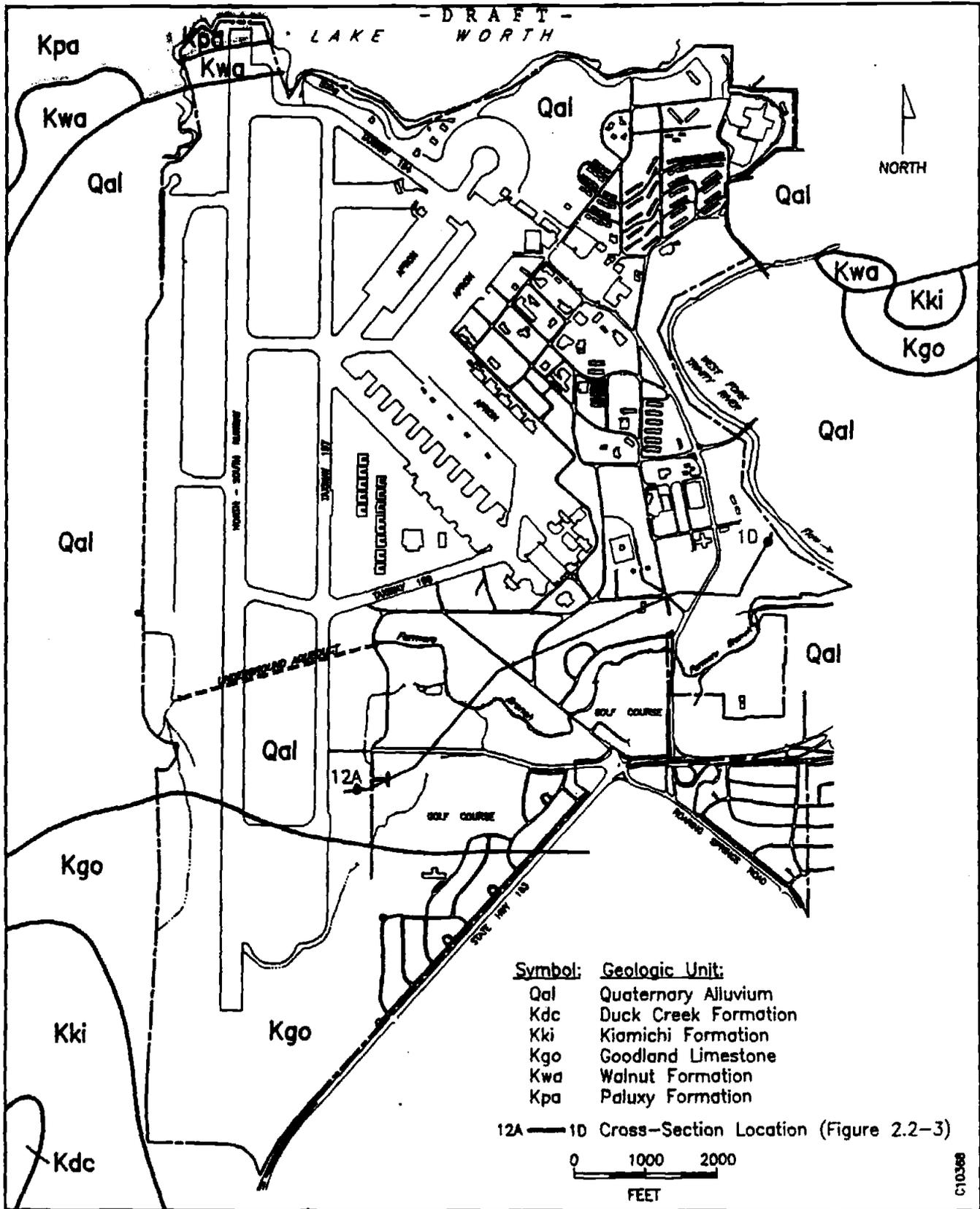


Figure 2.2-2. Geologic Map of Carswell AFB, Texas

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U.S. GEOLOGICAL SURVEY, WATER RESOURCES DIVISION, BRANCH OF HYDROLOGIC ENGINEERING, WASHINGTON, D.C.

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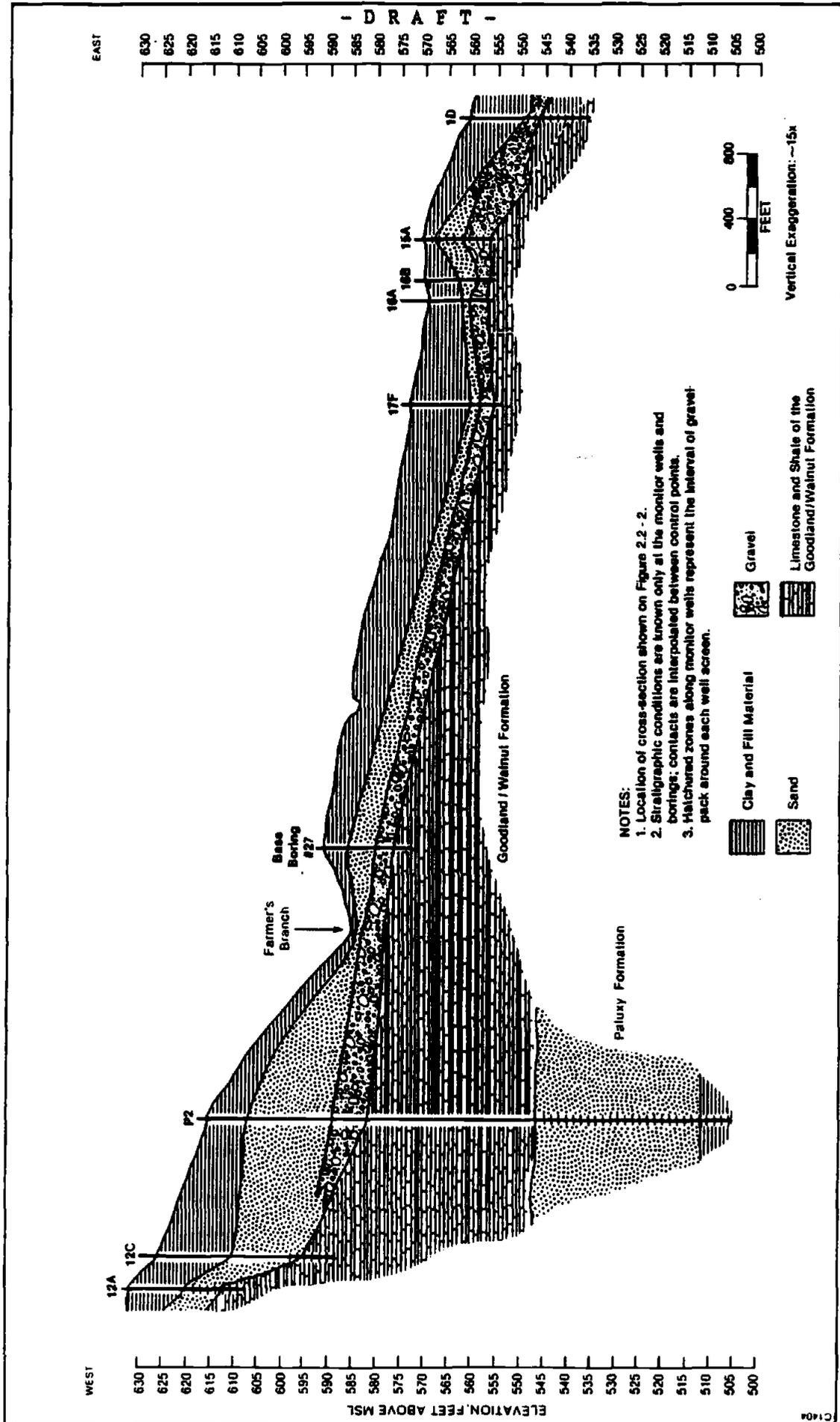


Figure 2.2-3. Geologic Cross-Section of Carswell AFB, Texas



Underlying the Paluxy Sand is the Glen Rose Formation, which represents the seaward facies of part of the Twin Mountains Formation, being deposited simultaneously to the north. The Glen Rose consists primarily of calcareous sedimentary rocks (limestone) and some sands, clays, and anhydrite.

The Twin Mountains Formation, with the Glen Rose Formation capping it, is the oldest Cretaceous age formation in the vicinity of Carswell AFB. In ascending order, the Twin Mountains Formation is divided into the Sycamore Sand Member, the Cow Creek Limestone Member, and the Hensell Sand Member. The Twin Mountains Formation does not crop out in Tarrant County. The Twin Mountains Formation consists of a basal conglomerate of chert and quartz, grading upward into coarse- to fine-grained sand interspersed with varicolored shale.

### 2.2.3 Surficial Geology

#### Unconsolidated Deposits

Surface deposits that underlie the Carswell AFB area consist of unconsolidated alluvium and fill materials, with the exception of outcrops of limestone and shale southwest of Landfill 4 and south of Fire Training Area 2. The alluvium consists of floodplain and fluvial terrace deposits of gravel, sand, silt, and clay that occur as a veneer on the eroded surface of the Goodland Limestone. The surficial deposits are referred to as the "upper zone," a term initially applied to similar alluvial deposits at AF Plant 4 (Hargis and Montgomery, 1983). Upper zone signifies a hydrogeologic unit at Carswell AFB that is a mixture of clay, silt, sand, and gravel of variable thickness and degree of saturation.

Drilling on the base indicates that upper zone deposits range from 13 feet to greater than 39 feet of interbedded clay, silt, sand, and gravel. The irregularity of the alluvium layer is due to depositional events, stream channeling, and erosion. In general, silt and clay with variable amounts of sand and gravel occur at the land surface down to depths of 5 to 10 feet.

Underlying the silt and clay is a sand and gravel unit that normally increases in grain size with increasing depth. These strata appear to be relatively continuous across the area of investigation, although coarse gravel deposits occur in limited areas generally east of the Fire Department Training Areas 1 & 2. The sand deposits are fine-grained to coarse-grained, tan to rust in color, and composed predominantly of quartz grains. Gravel is mostly limestone and shell fragments ranging up in size from fine gravel to cobbles.

### Soils

The U.S.D.A. Soil Conservation Service has identified four soil associations at Carswell AFB. The soils range in thickness from 8-80 in. and are predominantly composed of clay loam. Table 2.2-2 gives a detailed description, and their occurrences on the base are shown on Figure 2.2-4. The surficial soils of the installation are nearly level to gently sloping clayey soils of the Sanger-Purves-Slidell and Aledo-Bolar-Sanger Associations. In addition to the above, the clayey soil of the Frio-Trinity Association and the loamy soil of the Bastil-Silawa Association occur on the floodplain and stream terraces of the West Fork of the Trinity River.

## 2.3 Hydrogeology

### 2.3.1 Ground Water

The water-bearing geologic formations located in the Carswell AFB area may be divided into the following five hydrogeologic units, listed from the shallowest to deepest: 1) an upper perched-water zone occurring in the alluvial terrace deposits associated with the Trinity River; 2) an aquitard of predominantly dry limestone of the Goodland and Walnut Formations; 3) an aquifer in the Paluxy Sand; 4) an aquitard of relatively impermeable limestone in the Glen Rose Formation; and 5) a major aquifer in the sandstone of the Twin Mountains Formation.

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TABLE 2.2-2. SOIL ASSOCIATIONS FOR CARSWELL AFB, TEXAS

Association	Description	Thickness (inches)	Permeability (cm/sec)
Sanger-Purves-Slidell: Clayey soils of nearly level to gently sloping uplands.	Clay loam Clay over bedrock Silty clay	8-80	$<4.2 \times 10^{-5}$ to $3 \times 10^{-4}$
Aledo-Bolar-Sanger: Loamy and clayey soils of gently sloping to moderately steep uplands.	Clay loam over bedrock Clay loam	8-70	$<4.2 \times 10^{-5}$ to $9 \times 10^{-4}$
Frio-Trinity: Clayey soil on nearly level flood plains.	Silty clay loam Clay	25-75	$<4.2 \times 10^{-5}$ to $3 \times 10^{-4}$
Bastsil-Silawa: Loamy soils on nearly level to sloping stream terraces.	Sandy clay loam	40-80	$9 \times 10^{-4}$ to $3 \times 10^{-3}$

Source: U.S. Department of Agriculture, 1981, Soil Survey of Tarrant County: Soil Conservation Service, 218 pp.



Occurrence and Movement of Ground Water

Upper Zone - The upper zone ground water occurs within the alluvial deposits at Carswell AFB. Low permeability is usually the case in this alluvium because of the large amounts of clay and silt. However, there are zones of greater permeability in the gravels of former channel deposits. Recharge to the water-bearing deposits is local, from rainfall and infiltration from stream channels and drainage ditches. The direction of ground-water flow is generally controlled by the bedrock topography of the Walnut Formation. Ground-water flow in the alluvium is generally eastward, toward the West Fork of the Trinity River.

Goodland/Walnut Aquitard - The perched water present in the alluvium is separated from the aquifers below by the low permeability limestones and shales of the Goodland Limestone and Walnut Formation. The aquitard is composed of moist clay and shale layers interbedded with dry limestone beds. Though primarily dry, drillers in the area report that small amounts of water enter the borehole while drilling through the Walnut Formation, suggesting that ground water may be moving through the Walnut along bedding planes (Hargis and Associates, 1985). The thickness of the Goodland/ Walnut aquitard is approximately 25 feet or greater beneath most of Carswell AFB. However, the top of the aquitard is an erosional surface and erosion may have reduced the thickness of the limestone in isolated areas. A soil boring at AF Plant 4, beneath Building 189 along Grants Lane, revealed that the Goodland Limestone is completely absent at this location and only three feet of the Walnut Formation is present (Hargis and Associates, 1985). It is also reported that the upper zone and the Paluxy Formation are in contact at the eastern boundary of AF Plant 4, where both the Goodland and Walnut Formations have been eroded away (Hargis and Associates, 1985). In areas of similarly extensive erosion, water in the upper zone could come into contact with water in the Paluxy aquifer.





13 to 140 gpd/ft<sup>2</sup>. Well yields within the Paluxy aquifer range from 10 to 480 gallons per minute (gpm), averaging approximately 100 gpm.

Glen Rose Aquitard - Below the Paluxy aquifer are the fine-grained limestone, shale, marl, and sandstone beds of the Glen Rose Formation. The thickness of the formation ranges from 250 to 450 feet. Although the sands in the Glen Rose Formation yield small amounts of water to wells in Fort Worth and western Tarrant County, the relatively impermeable limestone is an aquitard restricting water movement between the Paluxy aquifer above and the Twin Mountains aquifer below.

Twin Mountains Aquifer - The Twin Mountains Formation is the oldest formation used for water supply in the Carswell AFB area. The formation occurs approximately 600 feet below Carswell AFB. The thickness of the formation ranges from 250 to 430 feet.

Recharge to the Twin Mountains aquifer occurs west of Carswell AFB, where the formation crops out. Ground-water movement is eastward in the downdip direction. Like the ground water in the Paluxy aquifer, Twin Mountains ground water occurs under water-table conditions in the recharge area and becomes confined as it moves downdip. Transmissivities in the Twin Mountains aquifer range from 1,950 to 29,700 gpd/ft and average 8,450 gpd/ft in Tarrant County. Hydraulic conductivities range from 8 to 165 gpd/ft<sup>2</sup> and average 68 gpd/ft<sup>2</sup> in Tarrant County (CH2M Hill, 1984).

#### Ground Water Quality

Ground-water quality data for the alluvial deposits in the Carswell AFB area is not available (except for IRP data). The lack of data reflects the general lack of use of alluvial ground water in the area. Water quality in the Paluxy aquifer is generally good and is satisfactory for potable use. Table 2.3-1 shows the range of chemical constituents in Paluxy ground water reported by the Texas Department of Water Resources.

TABLE 2.3-1. RANGE OF CONSTITUENTS IN GROUND WATER FROM SELECTED WELLS IN THE PALUXY FORMATION, TARRANT COUNTY

Constituent or Property	Concentration
Bicarbonate ( $\text{HCO}_3$ )	177-689
Boron (B)	0.1-0.6
Calcium (Ca)	0-120
Chloride (Cl)	5-117
Fluoride (F)	0-4.5
Iron (Fe)	0-9.9
Magnesium (Mg)	0-43
Nitrate ( $\text{NO}_3$ )	0-10.0
Silica ( $\text{SiO}_2$ )	1-30
Sodium ( $\text{Na}^2$ )	11-740
Sulfate ( $\text{SO}_4$ )	6-1,080
Dissolved Solids	264-2,176
Total Hardness ( $\text{CaCO}_3$ )	2-401
Percent Sodium (%)	7.1-99.5
pH	7.1-9.2
Sodium-Absorption Ratio (SAR)	0.2-68.8
Residual Sodium Carbonate (RSC)	0-10.0
Specific Conductance ( $\mu\text{mhos}$ at $25^\circ\text{C}$ )	427-3,193

Note: Analyses given are in milligrams per liter except percent sodium, specific conductance, pH, SAR, and RSC.

Source: Texas Department of Water Resources, 1982.

Ground water suitable for potable use occurs in the Twin Mountains aquifer throughout the Fort Worth area; however, water in the upper sands in the aquifer east of Fort Worth may be too mineralized for human consumption. Table 2.3-2 lists the range of chemical constituents found in the Twin Mountains aquifer in Tarrant County.

### Ground Water Uses

The need for usable ground water in Tarrant County, specifically the Fort Worth area, is great and the demands have been high. Primarily, the municipal need for drinking water has made the greatest impact on the available ground water. Industrial and agricultural needs have placed lesser demands on the ground water, while still contributing to the overall decline in the water table.

Ground water present in the upper zone occurs as a perched water table and, in general, it is not hydraulically connected to the underlying aquifers (CH2M Hill, 1984). For the most part, it is not economical to develop ground water from the alluvium because of the water's limited distribution and susceptibility to surface pollution. In parts of Tarrant County, generally close to the Trinity River, water in the alluvium is developed for irrigation and residential use. The community of River Oaks, immediately east of Carswell AFB, had supply wells that developed water from the alluvial deposits at a location near the USAF Hospital. The wells were abandoned when Carswell AFB purchased the property.

The Paluxy aquifer is an important source of potable ground water for the Fort Worth area. Many of the communities, particularly White Settlement, surrounding Carswell AFB develop their municipal water supplies from the Paluxy aquifer. Ground water from the Paluxy is also used in some of the surrounding farms and ranches for agricultural purposes. Because of its extensive use as a potable and municipal water supply, water levels in the Paluxy aquifer have declined significantly over the years. Water levels in

TABLE 2.3-2. RANGE OF CONSTITUENTS IN GROUND WATER FROM SELECTED WELLS IN THE TWIN MOUNTAINS FORMATION, TARRANT COUNTY

Constituent or Property	Concentration
Silica (SiO <sub>2</sub> )	5-79
Iron (Fe)	0-2.6
Calcium (Ca)	1-114
Magnesium (Mg)	0-11
Sodium (Na)	141-670
Bicarbonate (HCO <sub>3</sub> )	288-659
Sulfate (SO <sub>4</sub> )	21-579
Chloride (Cl)	14-650
Fluoride (F)	0-7.0
Nitrate (NO <sub>3</sub> )	0-5.9
Boron (B)	0.2-1.9
Dissolved Solids	381-1,735
Total Hardness (CaCO <sub>3</sub> )	5-302
Percent Sodium (%)	12.8-99.3
pH	7.4-9.1
Sodium-Absorption Ratio (SAR)	0.4-72
Residual Sodium Carbonate (RSC)	0-10.1
Specific Conductance (µmhos at 25°C)	607-3,317

Note: Analyses given are in milligrams per liter except percent sodium, specific conductance, pH, SAR, and RSC.

Source: Texas Department of Water Resources, 1982.

the immediate Carswell AFB vicinity have not decreased as much as in the Fort Worth area in general because of the proximity of the Lake Worth recharge area and because the base does not develop water from the Paluxy aquifer.

The Twin Mountains aquifer is the principal aquifer supplying potable ground water in Tarrant County. The aquifer yields large water supplies for municipal and industrial purposes. Because of the high ground-water withdrawals from the Twin Mountains aquifer, ground-water levels have declined substantially. Between 1955 and 1976, the potentiometric surface of the aquifer dropped approximately 250 feet at Carswell AFB.

#### Well Inventory

All ground-water monitor wells installed at Carswell AFB for the IRP were designed for the purpose of evaluating the hydrogeologic setting and the contaminant concentrations and distribution. A total of 46 ground-water monitoring wells for the IRP have been installed in the following areas: Flightline Area, East Area (near main entrance), and the Base Service Station. All but two of these wells were completed (screen-interval) in the alluvium or man-made fill. The remaining two wells are completed in the Paluxy Formation. Completion on all upper zone wells used two-inch diameter PVC casing from total depth to surface. Construction specifications and installation techniques are provided in Chapter 3.

In addition to the ground-water monitor wells that were installed at Carswell AFB, an inventory of water wells that lie within one mile of the Carswell AFB boundary was conducted. Figures 2.3-2 and 2.3-3 detail the location of the ground-water water wells near Carswell AFB and the Weapons Storage Area. Texas Water Commission records were used to supply information on existing wells and wells that are no longer in use. Table 2.3-3 represents the wells that were found in the specified proximity to Carswell AFB and gives pertinent information on each of these wells. Table 2.3-4 provides information on wells located within 1 mile of the WSA.



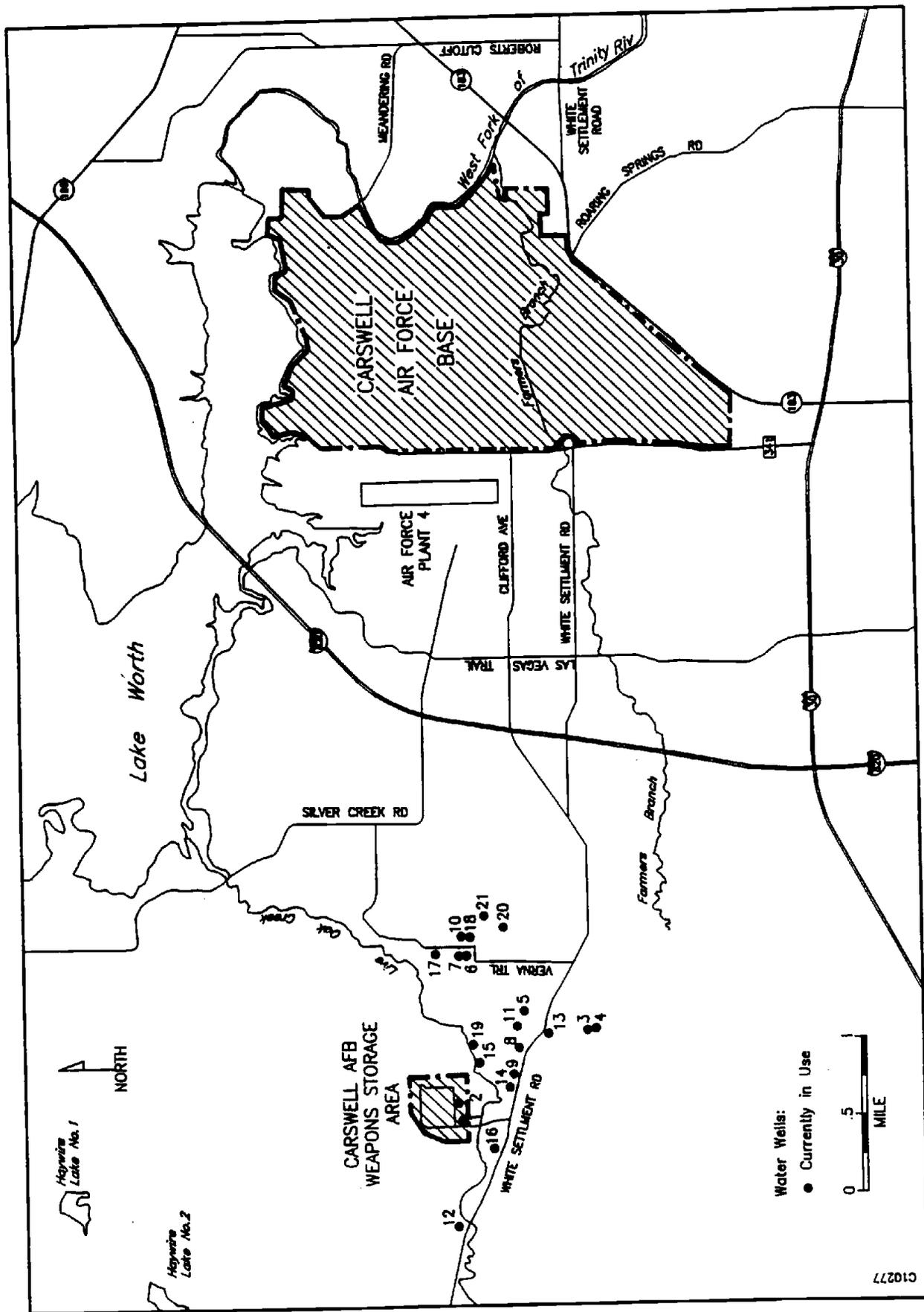


Figure 2.3-3. Location of Water Wells Within 1 Mile of the Weapons Storage Area, Carswell AFB, Texas

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**TABLE 2.3-3. INVENTORY OF WATER WELLS WITHIN 1 MILE OF CARSWELL AFB, TEXAS**

TWC Well #	Owner	Depth	Use	Date Drilled	Screened Formation/Lithology
(1) 32-13-504	J. E. Ritchie	250'	Public Supply	3/30/83	Paluxy/Sand, Shale
(2) 32-13-601	Sansom Park	1044'	Public Supply/ Not Used	1/6/48	Twin Mountains/ Sand, Shale, Limestone
(3) 32-13-608	Sansom Park	345'	Public Supply/ Not Used	1938	Paluxy/--
(4) 32-13-610	Sansom Park	338'	Public Supply	1948	Paluxy/Sand, Shale, Limestone
(5) 32-13-611	Sansom Park	335'	Public Supply	1948	Paluxy/Sand, Shale, Limestone
(6) 32-13-7Q	Bill Beckman	220'	Domestic	5/3/77	Paluxy/Sand, Limestone
(7) 32-13-702	City of White Settlement	201'6"	Public Supply	7/10/50	Paluxy/Sand, Shale
(8) 32-13-703	City of White Settlement	238'	Public Supply	1945	Paluxy/Sand, Shale, Limestone
(9) 32-13-706	City of White Settlement	720'	Public Supply	April, 1965	Twin Mountains/ Sand, Limestone
(10) 32-13-707	City of White Settlement	305'	Public Supply	March, 1966	Paluxy/Sand, Shale, Limestone
(11) 32-13-709	Bud Crow	225'	Industrial	March, 1965	Paluxy/Sand, Shale
(12) 32-13-710	Carswell Air Force Base	235'	Public Supply	Sept., 1951	Paluxy/--
(13) 32-13-8 (a)	Rudene Leach	148'	Domestic	2/28/86	Paluxy/Sand, Shale, Lignite
(14) 32-13-8 (b)	Steven Neshyba	180'	Domestic	10/16/86	Paluxy/Sand, Shale
(15) 32-13-8 (c)	El Campo Restaurant	200'	Domestic	7/8/85	Paluxy/Sand, Shale

(Continued)



**TABLE 2.3-3. INVENTORY OF WATER WELLS WITHIN 1 MILE OF CARSWELL AFB, TEXAS  
(Cont.)**

<b>TWC Well #</b>	<b>Owner</b>	<b>Depth</b>	<b>Use</b>	<b>Date Drilled</b>	<b>Screened Formation/Lithology</b>
(29) 32-13-912	Russell Peck (East Gate Mobile Home Park)	200'	Public Supply	10/12/71	Paluxy/Sand & Limestone
(30) 32-13-915	Carswell Air Force Base	173'	Originally public supply, now not used. Covered by hos- pital grounds	1945	Paluxy/--
(31) 32-13-917	W. T. Casstevens	395'	Public Supply	Feb., 1947	Paluxy/--
(32) 32-21-101	City of White Settlement	279'	Public Supply (Standby)	1947	Paluxy/--
(33) 32-21-102	City of White Settlement	286'	Public Supply	3/3/66	Paluxy/Sand, Shale, Limestone
(34) 32-21-103	City of White Settlement	950'	Public Supply	1952	Twin Mountain/--
(35) 32-21-104	City of White Settlement	360'	Public Supply (Plugged)	1952	Paluxy/--
(36) 32-21-205	City of White Settlement	240'	Public Supply (Plugged in 1959)	1949	Paluxy/--
(37) 32-21-206	City of White Settlement	240'	Public Supply (Plugged)	1949	Paluxy/--
(38) 32-21-207	City of White Settlement	240'	Public Supply (Plugged)	1949	Paluxy/--
(39) 32-21-208	City of White Settlement	250'	Public Supply (Plugged)	--	Paluxy/--



TABLE 2.3-4. INVENTORY OF WATER WELLS WITHIN 1 MILE OF THE WEAPONS STORAGE AREA, CARSWELL AFB, TEXAS (Cont.)

TWC Well #	Owner	Depth	Use	Date Drilled	Screened Formation/Lithology
(17) 32-13-9H (a)	Gary Simmons	260'	Domestic	11/2/78	Paluxy/Sand
(18) 32-12-9H (a)	Paul Miller	330'	Domestic	11/6/79	Paluxy/Sand, Limestone
(19) 32-12-9M	R.L. Fendelton	300'	Domestic	Feb., 1983	Paluxy/Sand, Limestone
(20) 32-13-711	S&W Water Co., Inc.	380'	Public Supply	7/24/74	Paluxy/Sand, Shale, Limestone
(21) 32-13-712	S&W Water Co., Inc.	210'	Public Supply	July, 1977	Paluxy/

2.3.2 Surface Water

Occurrence and Flow

Carswell AFB is located within the Trinity River Basin, adjacent to Lake Worth. This lake was man-made, created by damming the Trinity River at a point just northeast of the base, and is used as a potable water reservoir. The surface area of the lake is approximately 2,500 acres. Lake Worth receives a limited amount of stormwater runoff from Carswell AFB during and immediately after rainfall events. Elevation of the water surface is fairly constant at approximately 594 feet mean sea level (MSL), the fixed elevation of the dam spillway. Part of the eastern boundary of Carswell AFB is defined by the West Fork of the Trinity River, a major river in north central Texas. Flow is towards the southeast, where the river discharges into the Gulf of Mexico.

The base is partly drained by Farmers Branch, a tributary into the West Fork of the Trinity River. Farmers Branch begins within the community of White Settlement and flows eastward. Just south of AF Plant 4, Farmers Branch flows under the runway within two large culverts identified as an aqueduct.

Surface drainage is mainly east towards the West Fork of the Trinity River. Most of the base drainage is intercepted by a series of storm drains and culverts, directed to oil/water separators and discharged to the West Fork of the Trinity River downstream of Lake Worth. A small portion of the north end of the base drains into Lake Worth.

Surface Water Quality

The City of Fort Worth receives a large percentage of its water from Lake Worth. Typical water quality of Lake Worth and the West Fork of the Trinity River several miles downstream of the Lake Worth Dam and Carswell AFB is shown in Table 2.3-5. These waters are moderately hard and contain slightly elevated salt levels during the warm summer season.

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east of Carwell  
West Fork  
Gateway  
Park  
east of  
235W

TABLE 2.3-5. WATER QUALITY DATA FOR SURFACE WATERS IN THE VICINITY OF CARSWELL AFB, TEXAS

Parameter	West Fork Trinity		
	Lake Worth 9/08/80	River at Beach Street 2/14/80	9/18/80
Specific Conductance ( $\mu\text{mhos/cm}$ )	418	448	610
ph (units)	-- <sup>a</sup>	7.9	8.6
Temperature ( $^{\circ}\text{C}$ )	22.0	9.5	30.0
Dissolved Oxygen	--	11.0	17.0
Oxygen Saturation (%)	--	96	227
BOD <sub>5</sub>	--	2.0	6.7
Total Hardness (as $\text{CaCO}_3$ )	130	180	150
Calcium	38	62	47
Magnesium	9.0	5.9	8.7
Sodium	30	24	63
Sodium Adsorption Ratio (SAR)	1.1	0.8	2.2
Potassium	6.8	5.3	8.4
Bicarbonate (as $\text{HCO}_3^-$ )	140	180	150
Carbonate (as $\text{CO}_3^{2-}$ )	0	0	7
Sulfate	27	43	63
Chloride	43	28	73
Fluoride	0.3	0.4	1.0
Silica	5.5	2.7	1.8
Dissolved Solids	229	260	347
Nitrate (as N)	--	0.39	0.02
Nitrate (as N)	--	0.03	0.05
Ammonia (as N)	--	0.39	0.88
Organic Nitrogen	--	0.71	1.6
Total Phosphorus	--	0.13	0.58

Source: USGS (1980).

<sup>a</sup>Dash indicates that no data were available.

<sup>b</sup>Units in mg/l unless otherwise indicated.

All potable water for Carswell AFB is provided under contract by the City of Fort Worth. Total contracted capacity is 2,500 gallons per minute (gpm) at a minimum pressure of 45 pounds per square inch (psi). The total annual consumption in 1981 was over 270 million gallons, with maximum and minimum monthly demands of 43 million gallons and 14 million gallons respectively.

Carswell AFB currently has three stormwater discharge points (001, 002, and 004) that are subject to National Pollutant Discharge Elimination System (NPDES) permits from the Environmental Protection Agency. Monitoring is done once a week at these sites for the parameters of Chemical Oxygen Demand (COD), oil and grease, and pH. Samples collected at these NPDES discharge points have shown numerous violations in the past; at one time (1979) prompting the EPA to formally demand corrective action (CH<sub>2</sub>M-Hill, 1984). The following paragraphs from CH<sub>2</sub>M-Hill (1984) summarize (as of 1984) the base's stormwater discharge system and its history.

Outfall 001 is located on a stormwater ditch in the Weapons Storage Area adjacent to Lake Worth. Outfall 002 is located in a small stormwater ditch flowing southwest from the hospital area, through the YMCA Camp Center, to the west fork of the Trinity River. Outfall 004 is located just below the main base oil/water separator (Facility No. 38) near the East Gate. Stormwater flows from much of the base are pumped to this location for treatment prior to discharge to the west fork of the Trinity River.

Samples collected at the NPDES discharge points on Carswell AFB have shown numerous violations during the past 6 years. Although the period of record at each outfall is different and tends to inflate the number of violations at Outfall 004, nevertheless, this outfall to the Trinity River has a high rate of documented violations, with some extremely high COD and oil and

grease values recorded. Since samples at Outfall 004 are only taken weekly, these documented violations are only an indication of the actual quantities of contaminants leaving the base at this discharge point. Also, the parameters chosen for monitoring give only a rough overview of the specific pollutants likely to be present in these discharges.

In a letter dated April 25, 1979, the EPA formally demanded corrective action concerning the numerous NPDES violations occurring at the Carswell AFB stormwater discharge points, specifically including Outfall 004. Air Force action identified several potential sources for the high COD levels observed at this outfall, including the JP-4 bulk storage tanks, fuel cell storage yard, oil/water separator, motor pool and aircraft washracks, fuel cell repair shop, motor pool, hydraulic shop, demineralization plant regeneration waste, and the Taxiway 77 stormwater runoff. In spite of the investigations instigated in response to EPA's letter, NPDES violations have continued since 1979, including a total of 20 COD violations at Outfall 004 since January 1980.

Additional surface-water quality sampling points have been added by the base bioenvironmental engineer to establish flows of other pollutants onto or off of the base. Known as Quarterly Points (QP), several of these stations have been moved since this program began.

The QP stations are sampled for a variety of parameters as circumstances (spills, fish kills, odors, and oil sheen) dictate. For example, recent sampling at the Unnamed Stream (formerly QP 5, now QP 6; also Site No. 16) has documented elevated levels of iron (2,800 to 10,500  $\mu\text{g}/\text{l}$ ), manganese (288  $\mu\text{g}/\text{l}$ ), and copper (57  $\mu\text{g}/\text{l}$ ).

During the summer of 1983, a detailed study was conducted of volatile organics in streams originating off base and also from on-base sources. This study included three successive episodes at several of the QP stations at monthly intervals. Measurable quantities of organics were found in a tributary to Farmers Branch which receives drainage from AF Plant 4.

Samples were collected in the tributary at the point where it flows onto Carswell AFB. Findings included: trichloroethylene (2.7 and 51.3  $\mu\text{g}/\text{l}$ ); 1,2 dichloroethylene (0.4  $\mu\text{g}/\text{l}$ ); bromodichloromethane (0.9  $\mu\text{g}/\text{l}$ ); and chloroform (trace). Sampling for these compounds in Farmers Branch on Carswell AFB (QP 8) and at the Trinity River (QP 7) indicated that they were still present in measurable quantities. At QP 8, volatile organics that were detected include: trichloroethylene (1.0, 1.4, and 3.1  $\mu\text{g}/\text{l}$ ) and 1,2 dichloroethylene (1.5  $\mu\text{g}/\text{l}$ ). At QP 7, where Farmers Branch flows into the West Fork Trinity River, trace quantities of these compounds were still present (trichloroethylene--0.9  $\mu\text{g}/\text{l}$  and 1,2 dichloroethylene--0.3  $\mu\text{g}/\text{l}$ ).

Volatile organics were also detected in a few streams assumed to be arising totally on Carswell AFB property. At NPDES Outfall 002 near the YMCA Camp Carter, and at Outfall 004 near the east gate, trace quantities of trichloroethylene were detected. Also at the Unnamed Stream (QP 6), trichloroethylene was detected during each of the three months at trace levels ( $\leq$  0.2 to 0.3  $\mu\text{g}/\text{l}$ ). The actual source of these compounds in the streams was not identified during the records search study.

#### 2.4 Natural Resources

Mineral resources in Tarrant County consist mainly of sand, gravel, and stone production. These resources are used primarily in road building and the construction business. Exposed limestone is available for construction purposes, but demand is low. Petroleum exploration has never been very active in this area. Of the few wells that have been drilled, only a small percentage were completed commercially. Based on Texas Railroad Commission records, there is no oil production and 200 million cubic feet (mcf) of natural gas produced per year.

Recreational water resources in the Carswell area include Worth, Grapevine, Eagle Mountain, and Benbrook Lakes. All of the usual water sports and activities can be found at these lakes. Water recreation is the most popular outdoor activity for the area. Tarrant County is a major agribusiness

center with over \$20 million in farm income per year. Dairy and beef cattle, hogs, and poultry generate the major revenue in the agribusiness. The primary crops produced in the area include grain sorghums, small grains, cotton, pecans, and vegetables. Fort Worth is also ranked fourth in the nation in grain storage capacity. It has eleven major grain brokers and elevator companies and was headquarters for the Texas Grain and Feed Association.

## 2.5 Ecology and Biology

Approximately 374 acres or 14 percent of Carswell AFB is considered unimproved, indicating the presence of semi-natural to natural ecological conditions. The base lies in the Cross Timbers and Prairies Region of Texas, and native vegetation of the area is characterized by alternating bands of prairies and woodlands. High ground on the base is dominated by native and cultivated grasses such as little bluestem, indian grass, big bluestem, side-oats, grama, and buffalo grass.

Forested areas on Carswell AFB occur primarily on lower land and along the banks of streams. Common native woody species include oak, elm, pecan, hackberry, and sumac. Several non-native species such as catalpa and china-berry are common.

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

Reported game fish include black bass, sunfish, and catfish, all of which can be found in Lake Worth, Farmers Branch, and one small pond located on-base near the golf course equipment shed. According to the Texas Department of Parks and Wildlife and the United States Fish and Wildlife Service, there are no threatened or endangered species known to occur on Carswell AFB.



TABLE 2.6-1. METEOROLOGICAL DATA SUMMARY FOR CARSWELL AFB, TEXAS (1946-1978)

	January	February	March	April	May	June	July	August	September	October	November	December	Annual
<u>Temperature (°F)</u>													
Mean	45	50	57	65	74	82	86	85	78	68	56	49	65
Average Daily Maximum	55	60	67	76	83	91	95	95	88	78	66	59	76
Average Daily Minimum	35	39	46	56	64	72	75	75	68	57	46	38	56
Highest Recorded	88	88	85	88	100	111	109	110	107	105	89	91	110
Lowest Recorded	2	6	11	31	42	55	61	60	46	33	17	11	2
<u>Precipitation (inches)</u>													
Mean	1.7	1.9	2.1	3.9	4.2	3.1	2.5	2.1	3.6	3.1	1.8	1.9	31.9
Maximum Monthly	5.9	4.7	6.5	14.2	15.2	8.8	9.0	6.0	9.6	10.7	7.4	6.7	15.2
Minimum Monthly	0.1	0.1	a	0.8	0.8	0.1	a	a	a	a	a	a	a
Maximum in 24 hours	2.8	3.2	3.4	3.3	5.7	3.5	5.9	3.1	4.0	3.2	2.8	2.9	5.9
Days with Thunderstorms	1	2	3	6	8	6	5	5	4	3	1	1	45
<u>Snowfall (inches)</u>													
Mean	2	1	b	0	0	0	0	0	0	0	b	b	3
Maximum Monthly	8	12	7	0	0	0	0	0	0	0	4	3	8
Maximum in 24 hours	5	8	7	0	0	0	0	0	0	0	4	3	8
<u>Relative Humidity (%)</u>													
Mean	62	61	61	64	68	64	58	60	65	65	63	62	63
<u>Surface Winds (knots)</u>													
Mean	8	8	9	9	7	8	6	5	6	6	8	8	7
Maximum	50	63	69	64	68	65	56	54	80	45	54	58	60
Prevailing Direction	S	S	S	S	S	S	S	S	S	S	S	S	S

Source: United States Air Force, Carswell AFB, Texas. Period of Record: 1946-1978.

a Less than one tenth inch.

b Less than 1 inch.

Lake evaporation at Carswell AFB is estimated to be approximately 57 inches per year. Evapotranspiration over land areas may be greater or less than lake evaporation depending on vegetative cover type and moisture availability. Average net precipitation is expected to be equal to the difference between average total precipitation and average lake evaporation, or approximately minus 25 inches per year.

Mean cloud cover averages 50 percent at Carswell AFB with clear weather occurring frequently during all months. Some fog is present on an average of 83 days per year. Wind speed averages 7 knots; however, a maximum of 80 knots has been recorded. Wind direction is predominantly from the south during all months.

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### 3.0 FIELD INVESTIGATION PROGRAM

Field activities for the Carswell AFB IRP RI/FS Stage 2 investigation were guided by the Stage 2 Work Plan (Radian, 1988), which was developed according to the USAFOEHL Statement of Work (SOW). The SOW was based on the recommendations of the RI/FS Stage 1 investigation (Radian, 1986). The Stage 2 program was conducted to further define the nature and extent of contamination at the IRP sites and allow evaluation of potential impacts to off-base areas and receptors. A series of planning documents (e.g., Work Plan, Quality Assurance Project Plan (QAPP), and Health and Safety Plan) were prepared in advance of the field work in order to provide an appropriate direction to the field work, describe the methods and techniques of the work, and identify the evaluation criteria to be used for the data collected during the field program. These planning efforts and the elements of the field program are discussed in the following sections.

#### 3.1 Organization and Development of the Field Program

The Stage 2 field program was organized and developed to collect environmental data for several tasks. These tasks consisted of:

- Remedial investigation (nature and extent of contamination);
- Baseline risk assessment; and,
- Scoping and screening of preliminary alternative remedial actions.

The general categories of data necessary to satisfy the requirements of the tasks listed above include:

- Hydrogeologic setting;
- Groundwater flow directions and velocity estimates;
- Contaminant distribution (vertical and horizontal);
- Contaminant concentrations; and,
- Off-base receptors and users of shallow ground water.

The methods and procedures used in the field program were described in the Carswell AFB IRP Phase II Stage 2 Work Plan. Health and safety policies and procedures for field activities were described in the Carswell AFB IRP Phase II Stage 2 Health and Safety Plan. Field and laboratory quality assurance and quality control (QA/QC) aspects of the Stage 2 program were contained in the Carswell AFB Phase II Stage 2 Quality Assurance Project Plan (QAPP). These plans were prepared by Radian Corporation and submitted to USAFOEHL for review. USAFOEHL approved these plans on 14 January 1988, prior to the start of borehole drilling and well installation work.

### 3.2 Data Quality Objectives

Data quality objectives (DQOs) for the Stage 2 field program were established during the project scoping and development of the Work Plan and QAPP. The DQOs were developed to ensure that the field program produced data that were of appropriate type (e.g., selection of appropriate drilling technologies, choice of chemical parameters for analysis) and adequate quality (e.g., appropriate analytical methods with sufficiently low detection limits) for their intended uses, as listed in Section 3.1 above.

The DQOs for field activities (i.e., sampling) were embodied in the sampling strategy for the Stage 2 effort and expressed in terms of sample intervals, decontamination procedures for field equipment, collection of field QA/QC samples, and sample handling and chain-of-custody procedures. These field activities are described in following sections and were presented in the Work Plan for the Stage 2 program. The DQOs for laboratory activities were identified in the QAPP, Section 1.4. These DQOs were expressed primarily in terms of the detection limit objectives for the analytical methods and the precision and accuracy objectives for the analytical methods.

3.3 Summary of Field Activities

The RI/FS Stage 2 investigation involved a variety of field activities to collect environmental data at 13 IRP sites at Carswell AFB. The following activities were performed: 1) soil gas surveys at two sites; 2) installation of 21 ground-water monitor wells in upper zone deposits; 3) hollow-stem augering of 13 boreholes at four sites; 4) soil sampling from 15 hand-augered borings at two sites; 5) slug tests conducted at 18 monitor wells; 6) sampling and analysis of ground water, surface water and soil; and 7) land surveying of all data collection sites for elevation and State Plane (horizontal) coordinates.

Sequence of Field Activities

The field activities were performed from December 1987 through April 1988. The time sequence for Stage 2 field activities was as follows:

<u>Activity</u>	<u>Period of Performance</u>
Soil Gas Survey	16 - 19 December 1987
Drilling and Well Installation	25 January - 24 February 1988
Ground-water Sampling (Round 1)	23 February - 4 March 1988
Hand Augering	28 - 31 March 1988
Slug Tests	5 - 13 April 1988
Ground-water Sampling (Round 2)	5 - 15 April 1988
Land Surveying	28 March - 5 April 1988

Identification and Role of Subcontractors

The following subcontractors participated in the Stage 2 field program at Carswell AFB:

Soil Gas Survey - McClelland Engineers, Houston, Texas  
Drilling Services - Atec Associates, Inc., Dallas, Texas  
Land Surveying - Brittain & Crawford, Fort Worth, Texas

### Field Personnel Health and Safety

Prior to the initiation of Stage 2 field work, a Health and Safety plan (October 1987) was prepared by Radian and approved by USAFOEHL. EPA Level C protection was prescribed in the Health and Safety plan during drilling and/or well installations at Sites 3, 4, 5, 10, 12, and 17. Level C equipment consists of tyvek coverall, hard hat, rubber boots, gloves, safety glasses, and half-face respirator. During drilling operations, soil samples and drill cuttings were screened with a photoionization detector. If no contamination was detected, then EPA Modified Level C protection was appropriate (same as level C, but with an option to wear the respirator). Level C protection was used on all drilling locations with the exception of Site 10, 12, and 17. During ground-water sampling rounds, Modified Level C protection was used at all sampling locations.

### 3.4 Field Investigation Methods

The following sections describe the methods used for the field investigation. Methods are described for the following activities: magnetometer survey, soil gas surveys, hollow stem auger drilling, well installation, hand augering, and soil and water sampling.

#### 3.4.1 Magnetometer Survey

The Statement of Work specified that magnetometer surveys be conducted at Sites 1 and 10 to further define magnetic anomalies that had been identified during the Stage 1 field program. A GeoMetrics G856AX magnetometer was initially planned for conducting these surveys. However, upon closer inspection of the reported anomalies for these sites and the field conditions at the sites, the approach to conducting the Stage 2 magnetometer surveys was revised.

At Site 1 (Landfill 1), located at the DMRO facility, the proximity of large metal objects (automobiles, metal scrap, etc.) would have rendered the direct use of a magnetometer useless. Since the Stage 1 program had recognized this situation and had conducted the survey outside the site boundaries, the available options for the Stage 2 effort were to either re-do the Stage 1 survey or to not perform the survey. Therefore, a Stage 2 magnetometer survey was not performed at Site 1.

At Site 10 (Waste Burial Area), fewer interferences were present to disrupt the survey. However, since an identical survey had been conducted as part of the Stage 1 program, the primary use of the magnetometer was to determine if metal objects were buried at the drilling locations for Site 10.

#### 3.4.2 Soil Gas Survey

Soil gas surveys were performed at two sites to provide information regarding the optimal location of drilling sites and monitor wells. Shallow soil gas containing volatile organic compounds (VOCs) generally indicates that contamination is present in the vadose zone near the probe or in the saturated zone below the probe. Soil gas surveys are most effective with halogenated solvent chemicals and petroleum hydrocarbons having high vapor pressures and low aqueous solubilities. These compounds have high gas/liquid coefficients and readily partition out of the ground water into the vadose zone. Once in the vadose zone, VOCs diffuse in response to a chemical concentration gradient where, typically, the above-ground atmosphere acts as a sink and the ground water acts as a source for the compounds.

The soil gas survey was conducted at two sites: the POL Tank Farm (Site 17) and the Base Service Station (BSS Site). Thirty-three locations were surveyed at Site 17 and sixteen locations were surveyed at the BSS site. Figures 3.4-1 and 3.4-2 illustrate the soil gas sampling sites at Site 17 and the BSS site, respectively.

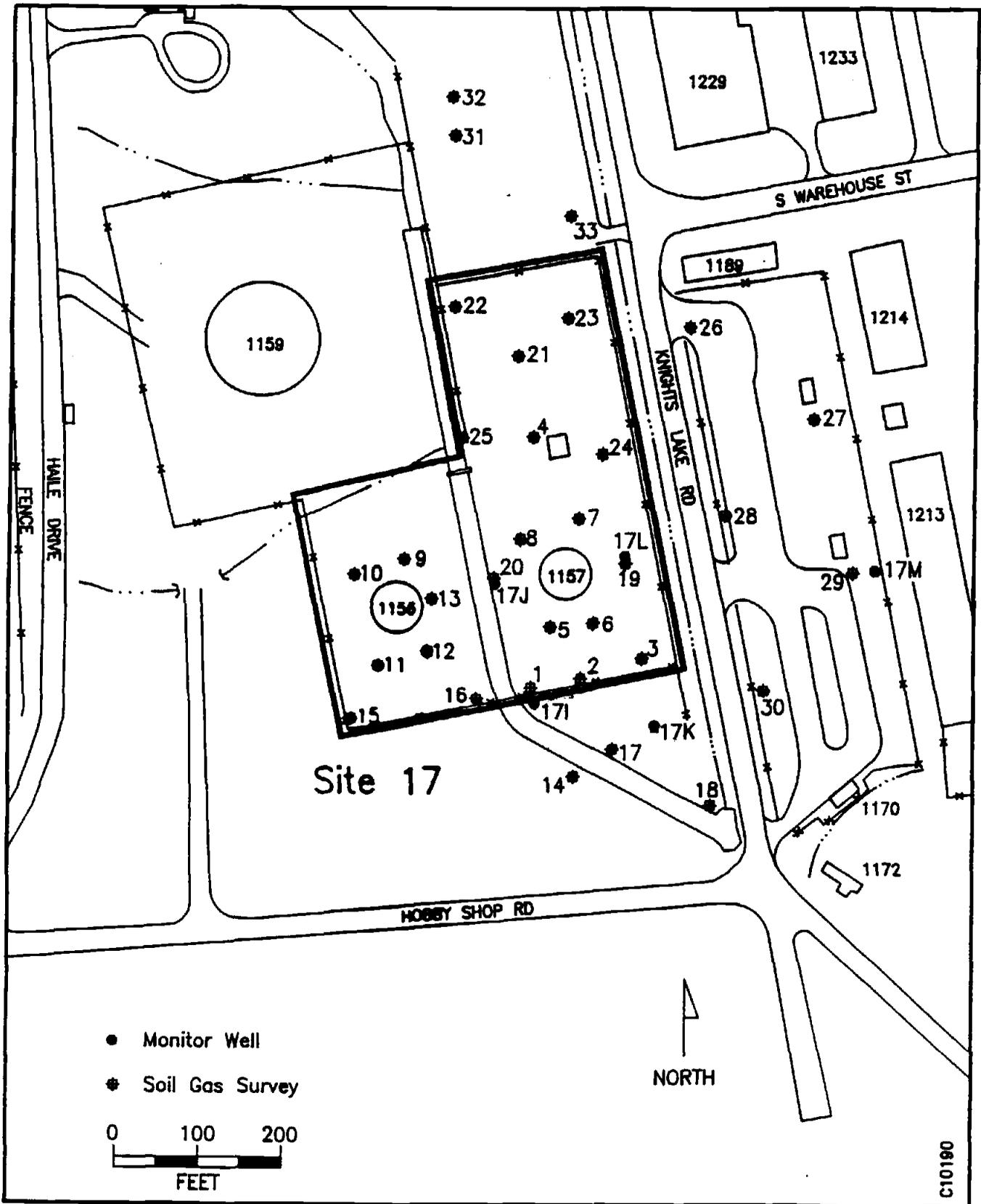


Figure 3.4-1. Location of Soil Gas Survey Sampling Points at the POL Tank Farm (Site 17), Carswell AFB, TX



The survey employed a field vehicle equipped with a Vadose Zone Vapor Probe (VZV Probe) and an organic vapor analyzer/gas chromatograph (Foxboro OVA/GC Model No. 128). The VZV probe consists of 3/8-inch hollow stainless steel tubing with a removable porous stainless steel sampling point. Soil gas samples were collected by pushing the VZV probe to the selected sampling depth, generally 2 to 4 feet above the saturated zone, exposing the drive point to the soil, and evacuating five probe and sample line volumes of soil gas through the system and venting to the atmosphere using a vacuum pump and an inline flow meter.

After the system was adequately purged, a soil gas sample was collected in a Tedlar bag positioned in a vacuum chamber. The Tedlar bag was then disconnected from the collection system and analyzed with the OVA/GC for total vapor concentration. If the total vapor concentration was above 10 ppm, a field gas chromatograph was run.

Quality assurance procedures were followed to ensure that cross-contamination of soil gas samples was not occurring during the survey. If total organic soil vapors exceeded 10 ppm a system blank was performed. The probe and tubing were purged with zero air (hydrocarbon-free air) and analyzed in the sample collection system with an OVA to ensure that the sampling equipment was not contaminated. A system blank was also performed prior to the start of each work day. Between each sample, the porous sampling point was cleaned with soap and water and rinsed with deionized water. Tedlar bags were replaced periodically. Analytical instruments were calibrated using methane-free air and a known concentration of methane in air.

#### 3.4.3 Slug Tests

Single-well aquifer tests (i.e., slug tests) were performed in order to determine the hydraulic conductivity of the upper zone. Slug tests were performed in 13 monitor wells (4A, 4B, 4D, 4E, 4G, 5A, 5B, 5C, 5D, 5E, 12A, 12B, and 12C) at the Flightline Area and five wells (1D, 1E, 17J, 17L, and



accuracy of  $\pm 0.01$  feet. The survey was conducted to an accuracy needed for a 2nd order survey. All of the data were supplied on a drafted map, along with numerical values of the survey data (Appendix D).

### 3.5 Drilling and Well Installation Program

Drilling was performed to obtain subsurface and hydrogeologic information at eight IRP sites (Sites 1, 3, 4, 5, 10, 12, 17, and BSS). Hollow-stem auger drilling was used for upper zone boreholes and monitor wells. Hand augering was used to collect soil samples at shallow depths at two IRP sites, Sites 15 and WSA. The depth of the hollow-stem auger boreholes ranged from 6 feet below land surface (BLS) in BSS-D to 40 feet BLS in 5E. A total of 819.6 feet of hollow-stem auger drilling was performed during the Stage 2 field program. Thirty feet of hand augering was also performed during the investigation. Table 3.5-1 presents the number and depth of boreholes, monitor wells, and hand augers installed at each IRP site.

The Stage 1 and 2 Flightline Area (Sites 3, 4, 5, 10, 11, 12) boreholes and monitor wells are shown in Figures 3.5-1 and 3.5-2. The Stage 2 boreholes and wells, by site, are: 3A-E (Site 3), 4F-H (Site 4), 5D-H (Site 5), 10D-F (Site 10), and 12D-K (Site 12). The Stage 2 boreholes and wells were located on the basis of previous ground-water level data, Stage 1 ground-water chemistry data, and topography. Stage 2 wells were located to better define the lateral extent of ground-water contamination known to exist at the flightline sites. Site 12 boreholes were drilled to examine soil conditions underlying the active fire department training area for the occurrence of fuel products.

The East Area (Sites 1, 15, 16, 17, and BSS) boreholes and monitor wells are shown in Figure 3.5-3. The Stage 2 borehole and well locations, according to sites, are: 1E-F (Site 1), 17J-M (Site 17), and BSS A-D (Base Service Station). The Stage 2 boreholes and monitor well locations were selected based on the results of the soil gas survey and other relevant Phase 1 soil and ground-water data, particularly at Sites 1 and 17.

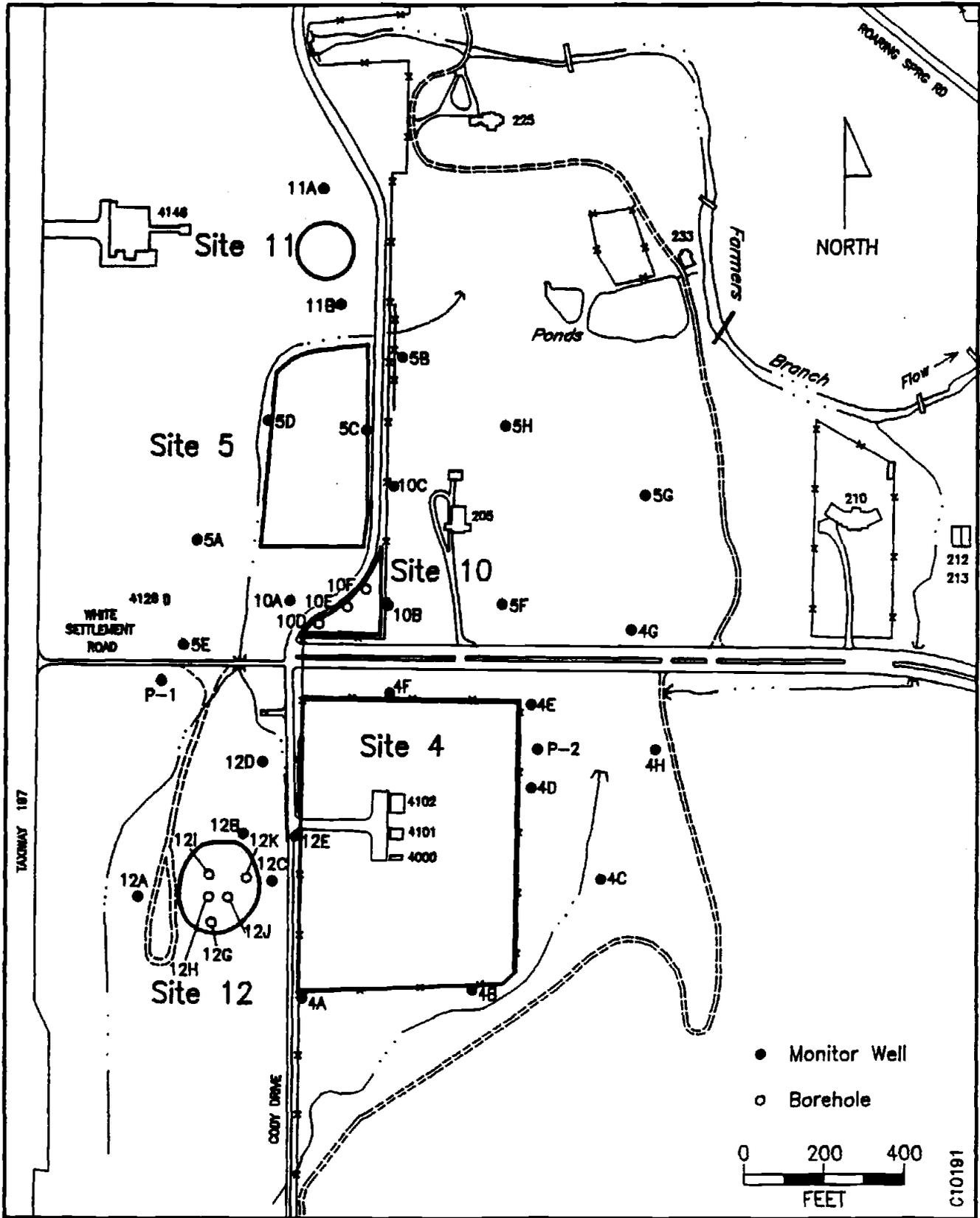


Figure 3.5-1. Location of Boreholes and Monitor Wells at the Flightline Area, Carswell, AFB, TX

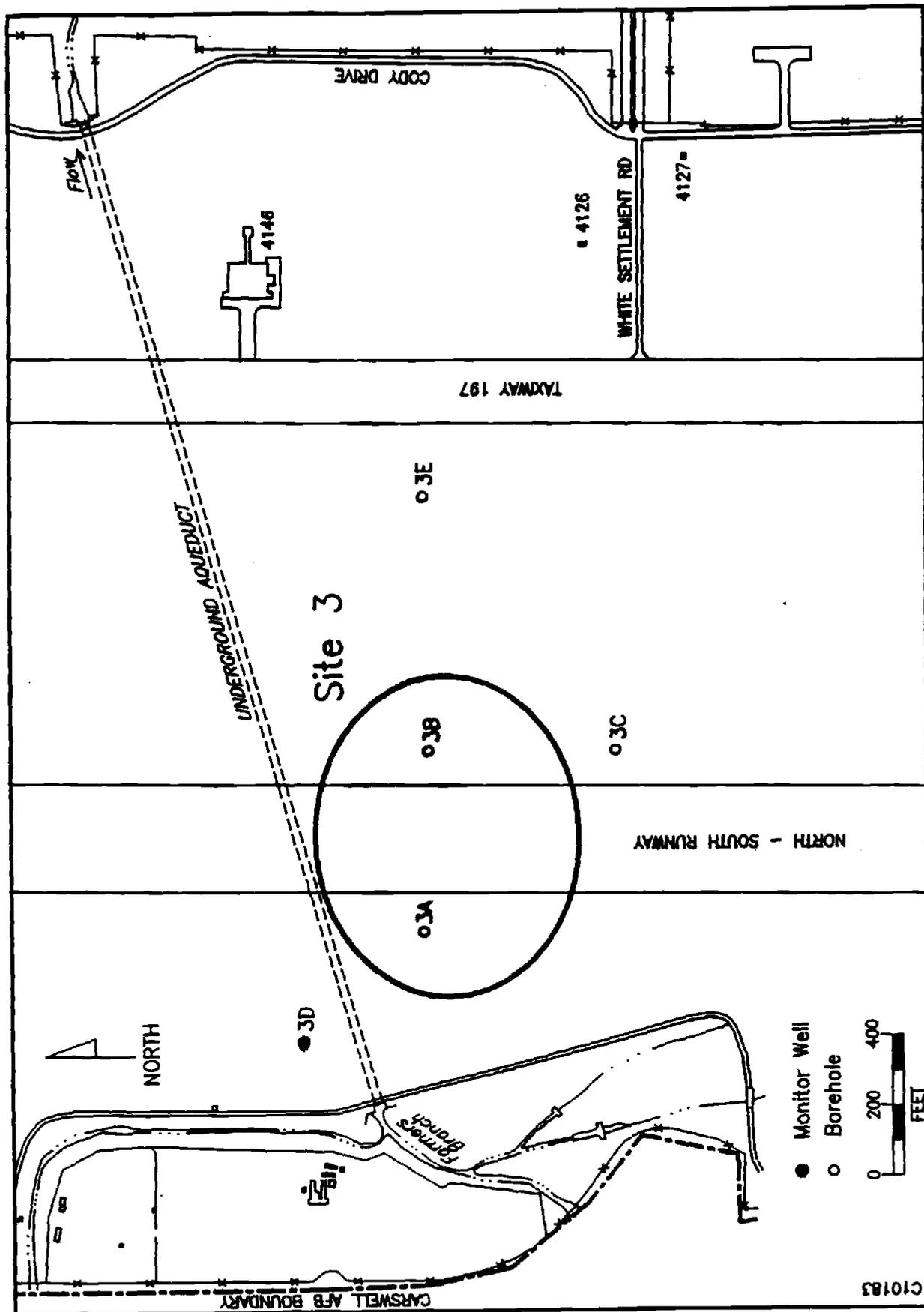


Figure 3.5-2. Location of Site 3 Boreholes and Monitor Well, Carswell AFB, TX



TABLE 3.5-1. SUMMARY OF STAGE 2 BOREHOLES, MONITOR WELLS AND HAND AUGER BORINGS, CARSWELL AFB, TEXAS

IRP Site	Description	Location Number	Boring Type <sup>1</sup>	Depth <sup>2</sup>
1	Landfill 1	1E	MW	30
		1F	MW	33
3	Landfill 3	3A	BH	18
		3B	BH	21
		3C	BH	12
		3D	MW	15.5
		3E	BH	16
4	Landfill 4	4F	MW	35.5
		4G	MW	40
		4H	MW	29
5	Landfill 5	5D	MW	24
		5E	MW	40
		5F	MW	37
		5G	MW	29
		5H	MW	25.6
10	Waste Burial Area	10D	BH	29
		10E	BH	29
		10F	BH	29
12	Fire Department Training Area 2	12D	MW	36
		12E	MW	40
		12G	BH	17
		12H	BH	25
		12I	BH	25
		12J	BH	25
		12K	BH	25
15	Entomology Dry Well	15D	HA	1
		15E	HA	4
		15F	HA	4
		15G	HA	2
		15H	HA	1
		15I	HA	2
		15J	HA	3

Continued

<sup>1</sup>MW - Monitor well  
 BH - Borehole  
 HA - Hand auger hole  
<sup>2</sup>Feet below land surface

TABLE 3.5-1. SUMMARY OF STAGE 2 BOREHOLES, MONITOR WELLS AND HAND AUGER BORINGS, CARSWELL AFB, TEXAS (Cont.)

IRP Site	Description	Location Number	Boring Type <sup>1</sup>	Depth <sup>2</sup>
17	POL Tank Farm	17I	MW	20
		17J	MW	20.5
		17K	MW	18
		17L	MW	20.5
		17M	MW	16
BSS	Base Service Station	BSS-A	MW	11
		BSS-B	MW	10
		BSS-C	MW	12
		BSS-D	BH	6
WSA	Weapons Storage Area	WSA-D	HA	1
		WSA-E	HA	1
		WSA-F	HA	1
		WSA-G	HA	1
		WSA-H	HA	1
		WSA-I	HA	1
		WSA-J	HA	4
		WSA-K	HA	3

<sup>1</sup>MW - Monitor well  
BH - Borehole  
HA - Hand auger hole  
<sup>2</sup>Feet below land surface

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FORM 10

The Weapons Storage Area (WSA) hand auger locations are shown on Figure 3.5-4. The hand auger locations were chosen to investigate possible soil contamination in the drainage ditch, adjacent to the Inspection Shop (Building 8503). Hand auger locations at the Entomology Dry Well (Site 15) were selected to investigate near surface soil at the former site of the Entomology Shop (Figure 3.5-5).

### 3.5.1 Drilling Technique

#### Hollow Stem Augering

A Mobile Drill B-61 hollow stem auger rig equipped with 5-foot lengths of 6 5/8-inch or 7-inch continuous flight augers was used for the Stage 2 drilling program. The hollow-stem auger method allowed for accurate examination of soil conditions, determination of the position of the water table, and the ability to recover soil samples for chemical analysis. Since no drilling fluids were used, the possibility of contaminating the ground water with drilling mud did not exist. After each borehole was completed, the drilling rig, auger flights, and equipment were decontaminated with a high temperature, high-pressure sprayer using Base potable water.

Cuttings suspected of contamination on the basis of visual evidence of contamination and OVA readings were placed in steel 55-gallon drums. Samples of the cuttings were collected and submitted for chemical analyses.

### 3.5.2 Well Design and Construction

Ground-water monitor wells were installed either immediately after completion of the drilling operations or after the borehole was noted to produce enough water to warrant a well. Construction specifications for the Stage 2 wells are presented in Table 3.5-2. Construction methods were generally consistent with the specifications provided in the SOW. Any necessary changes were made on an as needed basis and approved by the USAFOEHL Technical Program Manager. Decisions regarding the setting of the screen and

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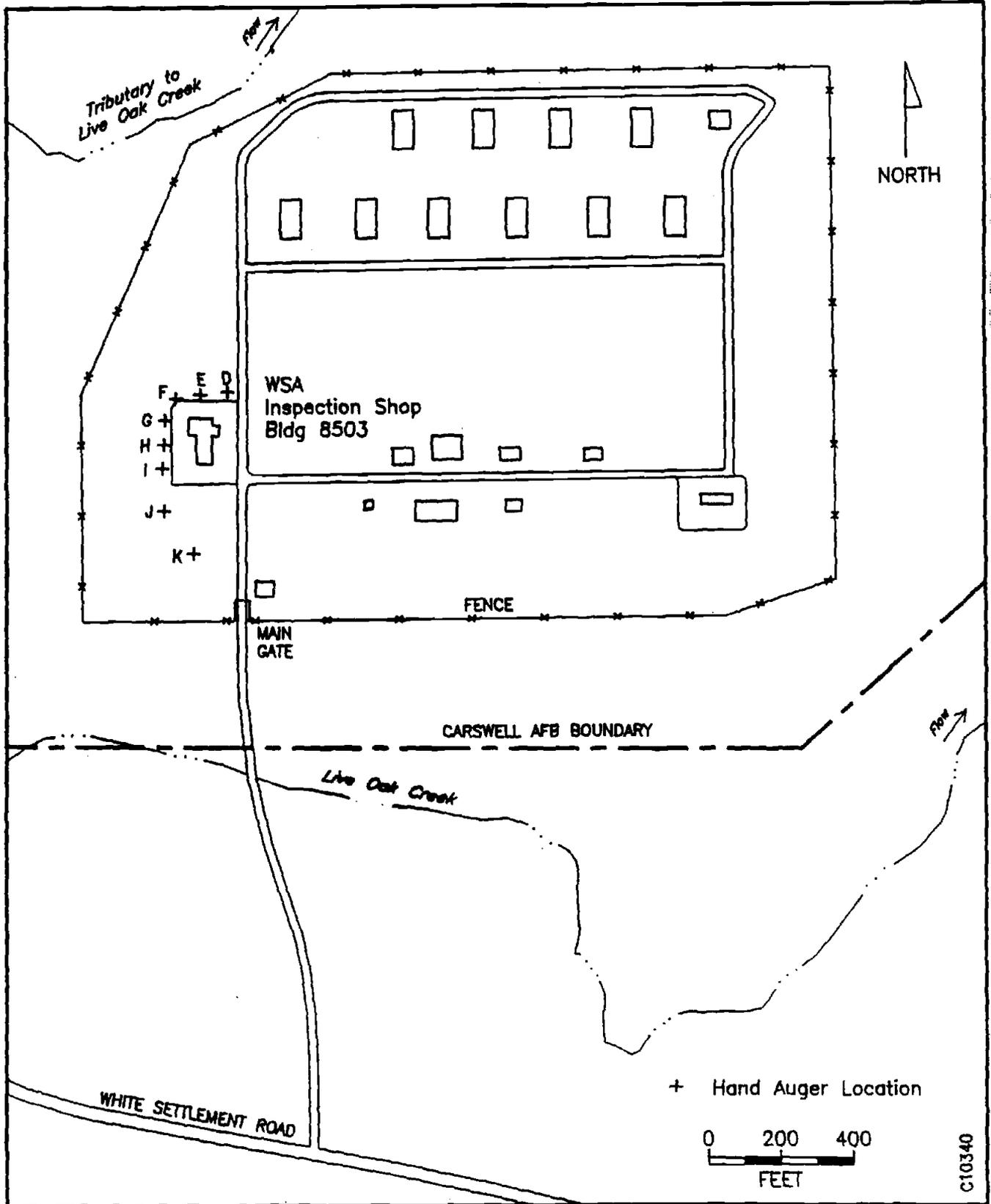


Figure 3.5-4. Location of Hand Auger Holes at the Weapons Storage Area (WSA), Carswell AFB, Texas

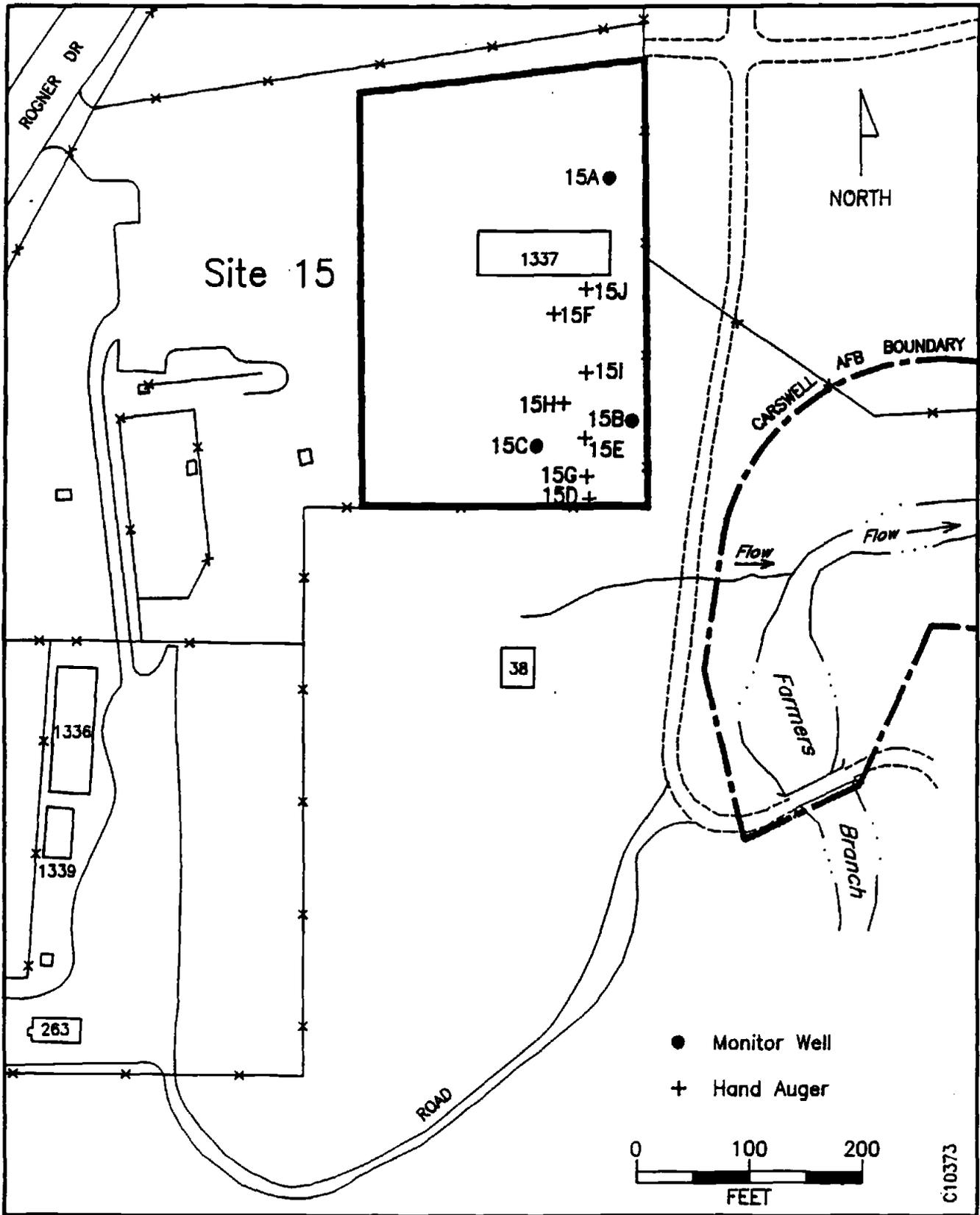


Figure 3.5-5. Location of Hand Auger Holes at the Entomology Dry Well (Site 15), Carswell AFB, Texas

casing, length of screen, amount of sand pack and bentonite were based on the observed static water level. Monitor wells were installed using the following procedures:

1. Prior to installation, the casing and screen sections were thoroughly washed using a high temperature, high-pressure sprayer, with Base potable water.
2. Screen and casing sections were assembled, then lowered carefully into the borehole. As the string of screen and casing was lowered, additional sections of casing were added until the bottom of the screen reached the bottom of the borehole. The top of the casing was capped to prevent any completion materials (sand and grout) from entering the casing during well construction activities. Where heaving or flowing sand was encountered, some well screens were wrapped in a filter fabric and installed using a natural, rather than artificial, sand pack. These wells were 4F, 4H, 5F, 5G, and 5H.
3. Except as previously noted, clean sand (Blastsand No. 8-20) was poured carefully inside the annular space as the augers were slowly withdrawn from the borehole. The sand pack was regularly measured by the supervising geologist until the level of the sand was two to five feet above the top of the screen. Bentonite pellets were placed on top of the sand to form a 2-foot thick seal. If necessary, water bailed from the borehole was poured down the annular space to hydrate the bentonite.
4. After the augers were removed from the borehole, neat cement (Type II Portland cement) grout containing approximately six percent bentonite was slowly poured down the annulus of the open hole.

TABLE 3.5-2. MONITOR WELL CONSTRUCTION SPECIFICATIONS, RI/FS STAGE 2, CARSWELL AFB, TEXAS

1. Casing: Two-inch diameter, threaded and flush joint, Schedule 40 PVC.
2. Screen: Two inch diameter, threaded and flush-joint factory-slotted, Schedule 40 PVC, 0.020 inch slot. Normal screen length is 10 feet. As noted in Section 3.5.4, some well screens were wrapped with filter fabric material.
3. Sand/gravel pack: Washed, bagged and rounded sand/gravel with grain size compatible with screen slot and formation (Blast Sand No. 8-20). A sand pack was placed from bottom of the borehole to 2 to 5 feet above the top of the well screen. Sand was placed at a controlled rate to avoid bridging within the auger.
4. Bentonite seal: Two feet of pelletized bentonite was placed above the sand section.
5. Grout: Neat cement (Type II Portland cement) grout poured into the open hole annular space from the top of the bentonite seal to land surface. A grout mixture of 6:1 Portland cement and bentonite was used. The grout was allowed to set for at least 24 hours before any well development activities.
6. Surface completion: The PVC casing was cut off to provide a two to three foot stickup and a solid PVC cap was placed on the casing. A 4-inch square protective steel well protector, 4 feet in length, was placed over the exposed PVC casing, and seated in the cement. A locking cap is incorporated in the well cover. The steel well protector and steel guard posts were painted for corrosion control and visibility.
7. Alternate flush completion: Flush completions involved cutting the casing two to three inches below land surface, and cementing in place a cast-iron valve box. To prevent any surface water infiltration, the valve box was slightly elevated above land surface. The lid to the valve box is secured with allen bolts. All wells installed with the exception of two wells at the Base Service Station and one well at Site 5 were above ground completions.
8. Guard pipes or posts: Three 3-inch diameter steel posts, 6 feet in length, with a minimum of 2 feet below ground, installed radially 4 feet from the wellhead (not emplaced for flush surface completion).

5. After completion of grouting, the casing was cut 2 to 3 feet above land surface and a protective 4-inch diameter steel casing protector with a lockable lid was cemented into place. Three steel guard posts were then placed around the well. If above-ground stickups were of concern in an area, the well was completed flush with the land surface.

Flush completions involved cutting the casing two to three inches below land surface, and cementing in place a cast-iron valve box. To prevent any surface water infiltration, the valve box was slightly elevated above land surface. The lid to the valve box is secured with allen bolts. All wells were above-ground completions with the exception of two wells at the Base Service Station and one well at Site 5. Table 3.5-3 presents the results of the surveyed elevations of the ground surface, the wellhead, and the screened interval of the wells.

#### Well Development

After allowing the cement grout to set for a minimum of 24 hours, the wells were developed by bailing using a bottom-entry bailer. Water levels in some of the wells recovered slowly and the wells were bailed dry several times. Other wells produced sufficient water and developed without a recovery period. Development was complete when the water in the well was virtually sediment free. The ground water removed from the wells was placed in steel 55-gallon drums, sealed and labeled with hazardous identification labels.

#### 3.6 Sampling Program for Water and Soil

The following sections provide information regarding the sampling techniques used in collection of ground water, surface water, soil, and surface sediment samples.

11/11/11 10:11 AM

11/11/11 10:11 AM

11/11/11 10:11 AM

TABLE 3.5-3. GENERAL SPECIFICATIONS FOR RI/FS MONITOR WELLS,  
CARSWELL AFB, TEXAS

Monitor Well Number	Measuring Point <sup>1</sup> Elevation (feet MSL)	Ground Level Elevation (feet MSL)	Screened Interval (feet BLS)	Screen Elevations (feet MSL)	Total Depth (feet BLS)
1A	570.27	566.5	2.8-7.8 S	563.7-558.7	7.8
1B	560.25	560.5	9-19 10	551.5-541.5	19.1
1C	560.0	560.3	23-33 10	537.3-527.3	33.1
1D	563.93	560.5	13-23 10	547.5-537.5	23.3
1E	562.25	559.4	16.75-27.5 10 <sup>15</sup>	542.65-531.9	29.6
1F	562.26	559.5	17.25-28 10 <sup>15</sup>	542.25-531.9	30.0
3D	625.25	621.6	8.5-14.4 5A	613.1-607.2	15.4
4A	625.76	624.6 1/4	14-24 10	610.6-600.6	24.0
4B	619.9	618.4	13-23 10	605.4-595.4	24.0
4C	613.04	610.9	18.5-28.5 10	592.4-582.4	29.5
4D	615.35	613.1	18-28 10	595.1-585.1	30.5
4E	618.54	617.5 3/5	15-35 10	602.5-582.5	35.0
4F	625.36	622.8	21-34 10	601.8-588.8	35.0
4G	620.02	619.1	22-35 10	597.1-584.1	36.0
4H	613.43	610.5	14-27 10	596.5-583.5	28.0
5A	623.18	619.4	18-28 10	601.4-591.4	32.0
5B	600.45	597.4	4-9 S	593.4-588.4	9.0
5C	608.68	606.8	7-22 10	599.8-584.8	22.0
5D	611.71	608.5	10.5-19.5 9	598.0-589.0	20.5
5E	626.89	623.9	25.1-38.1 10	598.8-585.8	39.1
5F	618.95	619.4	23-36 10	596.4-583.4	37.0
5G	615.39	612.0	15.25-26 10 <sup>15</sup>	596.75-586.0	27.0
5H	610.62	608.4	13.85-24.6 10 <sup>15</sup>	594.55-583.8	25.6
10A	626.7	626.7	27-37 10	599.7-589.7	39.0
10B	624.46	621.1	23-33 10	598.1-588.1	36.0
10C	617.24	615.4	20-30 10	595.4-585.4	32.5

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Notes: 1. Measured from top of casing.

Contir

**TABLE 3.5-3. GENERAL SPECIFICATIONS FOR RI/FS MONITOR WELLS,  
CARSWELL AFB, TEXAS (Cont.)**

Monitor Well Number	Measuring Point <sup>1</sup> Elevation (feet MSL)	Ground Level Elevation (feet MSL)	Screened Interval (feet BLS)	Screen Elevations (feet MSL)	Total Depth (feet BLS)
11A	608.22	604.8	4-14 10	600.8-590.8	14.5
11B	608.14	603.8	3.5-13.5 10	600.3-590.3	15.0
12A	635.66	632.0	13-23 10	619.0-609.0	25.0
12B	627.55	625.6	27.5-37.5 10	598.1-588.1	40.0
12C	628.05	625.5	27.5-37.5 10	598.0-588.0	38.0
12D	627.45	624.8	21.4-34.4 13	603.4-590.4	35.4
12E	627.48	624.5	24-27.5 3.5	600.5-597.0	38.5
17I	578.19	575.2	4-16.5 12.5	571.2-558.7	17.5
17J	578.19	577.0	8.45-19.2 10.75	568.55-552.8	20.2
17K	575.34	573.8	7.7-17.7 10	566.1-556.1	18.7
17L	577.27	574.4	8.45-19.2 10.75	565.95-555.2	20.2
17M	574.28	572.6	4.9-14.9 10	567.7-557.7	15.9
BSS-A	566.38	566.9	5-10	561.9-556.9	11.0
BSS-B	569.73	567.1	3.8-8.8	563.3-558.3	9.8
BSS-C	559.57	560.0	6-11	554.0-549.0	12.0
P1	628.58	625.5	69-109 40	556.5-516.5	109.0
P2	618.78	615.5	69-109 40	546.5-506.5	109.0

Notes: 1. Measured from top of casing.

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3.6.1 Sampling Methodology and Protocols

Ground-Water Sampling

During the Stage 2 program, 41 upper zone monitor wells and 2 Paluxy wells were sampled for ground water. Sampling was performed in two rounds; the first round started on 24 February 1988 and the second round started on 5 April 1988. Ground-water sampling in each round proceeded from the least contaminated areas to the most contaminated areas, based on the results of the RI/FS Stage 1 investigation.

Prior to sample collection, water-level measurements at each of the monitor wells were taken with an Olympic Actat water level meter and recorded in a field notebook. Measurements were taken from the top of the casing, and read to the nearest 0.01-foot. Between measurements, the probe and associated electrical line were washed with laboratory grade detergent, rinsed with potable water, and then rinsed with deionized water to prevent the possibility of cross-contamination.

Before samples were collected, three well volumes of water were bailed from the well using a bottom-entry Teflon bailer attached to a nylon line. This procedure ensured that representative formation water was collected. Purge water was placed in 55-gallon drums for final disposal pending the outcome of chemical analyses (later provided to the Base Environmental Coordinator). Between wells, all equipment used for bailing operations was cleaned with laboratory grade detergent (Alconox), rinsed with potable water, then rinsed with deionized water to prevent cross-contamination. The nylon line was replaced between wells. For wells with a known history of chemical contamination, the bailer was washed with technical grade methyl alcohol, cleaned with laboratory grade detergent (Alconox), rinsed with potable water, rinsed with deionized water and allowed to dry completely.

Specific conductance, pH and temperature were taken from an aliquot of the sample recovered. Specific conductance and pH were taken with a portable pH/conductivity (DSPH-1) meter and the temperature was taken with a







TABLE 3.6-1. SUMMARY OF RI/FS STAGE 2 WATER SAMPLING AND ANALYSIS REQUIREMENTS, CARSWELL AFB, TEXAS (cont.)

Reference Method	Parameter	Method Detection Limit	Method Type	Container Type, No. and Volume	Preservation and Storage Requirements	Sample Preparation Procedures	Maximum Holding Time (Extraction) <sup>2</sup>	Maximum Holding Time (Analysis)
EPA 604	Phenols	0.5 - 80 ug/L	GC	(2) 1-L Glass Bottle	Refrigerated at 4°C	Methylene Chloride Extraction	7 days	40 days
EPA 625	Priority Pollutants	50 ug/L	GC/MS	(2) 1000 mL glass; TFE-lined cap	Refrigerated at 4°C	Continuous extraction with methylene chloride	7 days	40 days
EPA 608	Organochloride Pesticides	0.05 - 1 ug/L	GC	(2) 1-L Glass Bottle	4°C pH 5 to 9	Methylene Chloride Extraction	7 days	40 days
SI609b	Chlorinated Phenoxy Acid Herbicides	0.01 ug/L	GC	1-L glass bottles w/TFE lined caps	4°C	Hydrolysis, Esterify, GC	7 days	40 days

Notes: 1. ICF = Inductively Coupled Plasma Resonance Spectrometry

AA = Atomic Absorption

IR = Infrared

GC/FID = Gas Chromatograph/Fluorescence Detector

GC/MSD = Gas Chromatograph/Mass Spectrometry

2. N/A = Not Applicable

WS = Not Specified

SM = Standard Method



At each of the locations, observations were made regarding the flow conditions and appearance of the stream. After collection, samples were placed directly into prelabeled sample bottles and preserved according to the requirements listed in Table 3.6-1.

#### Soil and Sediment Sampling

Soil samples were collected from both hollow-stem auger boreholes and hand-auger holes during the Stage 2 field program. In addition, two rounds of sediment samples were collected from the five sampling points along the Flightline Drainage Ditch (Site 13). The parameters selected for chemical analysis of soils are listed in Table 3.6-2.

Hand Auger Sampling--Hand augers were used to collect soil samples from just below land surface (BLS) to as deep as 6 feet BLS at Sites 15 and WSA. The auger bit is constructed of stainless steel and is approximately 3 inches in diameter. Soil samples for visual observation were collected at 1-foot intervals at depths over the length of the auger hole. Samples collected for chemical analysis were generally taken at the 1-foot depth and from the total depth of the auger hole. Between sampling, the auger was cleaned with laboratory grade soap (Alconox) and water, rinsed with potable water, and rinsed with deionized water. Samples were collected by augering to the selected depth interval, cleaning the auger, collecting the soil in the auger and raising the auger to the surface, removing the soil from the auger, and placing the sample in a glass container. Containers were placed in an ice chest, cooled to 4°C, and shipped to the laboratory for chemical analysis.

Hollow-Stem Auger Sampling--Samples of soil were collected with a Shelby tube in the upper 5-feet of the borehole, with the remainder of the samples collected with a 5-foot long continuous split-barrel sampler. Samples were collected in the continuous sampler as the auger was advanced in 5-foot increments to the water table. The samples were recovered at the surface and described in terms of lithology, texture, and moisture. After each sampling event, the continuous sampler was washed with soap and water, rinsed with water, and then given a final rinse with deionized water. The selection of

TABLE 3.6-2. SUMMARY OF RI/FS STAGE 2 SOIL SAMPLING AND ANALYSIS REQUIREMENTS, CARSWELL AFB, TEXAS

Reference Method	Parameter	Method Detection Limit	Method Type <sup>1</sup>	Container Type, No. and Volume	Preservation and Storage Requirements	Sample Extraction Procedures	Medium Holding Time (Preparation) <sup>2</sup>	Medium Holding Time (Analysis)
EPA 6010	Metals	0.2 - 90 ug/g	ICP Emission	250 ml glass bottle	Refrigerated at 4°C	Acid digestion (3050R)	N/S	6 months
EPA 7060	Metals: As	0.5 ug/g	Furnace AA	250 ml Glass Bottle	Refrigerated at 4°C	Acid digestion (3050R)	N/S	6 months
EPA 7740	Metals: Se	0.5 ug/g	Furnace AA	250 ml Glass Bottle	Refrigerated at 4°C	Acid digestion (3050R)	N/S	6 months
EPA 7471	Metals: Hg	0.5 ug/g	Cold Vapor AA	250 ml Glass Bottle	Refrigerated at 4°C	Acid digestion (3050R)	N/A	28 days
EPA 7420	Metals: Pb	0.5 mg/g	AA(furnace)	250 ml Glass Bottle	Refrigerated at 4°C	Acid digestion (3050R)	N/S	6 months
EPA 413.2	Oil and Grease	10 ug/g	Infrared	250 ml glass bottle	Refrigerated at 4°C	Freon Extraction by Sonication (3550)	N/S	28 days
EPA 418.1	Petroleum Hydrocarbons	50 ug/g	IR	250 ml Glass Bottle	Refrigerated at 4°C	Sonication extraction (3550) with Freon	N/S	28 days
EPA 8240	Volatile Organic Compounds	0.1 ug/g	GC/MS	250 ml Glass Bottle	Refrigerated at 4°C	Purge and Trap (5030)	14 days	14 days

Notes: 1. ICP = Inductively Coupled Plasma Emission Spectroscopy  
 AA = Atomic Absorption  
 IR = Infrared

GC/FID = Gas Chromatograph/Fluorimetric Detector  
 GC/MSD = Gas Chromatograph/Mass Specific Detector

2. N/A = Not Applicable  
 N/S = Not Specified  
 SM = Standard Method

(Continued)

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**TABLE 3.6-2. SUMMARY OF RI/FS STAGE 2 SOIL SAMPLING AND ANALYSIS REQUIREMENTS, CARSWELL AFB, TEXAS**

Reference Method	Parameter	Method Detection Limit	Method Type	Container Type, No. and Volume	Preservation and Storage Requirements	Sample Preparation Procedures	Maximum Holding Time <sup>2</sup> (Preparation)	Maximum Holding Time <sup>2</sup> (Analysis)
EPA 8270	Semi-Volatile Organic Compounds	1 ug/g	GC/MS	250 mL stainless steel sleeve or 250 mL glass bottle	Refrigerated at 4°C	Sonication (3550)	14 days	40 days
EPA 8150	Chlorinated Phenyl Herbicides	0.1 - 160 ug/g	GC/ECD	250 mL Glass Bottle	Refrigerated at 4°C	Extraction, hydrolysis, GC	7 days	40 days
EPA 8080	Organochloride Pesticides and PCB's	0.01 - 0.2 ug/g	GC/ECD	250 mL Glass Bottle	Refrigerated at 4°C	Sonication Extraction (3550)	7 days	40 days
40 CFR 261.21 (EPA 1310)	EP Toxicity	0.002-0.5 mg/L	Extraction AA, ICP	250 mL Glass Bottle	Refrigerated at 4°C	Extraction	N/S	28 days
EPA 8140	Organophosphorus Pesticides	0.5 - 5 ug/g	GC	250 mL Glass Bottle	Refrigerated at 4°C	Sonication, Extraction (3550) with Freon	7 days	40 days
ASTM D2216	Soil Moisture							

Notes: 1. ICP = Inductively Coupled Plasma Resonance Spectroscopy

AA = Atomic Absorption

IR = Infrared

GC/FID = Gas Chromatograph/Fluorescence Detector

GC/MSD = Gas Chromatograph/Mass Spectrometry Detector

2. N/A = Not Applicable

N/S = Not Specified

SH = Standard Method

soil samples collected for chemical analysis was based on several factors: visible evidence of contamination of the soil, OVA, and/or Draeger-tube reactions. If no visible contamination was observed in the soil, the sample taken at the water-table interface was chosen for chemical analysis. Samples selected for analysis were cooled to 4°C and shipped to Radian's laboratories in Sacramento or Austin.

Sediment Sampling--Sediment samples from the Flightline Drainage Ditch (Site 13) were collected approximately 4 to 6 inches below the surface. Figure 3.6-2 shows the sediment sample locations at the Flightline Drainage Ditch. Sediment was placed in a stainless steel bowl, mixed to ensure homogeneity of the sample, and placed into a sample container. Containers were placed in an ice chest at 4°C and shipped to Radian's laboratory for chemical analysis. Between sampling, all equipment was cleaned with laboratory grade soap and water, rinsed with potable water, and given a final rinse with deionized water.

### 3.6.2 Sample Preservation Methods, Required Containers and Holding Times

The sample preservation methods, required containers, and holding times for ground water, surface water, soil, and soil sediment are presented in Tables 3.6-1 (water) and 3.6-2 (soil).

### 3.6.3 Field Quality Assurance/Quality Control (QA/QC)

In addition to sampling procedures and decontamination practices observed during the Stage 2 field program, the following field QA/QC sampling was performed to provide a measure of the accuracy of the analytical results. The following QA/QC samples were collected, as discussed in the Stage 2 QAPP.

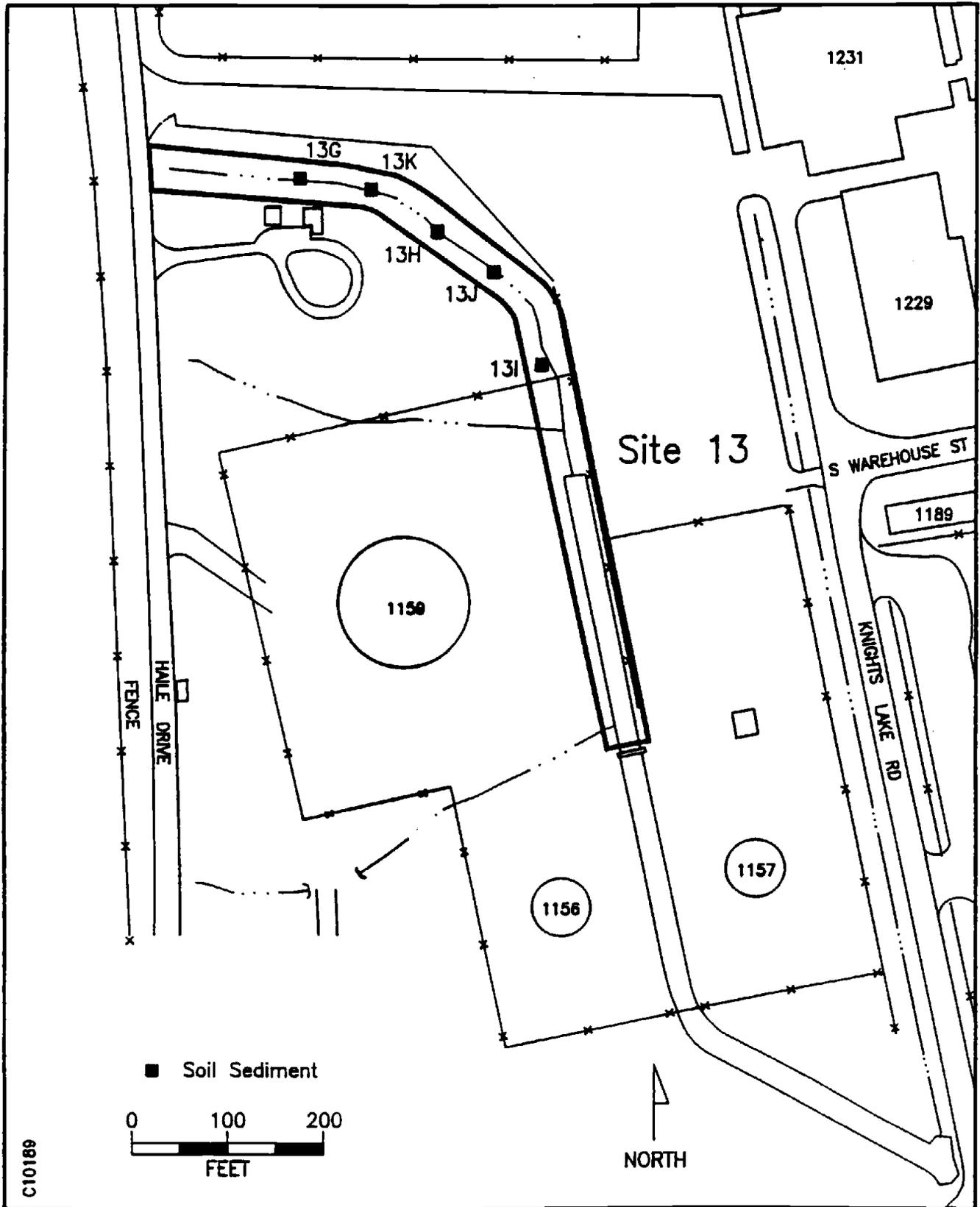


Figure 3.6-2 Location of Site 13 Sediment Sampling Points, Carswell AFB, TX



TABLE 3.7-1. IDENTIFICATION OF ANALYTICAL LABORATORIES AND CHEMICAL PARAMETERS, CARSWELL AFB, TEXAS

Laboratory	Parameter	EPA Method
Field	Alkalinity	A403
	Specific Conductance	E120.1
	pH	E150.1
	Temperature	E170.1
-----		
Radian - Austin, Texas	Fluoride	E340.2
	Chloride	E325.3
	Sulfate	E375.4
	Total Dissolved Solids	E160.1
	Orthophosphate	E365.1
	Nitrate	E353.1
	Metal Screen	E200.7
	Arsenic	E206.2
	Lead	E239.2
	Mercury	E245.1
	Selenium	E270.2
	Oil and Grease	E413.2
	Petroleum Hydrocarbons	E418.1
	Purgeable Halocarbons	E601
Purgeable Aromatics	SW8020	
-----		
Radian - Sacramento, California	Phenols	E604
	Organochlorine Pesticides	E608
	Extractible Priority Pollutants	E625
	Chlorinated Phenoxy Acid Herbicides	A509B



TABLE 3.7-2. ELEMENTS DETECTED BY EPA METHOD 6010/200.7 (ICP),  
CARSWELL AFB, TEXAS

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Ag - Silver  
Al - Aluminum  
As - Arsenic  
B - Boron  
Ba - Barium  
Be - Beryllium  
Ca - Calcium  
Cd - Cadmium  
Co - Cobalt  
Cr - Chromium  
Cu - Copper  
Fe - Iron  
K - Potassium  
Mg - Magnesium  
Mo - Molybdenum  
Na - Sodium  
Ni - Nickel  
Pb - Lead  
Sb - Antimony  
Se - Selenium  
Si - Silicon  
Tl - Thallium  
V - Vanadium  
Zn - Zinc

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EPA Method 413.2 - Oil and Grease (Infrared)--This method includes the measurement of fluorocarbon-113 extractable matter from surface water and industrial and domestic wastes. It is applicable to the determination of hydrocarbons, vegetable oils, animal fats, waxes, soaps, greases and related matter. It will measure light petroleum fuels, and is generally a more accurate estimation of the oil and grease parameter than the gravimetric method. The sample is acidified to a low pH and extracted with fluorocarbon-113. The oil and grease is determined by comparison of the infrared absorbance of the sample extract with standards.

EPA Method 418.1 - Petroleum Hydrocarbons (Infrared)--Oil and grease is a measure of biodegradable animal greases and vegetable oils, whereas petroleum hydrocarbons are considered mineral oils. A sample of 1 liter volume is collected in a wide-mouth glass bottle. The sample is acidified to <2 pH with  $H_2SO_4$  as a means of preventing microbial activity. Serial extraction with fluorocarbon-113 is accomplished in a separatory funnel, with interferences removed in silica gel adsorbant. Analysis is performed by infrared spectrophotometry.

#### Extraction Procedures

EPA Method 1310 - Extraction Procedure (EP) Toxicity Test--This extraction procedure is employed to determine whether a waste exhibits characteristics of Extraction Procedure Toxicity (EP Toxicity) as specified in 40 CFR Part 261.24. It may also be used to simulate leaching in a sanitary landfill. If the sample contains >0.5% solids, the solid phase must be ground to pass a 9.5 mm sieve. This solid phase is extracted with deionized water in a specially designed mixer for 24 hours. The pH is maintained at 5 with acetic acid. The sample is then filtered and the filtrate analyzed for the specified metals and organics. Samples containing less than 0.5% solids are directly analyzed.

EPA Method 3550 - Sonication Extraction--EPA Method 3550 is a procedure for extracting nonvolatile and semivolatile organic compounds from solids such as soils and sludges. The sonication process ensures intimate contact of the sample matrix with the extraction solvent.

A weighed sample of the solid material is ground, mixed with the extraction medium, then dispersed into the solvent using sonication. The extract may be dried with anhydrous sodium sulfate. The resulting solution may then be cleaned up further or analyzed directly using the appropriate technique. Freon is typically used as the solvent, although other solvents may be used for specific analytical applications.

EPA Method 5030 - Purge and Trap--EPA Method 5030 is used to determine the concentration of volatile organic compounds in a variety of liquid and solid matrices. It is based upon a purge-and-trap, gas chromatographic procedure.

The method is applicable to nearly all types of samples, regardless of water content, including aqueous sludges, caustic liquors, acid liquors, waste solvents, oily wastes, water, mousses, tars, fibrous wastes, polymeric emulsions, filter cakes, spent carbons, spent catalysts, soils, and sediments. The success of this method depends on the level of interferences in the sample; results may vary due to the large variability and complexity of matrices of solid waste samples.

A portion of the solid sample is dispersed in polyethylene glycol (PEG), tetraglyme, or distilled-in-glass methanol to dissolve the volatile organic constituents. A portion of the PEG, tetraglyme, or methanol solution is combined with water in a specially designed purging chamber. An inert gas is then bubbled through the solution at ambient temperature and the volatile components are efficiently transferred from the aqueous phase to the vapor phase. The vapor is swept through a sorbent column where the volatile components are trapped. After purging is completed, the sorbent column is heated and backflushed with inert gas to desorb the components onto a gas chromato-

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graphic column. (For EPA Method 8020, drying of the trap for 4 minutes under helium flow is required.) The gas chromatographic column is heated to elute the components which are detected by the appropriate detector.

#### Organic Analyses by GC/MS

Several analytical techniques were used for analysis of the sample extracts. Halogenated volatiles were analyzed by GC with a halide-specific detector (GC/HSD). Ethylene dichloride, ethylene dibromide, and benzene were be analyzed by GC/MS. Semi-volatile extractables were also analyzed by GC/MS. Analytical techniques for chlorinated hydrocarbons and volatile aromatics are GC methods, with an electron capture detector (ECD) used for chlorinated hydrocarbons, and a photoionization detector (PID) used for aromatic hydrocarbons.

EPA Method 8240 - GC/MS for Volatile Organics--This method is based upon a purge-and-trap, gas chromatographic/mass spectrometric (GC/MS) procedure and may be used to determine volatile organic compounds in a variety of solid matrices. It is applicable to nearly all types of samples, regardless of water content. The detection limit of EPA Method 8240 for an individual compound is approximately 1 ug/L (wet weight) in solid samples. For samples containing more than 1 mg/g of total volatile material, the detection limit is proportionately higher.

The volatile compounds are introduced to the GC by the purge-and-trap method, using water as the solvent and dispersion medium. The components are separated via the GC and detected using a mass spectrometer which provides both qualitative and quantitative information.

Qualitative identification of sample components was based upon the Extracted Ion Current Profile (EICP) for the primary characteristic ion and at least two other characteristic ions for each compound. A qualitative identification required that the following criteria be met:

1. The characteristic ions of each compound of interest must maximize in the same scan or within one scan of each other.
2. The retention time must fall within +/-30 seconds of the retention time of the authentic compound.
3. The relative peak heights of the characteristic ions in the internal standard EICPs must fall within -50% to 100% of the relative intensities of these ions in a reference mass spectrum.

When a compound has been identified, quantitation of that compound will be based on the integrated abundance from the EICP of the primary characteristic ion. In general, the primary characteristic ion selected should be a relatively intense ion, as interference-free as possible, and as close as possible in mass to the characteristic ion of the internal standard used. Generally, the base peak of the mass spectrum is used.

Internal standards were employed during analysis of all samples and during all calibration procedures. The analyst selected one or more internal standards that are similar in analytical behavior to the compounds of interest. The analyst further demonstrated that the measurement of the internal standard was not affected by method or matrix interferences. Because of these limitations, no internal standard can be suggested that is applicable to all samples. However, for general use, bromochloromethane, 1,4-difluorobenzene, and  $d_5$ -chlorobenzene were used as internal standards covering a wide boiling point range.

4-Bromofluorobenzene (BFB) was added to the surrogate standard solution to permit the mass spectrometer tuning for each GC/MS run to be checked. Surrogate standards were added to samples and calibration solutions to assess the effect of the sample matrix on recovery efficiency. The compounds employed for this purpose were  $d_8$ -toluene, p-bromofluorobenzene, and  $d_4$ -1,2-dichloroethane.

EPA Method 8270/625 - GC/MS for Semi-Volatile Organics--Semi-volatile extractable organics in solid samples were determined using EPA Method 8270 as modified for CLP use (EPA Method 625 in water samples). This is a capillary column gas chromatographic/mass spectrometric (GC/MS) procedure. The method is applicable to nearly all types of samples, regardless of water content, as long as the samples can be volatilized without decomposition. EPA Method 8270 can be used to quantitate most neutral, acidic, and basic organic compounds that are soluble in methylene chloride and capable of being eluted without derivatization as sharp peaks from a gas chromatographic-fused silica capillary column coated with a slightly polar silicone. Such compounds include polynuclear aromatic hydrocarbons, chlorinated hydrocarbons and pesticides, phthalate esters, organophosphate esters, nitrosamines, haloethers, aldehydes, ethers, ketones, anilines, pyridines, quinolines, aromatic nitro compounds, and phenols, including nitrophenols. The detection limit of EPA Method 8270 for determining an individual compound is approximately 1 ug/g (wet weight). For samples that contain more than 1 mg/g of total solvent extractable material, the detection limit is proportionately higher. Prior to using this method, solid samples must be prepared for chromatography using the appropriate sample preparation method -- i.e., sonication (EPA Method 3550), or Soxhlet extraction (EPA Method 3540). Qualitative identification and quantitative determination of the species of interest are performed in the manner described for EPA Method 8240.

#### Organic Analyses by GC

EPA Method 601 - Halogenated Volatile Organics--Halogenated volatile organics in samples were determined using EPA Method 601, which is a packed-column gas chromatographic method. Samples are typically extracted using the purge-and-trap method (EPA Method 5030). Separation for the species of interest is accomplished by operating the GC in temperature-programmed mode. Detection is achieved using a halide-specific detector (i.e., an electrolytic conductivity detector).

EPA Method 8020 - Purgeable Aromatics--Aromatic volatile organics in samples were determined using EPA Method 8020. This is a packed-column chromatographic technique utilizing a photoionization detector (PID). Samples may be analyzed using direct injection or purge-and-trap (Method 5030); water samples must be analyzed using Method 5030. Separation for the individual species is accomplished by operating the GC in temperature-programmed mode.

EPA Method 8080/608 - Organochlorine Pesticides and PCBs--Method 8080/608 is used to determine the concentration of various organochlorine pesticides and polychlorinated biphenyls (PCB's). The esters are hydrolyzed with potassium hydroxide, and extraneous organic material is removed by a solvent wash. After acidification, the acids are extracted with solvent and converted to their methyl esters using diazomethane as the derivatizing agent. After excess reagent is removed, the esters are determined by gas chromatography employing an electron capture detector, microcoulometric detector, or electrolytic conductivity detector. The results are reported as the acid equivalents.

#### Other Water Parameters

EPA Method 300-Series (Common Anions)--Determination of common anions is performed to characterize a specific water type, and is accomplished by several techniques. Samples are collected and stored in polyethylene bottles and filtered prior to analysis. A selective ion electrode is used to determine fluoride (E340.2); colorimetry is used for determining nitrate (E353.1), orthophosphate (E365.1), and chloride (E325.3); and the turbidimetric method is used for sulfate (E375.4).

EPA Method 160.1 - Total Dissolved Solids--Total dissolved solids are determined by thoroughly mixing the solution sample, passing the solution through a standard glass fiber filter, and then evaporating the filtrate to isolate the residue. The residue is dried at a constant temperature of 180°C until mass stabilization indicates that the residue is dry. Residue mass is then comparable to volume of solvent.

3.7.2 Laboratory QA/QC Program

The following sections summarize the laboratory QA/QC procedures that were identified in the QAPP and followed throughout the duration of the Stage 2 laboratory program. QA/QC results are provided in Appendix G.

Methods 509B/8150, 601, 604, 608/8080, 8020, 8140 (GC)

Analytical quality control procedures for GC analyses are described generally in Method 8000-series of SW-846, 3rd ed. (and equivalent methods in the 600 and 500 series EPA Methods) and include the following:

- Initial demonstration of capability;
- Calibration verification;
- Analysis of surrogate spiked samples;
- Method blank analyses;
- Analysis of matrix spike/matrix spike duplicates;
- Retention time window checks; and
- Analysis of QC check samples.

These procedures are described below.

Initial Demonstration of Capability--Before analyzing samples by a method, the laboratory must demonstrate the ability to generate acceptable accuracy and precision. This was done by analyzing four aliquots of a QC check sample (QCCS) by the same procedure used to analyze samples. The laboratory calculated the average recovery and the standard deviation of the recovery for each analyte of interest using the four results. The mean recovery and standard deviation for each analyte was then compared with the corresponding acceptance criteria published in the SW-846 method. If the experimental accuracy and precision data were acceptable, analyses proceeded; if not, remedial action was taken to improve system performance.

QC Check Sample Analyses--QC check samples were obtained from EPA or prepared from suitable reference materials independently of calibration standards. The QCCS contained the analyte(s) of interest at a concentration in the mid-calibration range. Measured values were plotted on a QC control chart. A QCCS was analyzed if matrix spike recoveries were unacceptable to verify that the analytical system was in a state of control.

Method Blank Analyses--Before processing any samples, the analyst demonstrated through the analysis of a reagent water method blank that all glassware and reagents were interference-free. Each time a set of samples was extracted or there was a change in reagents, a method blank was processed as a safeguard against chronic laboratory contamination. The blank samples were carried through all stages of the sample preparation and measurement steps.

Matrix Spike/Matrix Spike Duplicate--For each analytical batch or matrix type (5 percent minimum frequency), matrix spike and matrix spike duplicate samples were analyzed. The laboratory maintained control charts (using two standard deviation control limits) of MS/MSD results, in terms of percent recovery of the spike and relative percent difference between duplicates. When matrix spike results fell outside the laboratory-established limits, or outside limits published in the respective methods, a QCCS was analyzed to demonstrate analytical control. If spike recoveries were outside normal limits due to matrix problems, the data was flagged.

Surrogate Spikes--A surrogate standard is a chemically inert compound not expected to occur in an environmental sample. The use of surrogate compounds may be project dependent, in which case their use may be limited by the inability to identify a suitable surrogate for a particular parameter class. In general, the laboratory must establish control limits (as the mean recovery  $\pm$ three standard deviations) for each surrogate compound after thirty samples of the same matrix have been analyzed. These control limits should be revised at least annually. If the surrogate spike recovery in any sample is not within limits, the laboratory must:

- Check for errors in calculations, surrogate solutions and standards, as well as instrument performance;
- Recalculate the data and/or reanalyze the extract if any of the above checks reveal a problem; and
- Reextract and reanalyze the sample if none of the above are a problem, or else flag the data as "estimated concentration".

Retention Time Windows--The laboratory calculates retention time windows for each standard on each GC column and whenever a new GC column is installed. Retention time windows are established by injecting three single-component standard mixtures and multiresponse products (e.g., PCBs) during a 72-hr period. For each single component standard, the standard deviation of the three absolute retention times is calculated; for multiresponse products, one major peak is chosen from the envelope. If the standard deviation for a particular standard is zero, the standard deviation of a compound with a similar retention time is substituted to establish the retention time window.

The laboratory established retention time windows for each analyte on a daily basis using the absolute retention time for each daily calibration standard as the midpoint of the window for that day. The daily retention time window equals the midpoint  $\pm$  three times the standard deviation determined above. All succeeding standards in an analysis sequence must fall within the daily retention time window established by the first standard of the sequence.

Methods 625, 8240, and 8270 (GC/MS)

Analytical quality control procedures for GC/MS analyses (Methods 8240 and 8270) are described in SW-846, 3rd ed. and include:

- Initial demonstration of capability;
- Calibration verification;
- Surrogate standard spike samples;
- Method blank analyses;
- Analysis of field blanks;
- Matrix spike duplicate analyses;
- Analysis of duplicate samples;
- Mass spectrometer sensitivity check; and
- Daily GC/MS performance tests.

Each of these is described below.

Initial Demonstration of Capability--Before analyzing samples by a method, the laboratory must demonstrate the ability to generate acceptable accuracy and precision. This was done by analyzing four aliquots of a QC check sample (QCCS) by the same procedure used to analyze samples. The laboratory calculated the average recovery and the standard deviation of the recovery for each analyte of interest using the four results. The mean recovery and standard deviation for each analyte was then compared with the corresponding acceptance criteria published in the SW-846 method. If the experimental accuracy and precision data were acceptable, analyses proceeded; if not, remedial action was taken to improve system performance.

QC Check Sample Analyses--QC check samples were obtained from EPA or prepared from suitable reference materials independently of calibration standards. The QCCS contained the analyte(s) of interest at a concentration in the mid-calibration range. Measured values were plotted on a QC control chart. A QCCS was analyzed if matrix spike recoveries were unacceptable to verify that the analytical system was in a state of control.

Calibration Verification--Instrument tuning and calibration procedures are described in Section 1.7 of the QAPP.

Surrogate Standard Spike Samples--All samples were spiked with a surrogate standards as described in SW-846. The spiking level used was that which gave an amount in the purge apparatus that was equal to 50 ug/kg of the sample. If the recovery for any surrogate standard did not fall within the control limits for method performance, the sample was reanalyzed. If the surrogate recovery failed twice, the results reported for that sample were qualified as being outside of control limits. The laboratory monitored the frequency of data so qualified to ensure that it was at or below 5%. Three surrogate standards, 4-bromofluorobenzene, 1,2-dichloroethane d<sup>4</sup>, and toluene d<sup>8</sup>, were used to monitor recovery of volatile compounds varying in volatility and polarity. Three base/neutral (nitrobenzene-d<sup>5</sup>, 2-fluorobiphenyl, and p-terphenyl-d<sup>14</sup>) and three acid (phenol-d<sup>5</sup>, 2-fluorophenol, and 2,4,6-tribromophenol) extractable surrogate compounds were used to monitor recovery of semivolatile organics.

Method Blank Analyses--A method (reagent) blank was analyzed every 12 hours to demonstrate that analytical system interferences were below acceptable limits. Surrogate recoveries for the blank had to meet the requirements established in SW-846 before analyses were allowed to continue.

Matrix Spike/Matrix Spike Duplicate Analyses (MS/MSD)--A minimum of 5% of the samples were split and spiked with target analytes. Whenever possible, samples which were collected in duplicate were chosen for MS/MSD analyses. This sample was split in the laboratory and each fraction was carried through all of the stages of sample preparation and analysis. If spike recoveries did not meet the acceptance criteria published in SW-846 for Methods 8240 and 8270, a QC check sample was analyzed to verify that the analytical system was in control. If the QCCS recovery was acceptable, the sample results were qualified as suspect due to matrix problems. If the matrix spike duplicates did not meet the precision limits published in the methods, the system was evaluated for the source of the imprecision.

Mass Spectrometer Sensitivity Check--If the extracted ion current profile (EICP) area for any internal standard changed by more than a factor of two (-50% - +100%), the mass spectrometer was inspected for malfunctions and corrective action taken. Samples analyzed while the system was malfunctioning were reanalyzed.

Daily GC/MS Performance Tests--Each day that analyses were performed, the GC/MS system was checked using bromofluorobenzene (BFB) or decafluorotriphenylphosphine (DFTPP). The acceptance criteria presented in Table 2 of Methods 8240 and 8270 had to be met prior to performing any analyses. If all criteria were not met, the instrument was retuned and the test repeated until all criteria were achieved.

#### Metals Analyses by ICPEs and Atomic Absorption

The quality control procedures associated with metals analyses are described in SW-846 Method 6010 (EPA Method 200.7) for ICPEs and Method 7000 (EPA Methods 206.2, 270.2, 245.1, 239.1) series for atomic absorption, and include:

- Calibration verification;
- Analysis of QC check samples;
- Calibration blank analyses;
- Reagent blank analyses;
- Analysis of matrix spike/matrix spike duplicates;
- Instrument check standard analyses; and
- Interference blank analyses.

These procedures are described below.

Calibration--Calibration procedures are described in Section 1.7 of the QAPP.

QC Check Sample Analyses--Immediately after calibration, a quality control check sample (QCCS) containing all elements of interest was analyzed. The results were calculated prior to analyzing any other samples. If the measured value differed from the theoretical value for any parameter by more than  $\pm 10\%$ , these parameters were restandardized. The QC standard was prepared from a stock standard solution which was different than that from which the calibration standards were prepared, or purchased from a commercial source. The QCCS was prepared in the same acid matrix as the calibration standards at 10 times the instrumental detection limit or in the mid-calibration range. Measured values were plotted on a QC control chart. To ensure the continuity of QC control charts, the same QC standard was used throughout the project.

After every 10 samples, the QC standard was reanalyzed. If the measured value differed from the theoretical value by more than  $\pm 10$  for ICPES, or  $\pm 20$  percent for AAS, the instrument was recalibrated.

Calibration Blank (ICPES)--At a frequency of 10 percent, a calibration blank was analyzed during sample analyses. As specified in Method 6010, this standard was prepared by diluting 2 mL of (1+1) $\text{HNO}_3$  and 10 mL of (1+1) $\text{HCl}$  to 100 mL DI  $\text{H}_2\text{O}$ . If response to this standard was verified to be outside three standard deviations of the mean calibration blank value, the problem was corrected, the system was recalibrated, and the previous ten samples were analyzed.

Reagent Blank--A reagent blank, containing all the reagents in the same volumes as used in the processing of the samples, was carried through the complete preparation/analysis procedure at a minimum frequency of 5 percent, or once per sample batch. Reagent blank results were used to correct for possible contamination resulting from varying amounts of the acids used in processing samples.

Matrix Spike/Matrix Spike Duplicate--For each analytical batch or matrix type (5 percent minimum frequency), matrix spike and matrix spike duplicate samples were analyzed. Matrix spike results had to fall within

75-125 percent recovery of the spike, or the data was flagged as suspect due to matrix effects. Standard-addition analysis procedures were established to compensate for matrix effects.

Duplicate spiked sample results had to agree within 20 percent RPD, or the system was evaluated for the source of the imprecision and the problem was corrected.

Instrument Check Standard (ICPES)--The instrument check standard is composed of compatible elements at a concentration equivalent to the midpoint of their respective calibration curves. This standard was analyzed at a frequency of 10% of the samples. If response to any parameter was verified to be outside  $\pm 5\%$  of the true value, the instrument was recalibrated before sample analysis continued.

Interference Check Standard (ICPES)--The interference check standard was analyzed at the beginning, end, and at regular intervals during analysis of a batch of samples. This standard contained the analytes of interest at minimal concentrations by known concentration of interfering elements. If results exceeded 1.5 times the standard deviation of the mean analysis value for this standard, instrument recalibration was performed before sample analysis was allowed to proceed.

#### Fluoride Analyses

Fluoride analyses were performed according to EPA Method 340.2. Quality control procedures included:

- Multipoint calibration;
- Method blank analyses;
- Analyses of QC check samples;
- Duplicate analyses; and
- Analyses of matrix spiked samples.

Calibration--Calibration procedures are described in Section 1.7 of the QAPP. The method specifies a daily multipoint calibration, followed by periodic verification.

Method Blank Analyses--A minimum of one reagent blank per sample batch (minimum 10 percent) was analyzed to determine if contamination or memory effects had occurred.

QC Check Sample Analyses--A QC check sample, prepared independently of calibration standards, was analyzed every 10 samples. Recovery had to be within  $\pm 10$  percent of the expected value.

Duplicate Analyses--A duplicate analysis or matrix spike duplicate analysis was run every 10 samples. The duplicate run included the whole sample-preparation and analytical process. Precision had to be within 10 percent RPD.

Matrix Spike Analyses--For each batch or matrix type (minimum 10 percent), an aliquot was spiked and analyzed. Recovery of the spike had to be within 10 percent of the amount added.

#### Titrimetric Determination of Chloride

Titrimetric determination of chloride was performed according to EPA Method 325.3. Quality control procedures included the following:

- Titrant standardization;
- QC check sample analyses;
- Method blank analyses;
- Duplicate analyses; and
- Matrix spike analyses.

Titrant Standardization--The mercuric chloride titrant was standardized daily against primary standard sodium chloride.

QC Check Sample Analyses--A chloride QC check standard was analyzed every 15 samples. Recovery within 90-110 percent of the expected value was required for analyses to proceed.

Method Blank Analyses--A blank sample was analyzed with every batch of routine samples (maximum 20) to assess memory effects.

Duplicate Analyses--A duplicate analysis (or matrix spike duplicate) was analyzed every 20 samples. The duplicate analysis included all sample preparation steps. Precision had to be within 15 percent RPD, or a third value was obtained and the data flagged.

Matrix Spike Analyses--For each batch of samples of a matrix type (20 maximum), an aliquot was spiked and analyzed. Recovery of the spike had to be within 20 percent of the expected value; if not, the data was flagged.

#### Turbidimetric Determination of Sulfate

Turbidimetric determination of sulfate was performed according to EPA Method 375.4. Quality control procedures include the following:

- Multipoint calibration;
- QC check sample analyses;
- Method blank analyses;
- Duplicate analyses; and
- Matrix spike analyses.

Multipoint Calibration--A multipoint calibration curve was prepared daily, as described in Section 1.7 of the QAPP.

QC Check Sample Analyses--A sulfate QC check standard was analyzed every 10 samples. Recovery within 90-110 percent of the expected value was required for analyses to proceed.

Method Blank Analyses--A blank sample was analyzed with every batch of routine samples (maximum 20) to assess memory effects.

Duplicate Analyses--A duplicate (or matrix spike duplicate) was analyzed every 20 samples. The duplicate analysis had include all sample preparation steps. Precision should be within 15 percent RPD, or a third value should be obtained and the data flagged.

Matrix Spike Analyses--For each batch of samples of a matrix type (20 maximum), an aliquot of sample was spiked and analyzed. Recovery of the spike had to be within 20 percent of the expected value; if not, the data was be flagged.

### 3.8 Risk Assessment Methodology

A baseline risk assessment was conducted to: 1) determine the potential carcinogenic risk associated with each Carswell AFB site, 2) characterize the potential for noncarcinogenic effects, and 3) use the results to rank and prioritize sites for remedial action.

The methodology used in the baseline risk assessment involved several sequential steps to derive the values and assumptions necessary to calculate exposure, dose, and risk. The steps included selecting and characterizing indicator chemicals, estimating contaminant release rates, determining contaminant transport and fate, evaluating exposure pathways, and developing exposure scenarios. These tasks produced inputs to a computerized risk assessment model, the Radian Risk Assessment Model (R-RAM), which calculates pollutant-specific estimates of exposure, dose, and risk for direct and indirect routes of exposure. Exposure pathways which are not quantified are described qualitatively.

3.8.1 Indicator Chemicals

Selection Process

Sampling and analysis of soil and water at Carswell AFB has demonstrated the presence of a large number of chemical substances at the IRP sites. Conducting a baseline risk assessment that included all identified chemicals would be unnecessarily time-consuming. The baseline risk assessment of the Carswell IRP sites is therefore based on selected indicator chemicals that pose the greatest potential risks at the sites, a methodology endorsed by the U.S. EPA for evaluation of the health impacts of waste sites (U.S. EPA, 1986).

Indicator chemicals were selected from approximately 80 chemicals known to be present at the sites according to procedures described in the U.S. EPA Superfund Public Health Evaluation Manual (U.S. EPA, 1986). The selection process involved four steps: (1) identification of chemicals present at the sites, (2) determination of representative concentrations from site monitoring data, (3) calculation of indicator scores based on maximum and representative concentrations and route-specific toxicity data, and (4) selection of indicator chemicals based on indicator scores and physical/chemical property data. This process is designed to select chemicals that represent the most toxic, mobile, and persistent chemicals at the sites, as well as those present in the largest amounts (i.e., the "highest risk" chemicals).

The following algorithm was used to score each chemical measured at the site:

$$IS_i = \sum_{j=1}^3 (C_{ij} \cdot T_{ij})$$

where

$IS_i$  - indicator score for chemical i (unitless)

$C_{ij}$  - concentration of chemical i in medium j at the site based on monitoring data (in mg/L for water, mg/kg for soil, and mg/m<sup>3</sup> for air)

$T_{ij}$  - a toxicity constant for chemical i in medium j (units are the inverse of above concentration units).

An overall arithmetic average soil concentration and ground-water concentration were derived for each chemical for all sites based on Stage 2 analytical results, omitting samples below detection limits. Air concentration data were not available for inclusion in the indicator chemical selection process. Toxicity constants derived for each environmental medium and two types of toxic effects (carcinogenicity and other chronic effects), as listed and documented in the U.S. EPA Superfund Health Evaluation Manual (U.S. EPA, 1986), were applied. Essentially, the indicator score is a ratio between measured concentration and a toxicity-based concentration benchmark that is used to rank the site chemicals. Chemicals were scored independently for carcinogenic effects and for noncarcinogenic effects.

Table 3.8-1 lists 30 candidate indicator chemicals. The candidate list includes 26 chemicals which rank in the top 15 for either carcinogenic or noncarcinogenic effects and four additional chemicals that were detected frequently in soil and ground water samples and/or that are potentially carcinogenic or toxic by inhalation. Chemicals that are potentially carcinogenic or toxic by inhalation only could not be scored because air concentration data were not available for inclusion in the indicator chemical selection process. Twenty-two chemicals from this group were selected as indicator chemicals. Table 3.8-1 indicates these 22 indicator chemicals and the basis for including or excluding each candidate chemical from the list.





Physical, Chemical, and Biological Characteristics

The 22 indicator compounds include 10 metals, one pesticide, one phthalate, two polynuclear aromatic compounds (PNAs), and eight volatile organic compounds (VOCs). Tables 3.8-2, 3.8-3, and 3.8-4 summarize various physical, chemical, and biological characteristics, including Chemical Abstract Service Registry Number (CAS#), evidence of carcinogenicity, inhalation and ingestion potencies, inhalation and ingestion acceptable daily intakes, molecular weight, water solubility, vapor pressure, Henry's Law constant, organic carbon partition coefficient (Koc), octanol-water partition coefficient (Kow), fish bioconcentration factor (BCF), and half-lives in various media. These characteristics are important determinants of environmental fate and transport, exposure potential, and health risk and were used in the baseline risk assessment.

3.8.2 Contaminant Release Rates

The Carswell IRP sites can contribute to the release of contaminants to: (1) the air via volatilization and fugitive dust generation, (2) ground water via site leaching and recharge of water from the surface, and (3) surface water via surface runoff and ground-water discharge to the surface in springs or seeps. For the purposes of this baseline risk assessment, direct releases from all sites to the air and to the ground water were evaluated and quantified. Direct releases to the surface water occur at only one site, the Unnamed Stream (Site 16). However, indirect contributions to the surface water via intermedia transfers from air and ground water were considered for all sites.

Releases to the Air

Emissions of the indicator chemicals from each Carswell AFB site were calculated using emission rate equations applicable to the various emission mechanisms. Four types of emission mechanisms were considered; these included:

TABLE 3.8-2. INDICATOR CHEMICALS: MEASURES OF CARCINOGENIC POTENCY AND ACCEPTABLE DAILY INTAKE<sup>a</sup>

Chemical	CAS #	Class	Potential Carcinogen	EPA Weight of Evidence <sup>b</sup>	Inhalation		Ingestion		Inhalation		Ingestion	
					Factor <sup>c</sup>	(mg/kg/day) <sup>-1</sup>	Potency Factor <sup>c</sup>	(mg/kg/day) <sup>-1</sup>	Acceptable Intake <sup>d</sup>	Chronic	Acceptable Intake <sup>d</sup>	Chronic
Antimony	7440-36-0	Metal	No	--	--	--	--	--	NA <sup>e</sup>	NA <sup>e</sup>	4.00E-04	4.00E-04
Arsenic	7440-38-2	Metal	Yes	A	5.00E+01	1.50E+01	1.70E-03	1.70E-03	1.70E-03	1.70E-03	1.70E-03	1.70E-03
Barium	7440-38-3	Metal	No	--	--	--	--	--	1.40E-04	1.40E-04	5.10E-02	5.10E-02
Beryllium	7440-41-7	Metal	Yes	B1	6.40E+00 <sup>g</sup>	NA	NA	NA	NA	NA	5.00E-04	5.00E-04
Cadmium	7440-43-8	Metal	Yes	B1	6.10E+00	NA	NA	NA	NA	NA	2.90E-04	2.90E-04
Chromium (VI)	7440-47-3	Metal	Yes	A	4.10E+01	NA	NA	NA	NA	NA	5.00E-03	5.00E-03
Lead	7439-92-1	Metal	No	--	--	--	--	--	4.30E-04	4.30E-04	1.40E-03	1.40E-03
Nickel	7440-02-8	Metal	Yes	A	1.10E+00	NA	NA	NA	NA	NA	1.00E-02	1.00E-02
Selenium	7782-49-2	Metal	No	--	--	--	--	--	1.00E-03	1.00E-03	3.00E-03	3.00E-03
Silver	7440-22-4	Metal	No	--	--	--	--	--	NA	NA	3.00E-03	3.00E-03
Chlordane	57-74-9	Peesticide	Yes	B2	NA	1.61E+00	NA	NA	NA	NA	5.00E-05	5.00E-05
Bis(2-ethylhexyl)phthalate	117-81-7	Phthalate	Yes	B2	NA	6.84E-04	NA	NA	NA	NA	2.00E-02	2.00E-02
Benzo(a)anthracene	56-55-3	PMA	Yes	B2	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	50-32-8	PMA	Yes	B2	6.10E+00	1.15E+01	2.70E-05	2.70E-05	2.70E-05	2.70E-05	2.70E-05	2.70E-05
Benzene	71-43-2	VOC	Yes	A	2.60E-02	5.20E-02	3.20E-01	3.20E-01	3.20E-01	3.20E-01	3.20E-01	3.20E-01
Chloroform	67-66-3	VOC	Yes	B2	NA	8.10E-02	NA	NA	NA	NA	1.00E-02	1.00E-02
Dichloroethane, 1,2-	107-06-2	VOC	Yes	B2	3.50E-02	9.10E-02	2.70E-03	2.70E-03	2.70E-03	2.70E-03	2.70E-03	2.70E-03
Methylene chloride	75-09-2	VOC	Yes	B2	1.84E-03 <sup>g</sup>	7.50E-03	NA	NA	NA	NA	6.00E-02	6.00E-02
Tetrachloroethene	127-18-4	VOC	Yes	B2	1.70E-03	5.10E-02	NA	NA	NA	NA	2.00E-02	2.00E-02
Toluene	108-88-3	VOC	No	--	--	--	--	--	1.50E+00	1.50E+00	3.00E-01	3.00E-01
Trichloroethene	79-01-6	VOC	Yes	B2	4.60E-03	1.10E-02	2.46E-02	2.46E-02	2.46E-02	2.46E-02	2.46E-02	2.46E-02
Vinyl chloride	75-01-4	VOC	Yes	A	2.50E-02	2.30E+00	1.30E-03	1.30E-03	1.30E-03	1.30E-03	1.30E-03	1.30E-03

<sup>a</sup> Source: U.S. EPA, 1986, unless otherwise indicated. Primary source for data reported in U.S. EPA, 1986 are EPA Health Effects Assessments (U.S. EPA, 1984a-z).

<sup>b</sup> Weight of evidence ratings qualify the level of evidence that supports designating a chemical as a carcinogen. Categories are: A - Human carcinogen; B1 - Probable human carcinogen (human evidence); B2 - Probable human carcinogen (animal evidence); C - Possible human carcinogen; D - Not classified; E - No evidence of carcinogenicity in humans.

<sup>c</sup> Carcinogenic potency factors are upper 95 percent confidence limits on the slope of the dose-response curve.

<sup>d</sup> Chronic Acceptable Intake (AIC) values represent long-term acceptable intake levels for noncarcinogenic effects. It is an estimate of an exposure level which would not be expected to cause adverse effects when exposure occurs for a significant portion of the lifespan (70 years).

<sup>e</sup> EPA revised potency.

<sup>f</sup> Risk assessment assumed value listed for other route of exposure.

<sup>g</sup> Risk assessment assumed same values listed for Benzo(a)pyrene.

<sup>h</sup> Radian Corporation, 1987. See Appendix J.

<sup>i</sup> See calculations in Appendix J.

TABLE 3.8-3. INDICATOR CHEMICALS: PHYSICAL AND CHEMICAL CHARACTERISTICS<sup>a</sup>

Chemical	Molecular Weight (g/mole)	Water Solubility <sup>b</sup> (mg/l)	Vapor Pressure <sup>a</sup> (mm Hg)	Henry's Law Constant <sup>d</sup> (atm-m <sup>3</sup> /mole)	Koc <sup>e</sup> (ml/g)	Log <sub>10</sub> Kow <sup>f</sup>	Fish BCF <sup>g</sup> (1/kg)
Antimony	122	--	1.00E+00	NA	--	--	1
Arsenic	75	--	0	NA	--	--	44
Barium	137	--	--	NA	--	--	NA <sup>h</sup>
Beryllium	9	--	0	NA	--	--	19
Cadmium	112	--	0	NA	--	--	81
Chromium (VI)	52	--	0	NA	--	--	16
Lead	207	--	0	NA	--	--	49
Nickel	59	--	0	NA	--	--	47
Selenium	79	--	0	NA	--	--	16
Silver	108	--	0	NA	--	--	3080
Chlordane	410	5.60E-01	1.00E-05	9.63E-06	140000	3.32	14000
Bis(2-ethylhexyl)phthalate	391	--	--	--	--	--	590 <sup>i</sup>
Benzo(a)anthracene	228	5.70E-03	2.20E-06	1.16E-06	1380000	5.8	930 <sup>1</sup>
Benzo(a)pyrene	252	1.20E-03	5.60E-09	1.55E-06	5500000	6.06	930 <sup>1</sup>
Benzene	78	1.75E+03	9.52E+01	5.59E-03	83	2.12	5.2
Chloroform	119	8.20E+03	1.51E+02	2.87E-03	31	1.97	3.75
Dichloroethane, 1,2-	98	8.52E+03	6.40E+01	9.78E-04	14	1.46	1.2
Methylene chloride	85	2.00E+04	3.62E+02	2.03E-03	8.8	1.3	5
Tetrachloroethene	166	1.50E+02	1.78E+01	2.58E-02	364	2.6	31
Toluene	92	5.35E+02	2.81E+01	6.37E-03	300	2.73	10.7
Trichloroethene	131	1.10E+03	5.79E+01	9.10E-03	126	2.36	10.6
Vinyl chloride	63	2.67E+03	2.66E+03	8.18E-02	57	1.38	1.17

<sup>a</sup> Source: EPA, 1986, unless otherwise indicated.

<sup>b</sup> Water solubility is the maximum concentration of a chemical that dissolves in pure water at a specific temperature and pH. Values are given for a neutral pH and a temperature range of 20 to 30°C.

<sup>c</sup> Vapor pressure is a relative measure of the volatility of a chemical in its pure state.

<sup>d</sup> Henry's Law Constant (atm-m<sup>3</sup>/mole) = vapor pressure (atm) x molecular weight (g/mole)/water solubility (g/m<sup>3</sup>).

<sup>e</sup> Organic Carbon Partition Coefficient (Koc) is a measure of the tendency for organics to be adsorbed by soil and sediment.

<sup>f</sup> Octanol-Water Partition Coefficient (Kow) is a measure of how a chemical is distributed at equilibrium between octanol and water.

<sup>g</sup> Bioconcentration Factor (BCF) is a measure of the tendency for a chemical in water to accumulate in fish tissue.

<sup>h</sup> Risk assessment assumed low BCF (1).

<sup>i</sup> See calculations in Appendix L.



**TABLE 3.8-4. INDICATOR CHEMICALS: HALF-LIVES IN VARIOUS MEDIA<sup>a</sup>**

Chemical	Half-Life Range in Various Media <sup>b,c</sup> (Days)					
	Soil		Air		Surface Water	
	Low	High	Low	High	Low	High
Antimony	--	--	4.8	--	Persistent	--
Arsenic	--	--	5	--	Persistent	--
Barium	--	--	4.8	--	Persistent	--
Beryllium	--	--	--	--	--	--
Cadmium	--	--	4.8	--	Persistent	--
Chromium (VI)	--	--	4.8	--	3	--
Lead	--	--	4.8	--	Persistent	--
Nickel	--	--	--	--	--	--
Selenium	--	--	--	--	--	--
Silver	--	--	--	--	--	--
Chlordane	--	--	40	--	420	500
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--
Benzo(a)anthracene	--	--	5.5	--	0.1	5
Benzo(a)pyrene	420	480	1	8	0.4	--
Benzene	--	--	6	--	1	6
Chloroform	--	--	80	--	0.3	30
Dichloroethane, 1,2-	--	--	36	127	0.017	--
Methylene chloride	--	--	53.2	--	1.2	5.8
Tetrachloroethene	--	--	47	--	1	30
Toluene	--	--	1.3	--	0.17	--
Trichloroethene	--	--	3.7	--	1	90
Vinyl chloride	--	--	1.2	--	1	5

<sup>a</sup> Source: EPA, 1986.  
<sup>b</sup> Half-lives are measures of persistence, or how long a chemical will remain, in various environmental media.  
<sup>c</sup> No data are available on half-lives in ground water.

- 1) volatilization of organic compounds from buried wastes,
- 2) volatilization of organic compounds from surface contamination,
- 3) volatilization of organics from water, and
- 4) wind entrainment of contaminated dust.

Each of the mechanisms and the equations used to calculate emission rates are discussed below.

Volatilization from Buried Wastes--The Shen equation (Shen, 1981) was used to estimate emissions from buried wastes at the Carswell AFB sites. This equation was used for Sites 1, 3, 4, 5, 10, 17, and the Base Service Station. Shen presents the following equation, which is derived from Fick's Law for steady-state diffusion:

$$E_i = D_i C_s A P_t^{4/3} \frac{W_i}{L}$$

where:

- $E_i$  - emission rate of component i (g/sec);
- $D_i$  - diffusion coefficient of component i ( $\text{cm}^2/\text{sec}$ );
- $C_s$  - saturation vapor concentration of component i ( $\text{g}/\text{cm}^3$ );
- $A$  - exposed area ( $\text{cm}^2$ );
- $P_t$  - soil porosity (dimensionless);
- $W_i$  - weight percent of component i in the soil (g/g); and
- $L$  - effective depth of soil cover (cm).

The weight fraction ( $W_i$ ) of each indicator chemical used in the above equation was the highest measured concentration at each site regardless of depth or whether the sample was aqueous or soil, or on-site or off-site.

Soil porosity ( $P_t$ ) was not actually measured at any of the sites; however, porosity was estimated to be 50% based on literature values, and was used in the Shen equation for all sites.

A minimum depth of cover (L) of 2 ft (60 cm) was assumed for all buried wastes at all sites except Site 11. At Site 11, a depth of 0.5 ft (15 cm) was assumed because contamination at this site was due to contamination from the surface rather than from buried waste. A depth of 0.5 ft was selected over a depth of zero, since Site 11 is an inactive site, and volatile compounds would no longer be present at the immediate soil surface.

Volatilization From Surface Contamination--Sites 12 and 13 have had recent contamination at the soil surface; therefore, the depth of cover was assumed to be zero, making the Shen equation not applicable. For volatilization from open landfills, Shen suggests using the open dump equation (Shen, 1981). The equation is Arnold's equation (Arnold, 1944) with Ziegler's modification (Ziegler, 1979). The equation, presented below, was used for calculation of emissions of VOCs at Sites 12 and 13.

$$E_i = \frac{2 C_e w}{A} \sqrt{\frac{DLv}{\pi F_v}} \left( \frac{W_i}{W} \right) P_i$$

where:  $E_i$  - emission rate ( $\text{g}/\text{m}^2\text{-sec}$ )  
 $C_e$  - equilibrium vapor pressure (%)  
 $L^e$  - length of open dump (cm)  
 $D$  - diffusion coefficient ( $\text{cm}^2/\text{sec}$ )  
 $v$  - wind speed (cm/sec)  
 $F_v$  - correction factor  
 $W_i/W$  - weight % of component i in bulk waste  
 $i$  - gas density of component i ( $\text{g}/\text{cm}^3$ )  
 $A$  - area of open dump ( $\text{m}^2$ )  
 $w$  - width of open dump (cm)  
 $P_i$  - gas density of component i

The annual average wind speed (v) for the Dallas-Fort Worth area of 10.8 miles per hour (480 cm/sec) was used in the equation. All other input parameters are either site-specific and based on site characteristics or compound-specific and based on literature values.



### Releases to the Ground Water

Results of chemical analyses of ground water collected during Stage 1 and Stage 2 investigations show that releases to the ground water have already occurred and that contaminants (using the EPA Maximum Contaminant Level (MCL) criterion) are present in the ground water at both the Flightline Area sites and the East Area sites. The contaminants occur in ground water directly under the sites, as well as hydraulically downgradient from several of the sites. The nature and extent of contamination is described in Section 4.0.

### Releases to the Surface Water

Direct release of contaminants to the surface water occurs at one site, the Unnamed Stream (Site 16). The Unnamed Stream drains into Farmers Branch which intersects the West Fork of the Trinity River. Stage 2 surface water quality data from this site provided quantitative evidence of contamination at several locations along the stream path.

#### 3.8.3 Contaminant Transport and Fate

Primary environmental transport media for chemical substances in the environment include the air, surface water, ground water, and soil. Inter-media transfers can occur and may be critical at some sites. For example, chemicals in the air can settle to the ground, mix in the soil, deposit on edible plant matter, or deposit on surface water. Chemicals in the ground water and soil are subject to uptake by edible plants.

Potentially significant mechanisms of contaminant transport from the Carswell sites which were evaluated in the baseline risk assessment are:

- Dispersion in the air of gaseous and particulate air emissions;

- Migration of contaminated ground water;
- Transport in surface water;
- Deposition of fugitive dust;
- Accumulation in agricultural crops;
- Accumulation in fish;
- Accumulation in livestock; and
- Accumulation in human milk.

Table 3.8-5 presents major assumptions and key input parameters used in the environmental fate analysis.

#### Air Dispersion

Model Section--The User's Network for Applied Modeling of Air Pollutants - Version 6 (UNAMAP 6) Industrial Source Complex Long Term (ISCLT) dispersion model was used to calculate annual ground level concentrations of each indicator chemical. The ISCLT model was selected for use because it is approved by the U.S. EPA and is capable of evaluating the range of situations encountered in this assessment. The important model capabilities include:

- Calculation of dispersion from both point and area sources;
- Urban dispersion;
- Efficient calculation of annual average concentrations;
- Evaluation of both a receptor grid and discrete receptor points; and

TABLE 3.8-5. KEY ASSUMPTIONS AND INPUT PARAMETERS USED IN THE ENVIRONMENTAL FATE ANALYSIS

Description	Input Value
<u>Ambient Air Concentrations:</u>	
Soil and ground-water quality data	see Section 4.0
Meteorological data	DFW Airport
Dispersion model	ISCLT
<u>Ground-Water Concentrations:</u>	
Ground-water quality data	see Section 4.0
Ground-water flow	
Flightline area sites	toward Farmers Branch
East area sites	toward Trinity River
<u>Surface-Water Concentrations:</u>	
Deposition velocity	0.02 m/s
Surface water quality data	see Section 4.0
Surface water drainage and flow	see Section 4.0
<u>Soil Concentrations:</u>	
Deposition velocity	0.02 m/s
*Soil density	1,500 kg/m
*Mixing Depth	15 cm
Soil Elimination Constants	
Chlordane	1.25E-04
Bis(2-ethylhexyl)phthalate	6.93E-02
Benzo(a)pyrene and Benzo(a)anthracene	3.47E-02
Degradation of other contaminants in soil	no degradation
<u>Edible Crops Concentrations (Background Gardens):</u>	
Root uptake	
VOCs	0%
Antimony	2.0%
Arsenic	0.15%
Barium	1.2%
Beryllium	0.037%
Cadmium	6.4%
Chromium	0.054%
Lead	0.2%

Continued

TABLE 3.8-5. KEY ASSUMPTIONS AND INPUT PARAMETERS USED IN THE ENVIRONMENTAL FATE ANALYSIS (cont)

Description	Input Value
<b><u>Edible Crops Concentrations: (cont)</u></b>	
Nickel	0.62%
Selenium	0.65%
Silver	4.0%
Chlordane	7.0%
Bis(2-ethylhexyl)phthalate	3.0%
Benzo(a)anthracene	1.0%
Benzo(a)pyrene	1.0%
*Edible crop density	2 kg/m <sup>2</sup>
*Crop interception fraction (rural)	0.054
*Elimination constant	0.0387 1/day
*Days exposed	60 days
*Cleaning efficiency	0%
<b><u>Fish Concentrations (Lake Worth):</u></b>	
<b>Bioconcentration factors for fish (See Table 3.8-3)</b>	
Benzene	5.2
Chloroform	3.75
Dichloethane, 1,2-	1.2
Methylene Chloride	5.0
Tetrachloroethylene	31
Toluene	10.7
Trichloroethene	10.6
Vinyl Chloride	1.17
Antimony	1
Arsenic	44
Barium	1
Beryllium	19
Cadmium	81
Chromium	16
Lead	16
Nickel	47
Selenium	16
Silver	3,080
Chlordane	14,000
Bis(2-ethylhexyl)phthalate	590
Benzo(a)anthracene	930
Benzy(a)pyrene	930

Continued

TABLE 3.8-5. KEY ASSUMPTIONS AND INPUT PARAMETERS USED IN THE ENVIRONMENTAL FATE ANALYSIS (cont)

Description	Input Value
<u>Dairy and Beef Concentrations (Local Beef and Dairy Operations):</u>	
*Grass consumption rate	14 kg/day
*Fodder consumption rate	16 kg/day
Fraction of feed from grazing	50%
*Fodder exposure period	2 days
*Fodder surface area	1 m <sup>2</sup> /day
*Quantity of fodder exposed	36 kg <sub>3</sub>
*Cattle inhalation rate	158 m <sup>3</sup> /day
*Water consumption rate	150 kg/day
*Soil consumption rate	2 kg/day
*Cattle body weight	
Total	600 kg
Fat-Adjusted	240 kg
*Milk production rate	
Total	27 kg/day
Fat-Adjusted	1.1 kg/day
Animal Elimination Rate Constant all indicator chemicals	1 (no elimination)
<u>Mother's Milk Concentrations:</u>	
*Female fat content	18 kg
*Human milk fat content	45.5 g/L
Elimination constants for mother's milk	
Chlordane	3.8E-04
Bis(2-ethylhexy)phthalate	7.6E-04
Benzo(a)anthracene	1.0E-01
Benzo(a)pyrene	1.0E-01
Other indicator chemicals	not evaluated for this pathway

\* These parameters and input values have been reviewed and approved by the California Department of Health Services for use in exposure and risk assessments (Radian Corporation, 1987). In general, these are health conservative values expected to provide overestimates of actual conditions. The U.S. EPA has not published comparable values for use in exposure and risk assessments.

- Simultaneous evaluation of multiple source impacts and individual source impacts.

The ISCLT model accepts a summarized statistical array of meteorological conditions based on data for a year or more. Model output consists of one average concentration for each source and/or source group at each input receptor.

The model was run using urban mode 3 as recommended by EPA for developed areas. Wind profile exponents, vertical potential temperature gradients, and the plume rise equation all affect source plume rise and were set to the EPA-recommended default values. The choice of these options had little or no effect on model results since all sites were modeled with no significant plume rise.

Meteorological Data--Meteorological data input to ISCLT consisted of a statistical array of wind speed, wind direction, and stability class calculated from National Weather Service data recorded at Dallas-Fort Worth International Airport. These data were for a five-year period from 1981 through 1985 and are considered representative of meteorological conditions existing at Carswell AFB.

For the ISCLT model, representative mixing heights and temperatures must be specified for each atmospheric stability class. As is recommended in the ISC user's guide, the mean afternoon mixing height presented by Holzworth (1972) was used for stability categories B and C; 1.5 times the mean afternoon mixing height was used for stability category A; the mean early morning mixing height was used for stability categories E and F; and the average of the mean early morning and afternoon mixing heights was used for stability category D. Also, as is recommended in the ISC user's guide, the average seasonal maximum daily temperature was used for stability categories A, B, and C; the average seasonal minimum daily temperature was used for stability categories E and F; and the average seasonal temperature was used for stability category D. The values used for mixing height and temperature are presented in Table 3.8-6.

TABLE 3.8-6. AMBIENT TEMPERATURES AND MIXING HEIGHTS INPUT TO ISCLT

Stability Category	Temperature ( $^{\circ}$ K)	Mixing Height (m)
A	298	2,250
B	298	1,500
C	298	1,500
D	292	1,000
E	286	500
F	286	500

Receptor Grid--A rectangular receptor grid with 500 receptors spaced at 250 meter intervals was placed over the AFB such that it covered the entire AFB and surrounding off-base property out to a minimum distance of about 1 km from the property line. The grid was then separated into 341 off-base receptors, and 159 on-base receptors for modeling. Additional discrete receptors were placed over Lake Worth and in sensitive areas identified in the Risk Assessment Methodology.

Because ground level emission sources with no plume rise will always result in decreasing ground level concentrations with increasing distance from the source, it was not necessary to extend the receptor grid to further distances to identify the maximum concentration.

Emission Source Characterization--All sites, with the exception of Site 16, were modeled as area sources. The ISCLT model requires area sources to be a square. Therefore, all sites were modeled as a square whose area was equal to the emitting area of the site. The total emitting area of each site was estimated based on knowledge of the areal extent of surface contamination or buried waste. Any areas covered by asphalt, concrete, or buildings were subtracted from the total site area.

Two sites, Site 1 and Site 13, were divided into three square areas as their elongated shapes did not conform well to the approximation of a single square.

Site 16, which is a small stream originating from an oil/water separator, was modeled as a single ground-level point source.

#### Ground-Water Migration

Contaminants that reach the ground water will migrate in a generally downgradient direction and may eventually cross the base boundary. Due to differing physiochemical properties, some chemicals, such as petroleum hydrocarbons, will float on top of ground water in a separate immiscible

phase. Others, such as chlorinated solvents, may be dissolved in the ground water. Some controls on the rate of contaminant migration in ground water are the solubility of the contaminant in water, the persistence of the contaminant and/or its transformation products, and its potential adsorption onto subsurface materials. In general, most ground-water contaminants at the Carswell AFB IRP sites were introduced by downward migration of relatively dilute solutions rather than of concentrated streams. Therefore, density stratification of contaminants dissolved in the ground water is not expected.

At the Flightline Area sites, ground water in the upper zone occurs in sand and gravel deposits that are underlain by relatively impermeable and dry limestone/shale bedrock. Based on a review of water level measurements, hydraulic head in the upper zone at these sites decreases toward Farmers Branch, indicating that ground-water flow is in this direction. The bed of Farmers Branch is cut into the same bedrock that forms the base of the upper zone; therefore ground water would be expected to discharge directly to Farmers Branch or be discharged by evapotranspiration as it exits the upper zone materials near the creek. Ground-water flow is not in the direction of the base perimeter in the Flightline Area. Thus, the available water-level and geologic data indicate that all upper zone ground-water flow under the Flightline Area sites moves toward Farmers Branch and is discharged in the vicinity of the creek.

At the East Area sites, available water-level and geologic data indicate that ground water in the upper zone flows to the east, toward the Trinity River. The subsurface conditions at the East Area are similar to those at the Flightline Area; ground water remains in the upper zone above the bedrock and flows to the nearest surface water drainage. As ground water flow nears the Trinity River, or the downstream portion of Farmers Branch (perhaps for areas of Site 15, 16, and 17), discharge will be directly to the creek or as broadly diffuse seepage that is consumed by evapotranspiration, perhaps without evidence of direct flow at the land surface. Ground-water flow will not be toward deeper aquifers or beyond the Trinity River or Farmers Branch.

### Surface-Water Transport

Specific surface runoff pathways of concern for this investigation are the Flightline Drainage Ditch (Site 13) and Farmers Branch and its tributaries, such as the Unnamed Stream (Site 16), on the base. These pathways lead to the West Fork of the Trinity River located east of the base.

Based on a review of drainage patterns from topographic maps at Carswell AFB, no surface water drainage from IRP sites is directed toward Lake Worth, which is the source of drinking water for Carswell AFB and Fort Worth. The surface water drainage from the IRP sites is toward either Farmers Branch or toward the Trinity River, downstream of Lake Worth.

### Deposition of Particulate Emissions

Mechanisms for transport of contaminants in the soil include fugitive dust generation/deposition, surface runoff, tracking from contaminated surface soil, and site leaching from contaminated soil. Of these, deposition of dust generated at the Carswell sites on land and water and directly onto exposed skin surfaces represents the most significant avenue for transport of contaminated soil off site and for public exposure to contaminated soil.

Particulates deposited on land will percolate down through the soil, forming a contaminated layer of soil. To provide a conservative assessment, elimination processes were assumed to be absent in estimating soil concentrations of all indicator chemicals except chlordane, bis(2-ethylhexyl) phthalate, benzo(a)anthracene, and benzo(a)pyrene. However, runoff, leaching, and resuspension would reduce the quantity of all indicator chemicals remaining in the soil. Soil elimination constants used for chlordane, bis(2-ethylhexyl) phthalate, benzo(a)anthracene, and benzo(a)pyrene are listed in Table 3.8-5.

Deposition of fugitive dust generated at the Carswell sites can contribute to contaminant concentrations in surface water as well, which can lead to human exposure via consumption of water and aquatic organisms and skin contact with the water.

Particles which contact exposed skin surfaces accumulate and are partially absorbed by the skin tissue. The origin of surface dust is assumed to be largely from soil. Thus, the concentration of contaminants on the skin surface is assumed to be equivalent to the concentration in soil.

#### Accumulation in Agricultural Crops

The land use surrounding the Carswell sites includes some commercial agriculture. Wheat, grain, sorghum, corn, and some vegetables are grown within a 5-mile radius of the base, to the north and northwest (South, 1988a). Hence, market produce, if subject to particulate deposition or contaminated water, represents a potential exposure pathway. Backyard gardens, which might also be subject to particulate deposition or contaminated water, present a pathway to human exposure as well. Consumption of locally-grown produce was considered in this baseline risk assessment.

Garden produce that is grown above ground can receive direct deposition of dust-generated particulates. An interception fraction to account for deposition on the exposed edible portion of plants and a particle weathering factor to account for removal from plant surfaces, are used to determine the final concentration in plants. Removal of particulates from edible plant matter by washing can reduce exposure by this pathway, but was ignored for this assessment.

Certain pollutants deposited onto the soil are subject to root uptake by plants. Availability for root uptake depends on solubility in water and other pollutant-specific chemical and physical characteristics. Root uptake of all indicator chemicals subject to deposition was included in the analysis. Root uptake values used are listed in Table 3.8-5.

Root uptake of contaminants potentially present in water used to irrigate crops was not quantified in this assessment. Of the potential carcinogens, only cadmium will translocate to above-ground portions of the plant.



Cattle exposure to contaminants originating at the Carswell sites can occur through consumption of feed and water that have received direct deposits of particulate-adsorbed pollutants, as well as inhalation of suspended particulates and gases. As cattle ingest feed, the pollutants will be absorbed in the animals gastrointestinal tracts. Once absorbed, milk and edible portions of the cattle will accumulate the lipophilic organic compounds.

#### Accumulation in Human Milk

Humans, as do fish and cattle, accumulate lipophilic (fat soluble) compounds in fatty tissue. The level of concentration is dependent on the rate of exposure and elimination from the body (Tuey, 1980). The lipophilic compounds will equilibrate with all body tissues according to fat content, but will be preferentially sequestered in adipose tissue (connective tissue in the body that contains stored cellular fat). This baseline risk assessment evaluated chlordane, bis(2-ethylhexyl)phthalate, benzo(a)anthracene, and benzo(a)pyrene for this pathway. Other organic compounds, due to volatility, and metals do not accumulate to any significant degree in milk (Tuey, 1980).

#### 3.8.4 Exposure Pathways

Figure 3.8-1 depicts potential pathways for contaminants originating at Carswell IRP sites to move from point of release to point of human exposure. Table 3.8-7 identifies possible exposure points and associated exposure routes by transport medium. Exposure pathways considered in the baseline risk assessment include: (1) inhalation of ambient air concentrations; (2) ingestion of soil; (3) ingestion of fruits and vegetables; (4) ingestion of fish, (5) ingestion of beef and dairy products; (6) dermal exposure; (7) ingestion of drinking water; and (8) ingestion of human milk.

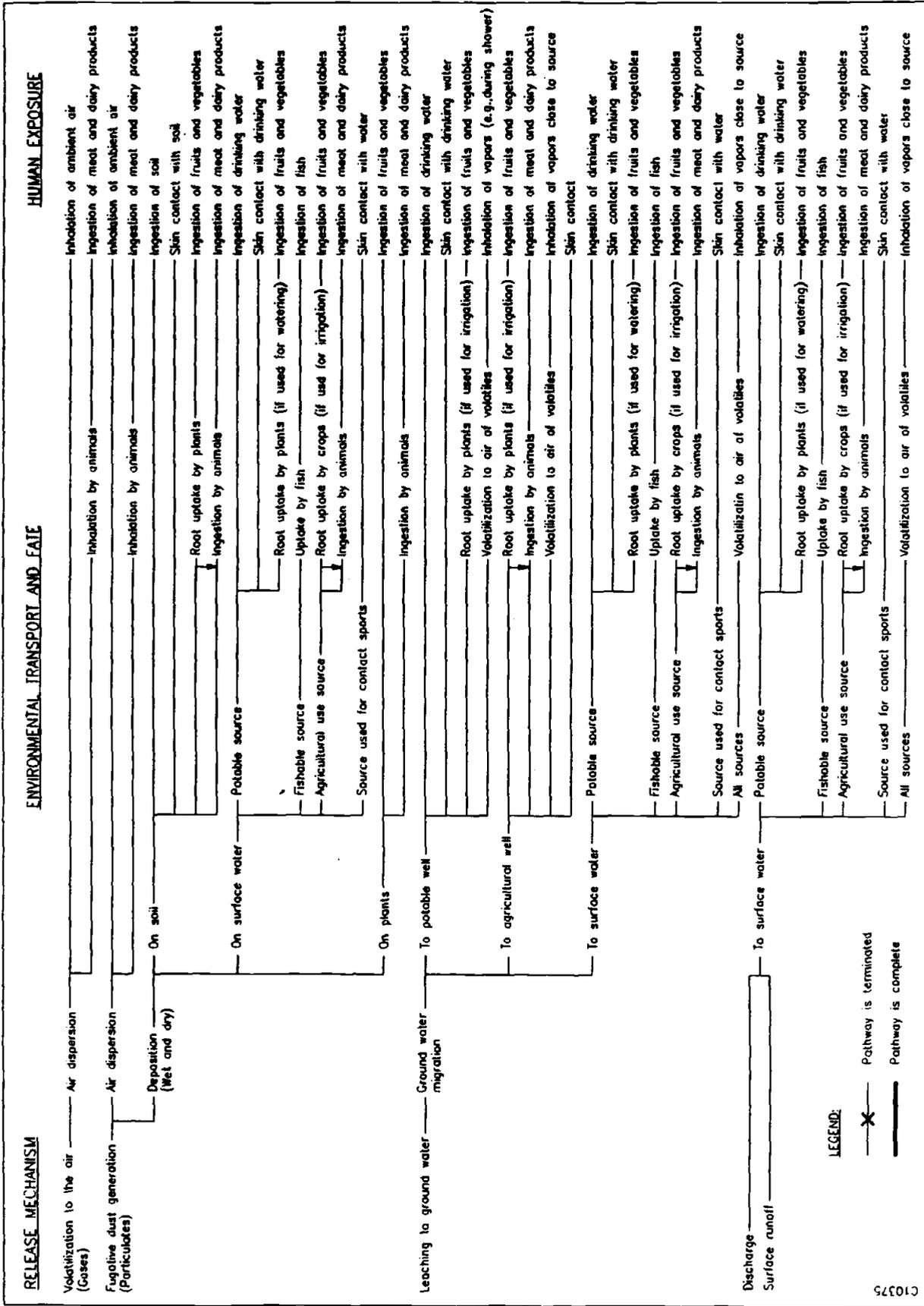


Figure 3.8-1. Potential Exposure Pathways for Contaminants Released from Carswell Sites

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TABLE 3.8-7. POSSIBLE EXPOSURE POINTS FOR CONTAMINANTS RELEASED FROM THE CARSWELL SITES

Transport/Exposure Medium	Possible Exposure Point	Exposure Route
Air	Nearest residence to source	Inhalation
	Nearest population magnet (e.g., shopping center, school)	Inhalation
	Nearest agricultural operations	Ingestion (food)
Ground Water	Nearest potable well	Ingestion, dermal, inhalation
	Nearest agricultural well	Inhalation, ingestion (food), dermal
Surface Water	Withdrawal point for potable use (Lake Worth)	Ingestion, dermal, inhalation
	Withdrawal point for agricultural use	Inhalation, ingestion (food), dermal
	Fishable source	Ingestion (fish)
	Source used for contact sports	Dermal, ingestion (water)
Soil	On site	Dermal, ingestion
	Off site	Dermal, ingestion
	Nearest agricultural operations	Ingestion (food)

Exposure pathways listed in Table 3.8-7 which were not included in the exposure and risk calculations are: (1) dermal exposure to potable water (e.g., during a bath or shower); (2) inhalation of volatile emissions from potable water; (3) ingestion of food irrigated with surface or ground water drawn for agricultural use; and (4) dermal exposure to surface water (e.g., while swimming). These pathways are discussed qualitatively.

### 3.8.5 Exposure Scenarios

The baseline risk assessment was based on two hypothetical exposure scenarios: (1) the maximally exposed on-site individual, and (2) the maximally exposed off-site individual. These two exposure scenarios were developed using plausible, but conservative assumptions about exposure. If the estimated exposures and risks associated with the hypothetical maximally exposed individuals can be demonstrated to be insignificant for any site, the potential for adverse health effects to other individuals, who will be subject to lower exposure levels, can be considered insignificant as well. If a site poses no significant threat to human health or the environment, further action to remediate the site may not be necessary.

Table 3.8-8 summarizes key exposure assumptions used to develop the maximally exposed on-site and off-site individuals. The maximally exposed on-site individual is assumed to both reside and work at the point where maximum annual on-site ground level contaminant concentrations are predicted to occur for a total of 10 years (which exceeds the typical tour of duty). This individual inhales the maximum predicted on-site concentrations continuously for a 10-year tour of duty. The diet of this individual for these 10 years includes appreciable portions of fruit and above-ground and root vegetables grown in a backyard garden, fish caught from Lake Worth, milk produced from a local dairy, beef products produced locally, and water from Lake Worth. As an infant, this individual subsisted on breast milk from the mother, who was also maximally exposed to site contaminants. This individual ingests a certain amount of contaminated soil as well. Finally this individual wears warm-weather clothing year-around and is thus maximally exposed to dermal uptake of contaminated dust.

TABLE 3.8-8. KEY PARAMETERS OF THE ON-SITE AND OFF-SITE MAXIMALLY EXPOSED INDIVIDUALS

Description	Input Values	
	Maximally Exposed On-Site Individual	Maximally Exposed Off-Site Individual
<u>General:</u>		
*Body weight	70 kg <sup>a</sup>	70 kg <sup>a</sup>
*Exposure period	10 year (tour of duty)	70 year (lifetime)
<u>Inhalation:</u>		
*Respiration rate	20 m <sup>3</sup> /day <sup>a</sup>	20 m <sup>3</sup> /day <sup>a</sup>
*Exposure level	Maximum predicted annual average on-site concentrations	Maximum predicted annual average off-site concentrations
*Exposure profile	Continuous (24 hrs/day)	Continuous (24 hrs/day)
<u>Fruit and Vegetable Consumption:</u>		
*Consumption of locally grown produce	150 g/day <sup>b</sup>	150 g/day <sup>b</sup>
*Source	Grown at location of maximum predicted annual average on-site concentrations (backyard garden)	Grown at location of maximum predicted annual average on-site concentrations (backyard garden)
<u>Fish Consumption:</u>		
*Consumption of local fish	6.5 g/day <sup>a</sup>	6.5 g/day <sup>a</sup>
Source	Lake Worth	Lake Worth
<u>Dairy and Beef Consumption:</u>		
*Consumption of locally produced milk		
Total	0.584 kg/day	0.584 kg/day
Fat-adjusted	0.023 kg/day	0.023 kg/day
*Consumption of locally produced beef		
Total	0.020 kg/day	0.020 kg/day
Fat-adjusted	0.006 kg/day	0.006 kg/day

Continued

TABLE 3.8-8. KEY PARAMETERS OF THE ON-SITE AND OFF-SITE MAXIMALLY EXPOSED INDIVIDUALS (cont)

Description	Input Values	
	Maximally Exposed On-Site Individual	Maximally Exposed Off-Site Individual
<u>Consumption of Mother's Milk:</u>		
*Infant milk consumption	850 ml/day	850 ml/day
*Infant body weight	5 kg	5 kg
*Duration of feeding period	1 year	1 year
<u>Ingestion of Contaminated Soil:</u>		
*Soil consumption rate	$7.0 \times 10^{-5}$ kg/day	$7.0 \times 10^{-5}$ kg/day
<u>Skin Contact with Soil (based on warm-weather climate):</u>		
*Skin surface area	4170 cm <sup>2</sup>	4170 cm <sup>2</sup>
*Dust on skin	0.5 mg/cm <sup>2</sup> /day	0.5 mg/cm <sup>2</sup> /day
*Dermal uptake	1%	1%
<u>Consumption of Drinking Water:</u>		
*Drinking water consumption	2 kg/day <sup>a</sup>	2 kg/day <sup>a</sup>
Source	Lake Worth	Lake Worth or nearest well (whichever contains higher concentrations of contaminants)

\* These parameters and input values have been reviewed and approved by the California Department of Health Services for use in exposure and risk assessments (Radian Corporation, 1987). In general, these are health conservative values expected to provide overestimates of actual exposure.

<sup>a</sup> Standard values used for exposure calculations listed in U.S. EPA, 1986.

<sup>b</sup> Derived from U.S. EPA, 1980.

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The maximally exposed off-site individual is assumed to both reside and work at the point where maximum annual off-site ground level contaminant concentrations are predicted to occur for a total of 70 years. This individual inhales the maximum predicted off-site concentrations continuously for a lifetime. The diet and lifestyle of this individual during a 70-year lifetime resembles the diet and lifestyle of the maximally-exposed on-site individual, with one exception. The source of drinking water for the off-site maximally exposed individual is either Lake Worth or the nearest well, whichever is predicted to contain higher concentrations of contaminants.

The two exposure scenarios are discussed in greater detail for each potential pathway in the subsections that follow.

#### Inhalation

To provide a conservative analysis, the maximally exposed on-site and off-site individuals are assumed to inhale the maximum predicted on-site and off-site concentrations continuously, 24-hours/day, for a defined exposure period. Although very few people will remain in the same location for a long period of time, rarely moving outside of the zone of maximum impact, microenvironment movements and population mobility are difficult to account for. These factors are, therefore, not considered in this risk assessment. A respiration rate of  $20 \text{ m}^3/\text{day}$  is a standard assumption for exposure calculations (U.S. EPA, 1986).

It was also conservatively assumed that respired particles and gases were completely retained in the lungs and that pollutants adsorbed to respired particulates and gaseous pollutants were completely absorbed into the body. Limited absorption of slightly soluble pollutants, and pulmonary mechanisms for cleaning deposited particulates were not used.

### Soil Ingestion

The quantity of soil ingested by humans varies by age, with the maximum occurring from 0 to 6 years (Kimbrough et al., 1984). To account for this variability, a time-weighted average of the daily consumption rate was determined. The concentration of pollutants in the ingested soil is site-specific and determined by the receptor-specific deposition. Removal mechanisms, such as soil runoff and leaching, were not used.

The exposure resulting from soil ingestion was determined by adjusting the soil ingestion by an appropriate absorption factor specific to each pollutant.

### Plant Ingestion

Exposure through plant ingestion may result if the local population eats locally-grown produce. Rural non-farm consumption patterns were used to determine the ingestion of plant matter produced in home gardens (U.S. EPA, 1980). The assumptions conform with consumption patterns for rural non-farm populations. Urban and suburban populations typically consume significantly less locally-grown produce than do rural non-farm populations. Rural farm populations typically consume more (U.S. EPA, 1980).

The concentration of pollutants in plant matter, as discussed previously, results from direct deposition and root uptake. No removal of particulate-bound pollutants present in the produce by rain and washing was conservatively assumed. To account for less than complete absorption of some pollutants by the body, gastrointestinal (GI) factors were applied, where appropriate, to adjust the final exposure.

### Fish Consumption

The consumption of fish from water bodies impacted by site contaminants may contribute to the local population's exposure to contaminants. This

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assessment assumes consumption of fish from Lake Worth, which is the most heavily used fishable resource in the immediate vicinity (South, 1988b). Pollutant-specific fish bioconcentration factors were applied to account for accumulation in fish of contaminant concentrations present in Lake Worth (U.S. EPA, 1986). A fish consumption rate of 6.5 g/day is a standard assumption for exposure calculations (U.S. EPA, 1986).

#### Dairy and Beef Consumption

The consumption of dairy products produced in the area affected by site contaminants may contribute to the local population's exposure to contaminants. It is conservatively assumed that some dairy products consumed by the maximum-exposed individuals were produced locally. The concentrations in milk of chlordane, bis(2-ethylhexyl)phthalate, benzo(a)anthracene, and benzo(a)-pyrene were estimated based on the annual average ground-level concentration and deposition values at the closest dairy site, a bioconcentration factor for milk, and gastrointestinal absorption factors for dairy products.

The consumption of beef products produced in the area affected by site contaminants may also contribute to the local population's exposure to contaminants. It is conservatively assumed that some beef products consumed by the maximum exposed individuals were produced locally. The concentrations of chlordane, bis(2-ethylhexyl)phthalate, benzo(a)anthracene, and benzo(a)-pyrene in beef were estimated based on the annual ground-level concentration and deposition values for the closest beef operation, a bioconcentration factor for beef, and gastrointestinal absorption factors for beef.

#### Dermal Exposure

Human exposure to site contaminants may occur through dermal (skin) contact with site emissions or surface dust. The concentration of pollutants present in the surface dust is assumed to equal the concentration present in the soil. A maximum surface dust exposure of  $0.5 \text{ mg/cm}^2$ , a warm climate exposed skin surface area of  $4170 \text{ cm}^2$ , and an absorption rate of 1 percent

were used to determine the exposure. These values have been recommended by the South Coast Air Quality Management District (SCAQMD) in California for use in exposure assessments (Radian Corporation, 1987). This is a conservative estimate, because bathing will reduce the likelihood of particulate-adsorbed pollutants being absorbed through the skin.

#### Drinking Water Consumption

The consumption of water from water bodies impacted by site contaminants may contribute to the local population's exposure to contaminants as well. This assessment assumes consumption of water from Lake Worth for the hypothetical on-site maximally exposed individual. It assumes consumption of water either from Lake Worth or from the nearest potable well, whichever contains the higher predicted concentrations of contaminants, for the hypothetical off-site maximally exposed individual. A drinking water consumption of 2 kg/day is a standard assumption for exposure calculations (U.S. EPA, 1986).

#### 3.8.6 Risk Characterization

The Radian Risk Assessment Model (R-RAM) was used to calculate pollutant-specific estimates of exposure, dose, and risk for all direct and indirect routes of exposure for each site. R-RAM is a fully-integrated, multi-media program which automates all necessary computations to estimate exposure, dose, and risk to a defined population. It is capable of calculating exposure, dose, and risk for an unlimited number of pollutants and receptors (locations) in a very small fraction of the time required for manual computation.

The model presents numerical results in terms of: (1) estimates of total inhalation and ingestion exposure; (2) the hypothetical maximum individual cancer risk, expressed as the probability of acquiring cancer in one's lifetime; and (3) comparisons of total exposures with pollutant-specific acceptable daily intake (ADI) levels, no observable adverse effects levels

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(NOAELs), or other appropriate comparison values considered protective of human health for effects other than cancer (e.g., liver or kidney damage).

R-RAM is a Fortran Code constructed in modular fashion. The variable inputs, such as emissions, exposure variables, and toxicological data, are each contained within separate model input files. The mathematical equations for calculating exposure and risk are contained within subroutines in the model code.

Using R-RAM, the possible routes of exposure which may be evaluated include:

- Inhalation;
- Soil ingestion;
- Dairy and beef consumption;
- Fish consumption;
- Human milk consumption;
- Water consumption; and
- Dermal absorption.

For each applicable pathway, the model estimates human dose and cancer risk for all identified pollutants, and sums these results to obtain total cancer risk at each selected receptor.

For noncarcinogenic effects, the model calculates the total dose (mg/kg/day) of each pollutant and compares the doses to acceptable daily intakes (ADIs), threshold limit values (TLVs), or other appropriate comparison values considered protective of human health, for effects other than cancer.





#### 4.0 RESULTS AND SIGNIFICANCE OF FINDINGS

This section contains the RI/FS Stage 2 results from each site and a discussion of their significance. The significance of the field and laboratory studies for each site is described in terms of regulatory criteria/standards and the results of a baseline risk assessment conducted for the site. Introductory topics in Section 4.1 deal with the available federal regulatory standards and guidelines and a summary of quality assurance and quality control results. In Sections 4.2 through 4.4, the field and laboratory results for each site and a baseline risk assessment are presented for the Flightline Area, East Area and Weapons Storage Area. Section 4.5 summarizes the Quality Control and Quality Assurance (QA/QC) results. Section 4.6 presents the prioritization of sites for remedial actions.

In sections 4.2, 4.3, and 4.4, the discussions of results are organized by site or activity, with appropriate references to base-wide trends or features common to more than one site. Plate 1 illustrates the areas of investigation and IRP site locations at Carswell AFB and the Weapons Storage Area (WSA). Figure 4-1 shows the areas of investigation at Carswell AFB for the Phase II Stage 2 investigation. For simplicity of discussion, the two major areas investigated are referred to as the Flightline Area and the East Area. The Flightline Area (Section 4.2) consists of Landfills 3 (Site 3), 4 (Site 4), and 5 (Site 5), Waste Burial Area (Site 10), and Fire Department Training Areas (FDTA) 1 (Site 11) and 2 (Site 12). The East Area (Section 4.3) consists of the Flightline Drainage Ditch (Site 13), POL Tank Farm (Site 17), the Unnamed Stream (Site 16), the Entomology Dry Well (Site 15), the Base Service Station (BSS Site), and Landfill 1 (Site 1). Figure 4-2 shows the area of investigation at the WSA. Results from the work performed in each area are presented in terms of the geology, hydrogeology, and soil and water chemistry observed during the investigation.

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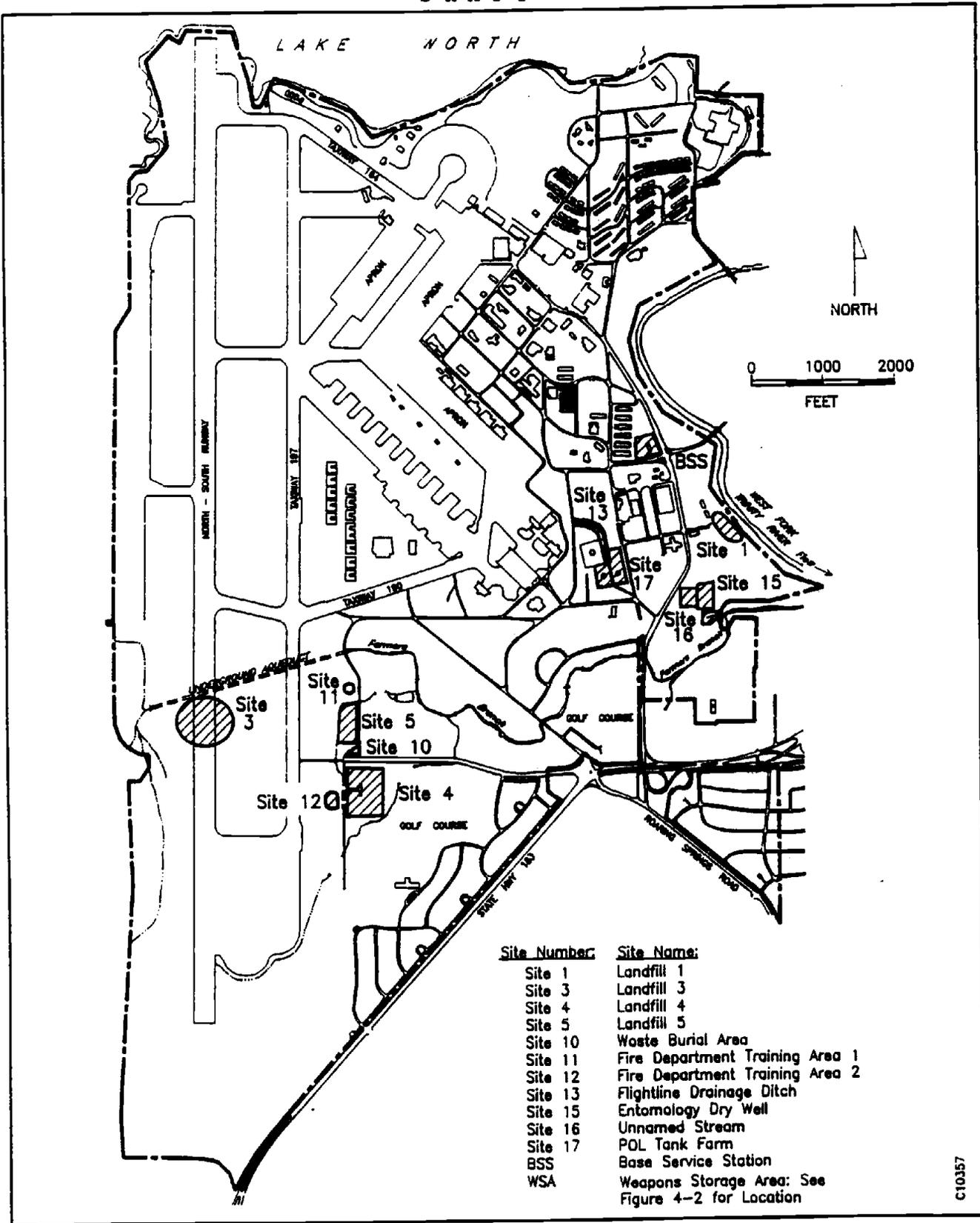


Figure 4-1. Location of RI/FS Stage 2 Sites at Carswell AFB, Texas



4.1 Analytical Chemistry Considerations

4.1.1 Regulatory and Human Health Criteria

To determine possible water quality effects on the local ground-water systems, concentrations of organic and inorganic compounds detected in ground-water samples were compared to water quality criteria from federal drinking water regulations, standards, and guidelines. These criteria include Maximum Contaminant Levels (MCLs) and proposed Maximum Contaminant Level Goals (MCLGs) established by the EPA as part of national drinking water regulations. The MCLGs are non-enforceable health goals, set with an adequate margin of safety at levels that would result in no known or anticipated adverse health effects. The MCLs are enforceable standards set at levels as close to the MCLGs as feasible.

Table 4.1-1 lists the federal primary drinking water standards (MCL) and secondary (recommended) standards for inorganic constituents in ground water. Table 4.1-2 lists EPA proposed MCLs, proposed MCLGs, and other criteria available for many of the organic compounds detected in ground-water analyses.

The body of literature concerning recommended or suggested guidelines is large and often contradictory. An attempt has been made to select criteria useful for the interpretation of IRP data. With the exception of the Safe Drinking Water Act standards (Table 4.1-1), the sole purpose of the criteria presented is to highlight contaminants of interest or of possible concern. Although most of these criteria do not now have the force of standards, they do provide a valid means for assessing the relative degree of contamination. For each site, parameters detected are compared to these standards and guidelines.

The status of the criteria for one parameter of potential concern, methylene chloride, is particularly ambiguous. The 1986 EPA Quality Criteria for Water recommend a value for "halomethanes" of 1.9 ug/L, corresponding to a

TABLE 4.1-1. REGULATORY STANDARDS FOR INORGANIC CONSTITUENTS IN GROUND WATER

Parameter	Maximum Contaminant Level <sup>1</sup> (mg/L)	Secondary Standards <sup>2</sup> (mg/L, except as noted)
Arsenic	0.05	
Barium	1.0	
Cadmium	0.01	
Chromium	0.05	
Lead	0.05	
Mercury	0.002	
Selenium	0.01	
Silver	0.05	
Fluoride	4.0	2.0
Chloride		250
Copper		1.0
Iron		0.3
Manganese		0.05
Zinc		5.0
pH		6.5 - 8.5 (standard units)
Sulfate		250
Total Dissolved Solids (TDS)		500
Nitrate (as N)	10.0	

<sup>1</sup>Primary Drinking Water MCLs; 40 CFR 141.11.

<sup>2</sup>Secondary Drinking Water Standards; 40 CFR 143.3.

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TABLE 4.1-2. REGULATORY STANDARDS FOR ORGANIC COMPOUNDS IN GROUND WATER

Compound	MCLs <sup>a</sup> (mg/L)	MCLGs <sup>b</sup> (mg/L)	10 <sup>-5</sup>	Toxicity (mg/L)
			Cancer Risk (mg/L)	
Vinyl Chloride	0.002	0		
1,1-Dichloroethene	0.007	0.007		
1,2-Dichloroethane	0.005	0		
trans-1,2-Dichloroethene		0.070		
Chloroform	* <sup>c</sup>			
1,1,1-Trichloroethane	0.200	0.200		
Carbon tetrachloride	0.005	0		
Bromodichloromethane	* <sup>c</sup>			
1,2-Dichloropropane		0.006		
Trichloroethene	0.005	0		
Bromoform	* <sup>c</sup>			
Tetrachloroethene			0.008 <sup>f, g</sup>	
Chlorobenzene		0.060		
Benzene	0.005	0		
Toluene		2.0		
Ethyl Benzene		0.68		
1,3-Dichlorobenzene				0.4 <sup>e</sup>
1,2-Dichlorobenzene		0.62		
1,4-Dichlorobenzene	0.75	0.75		
2,4,5-TP Silvex	0.01			
2,4-D	0.1			
Endrin	0.0002			
Lindane	0.004			
Methoxychlor	0.1			
Toxaphene	0.005			
2,4-Dichlorophenol				3.09 <sup>g</sup>
2,4-Dimethylphenol				0.40 <sup>g, i</sup>
Phenol				3.5 <sup>g</sup>
Acenaphthene			** <sup>d, g</sup>	
Fluoranthene			** <sup>d, g</sup>	
Butyl benzyl phthalate				0.94 <sup>g, i</sup>
bis[2-ethylhexyl]phthalate				15 <sup>g</sup>
di-n-butyl phthalate				35 <sup>g</sup>
Naphthalene				0.62 <sup>g, h</sup>
Fluorene			** <sup>d, g</sup>	
Phenanthrene			** <sup>d, g</sup>	
N-nitrosodimethylamine			0.014 <sup>g</sup>	
N-nitrosodiphenylamine			0.049 <sup>g</sup>	
Isophorone			5.2 <sup>g</sup>	
Pyrene			** <sup>d, g</sup>	

<sup>a</sup> 40 CFR 141.12, 141.60.

<sup>b</sup> 50 Federal Register 47022, 13 November 1985, 40 CFR 141.50.

<sup>c</sup> \* CFR 141.12 Primary Drinking Water MCL for all trihalomethanes, sum less than 0.10 mg/L.

<sup>d</sup> \*\* 28 ng/L for all PNAs.

<sup>e</sup> EPA 440/5-80-039, Ambient Quality Criteria for Dichlorobenzenes.

<sup>f</sup> EPA 440/5-80-073, Ambient Quality Criteria for Tetrachloroethylene.

<sup>g</sup> EPA 440/5-86-001, Quality Criteria for Water 1986.

<sup>h</sup> Lowest Observed Effect Level - Chronic.

<sup>i</sup> Lowest Observed Effect Level - Acute.

10<sup>-5</sup> cancer risk. For methylene chloride, this level is substantially below what might be otherwise dismissed as inadvertent sample or laboratory contamination of no health or environmental significance. The State of California regulates methylene chloride at the substantially higher level of 40 ug/L. Although methylene chloride is a common industrial solvent, no MCLG exists for it. In view of the ambiguity of the available documentation, methylene chloride is listed on the tables containing laboratory results of samples collected at the IRP sites, but without an accompanying criterion.

Using human health criteria and standards is a stringent way to evaluate ground-water contamination at Carswell AFB. Since the shallow ground water in the upper zone is not used as a drinking water supply source, contaminants in-situ will have no immediate human health consequences. Since these contaminants exit from the shallow ground-water system, however, they may encounter potential receptors. Where waters come to the land surface, either as seeps or as ground-water outflow to streams, the potential exists for exposure. Ground water within the Paluxy Formation is used directly as a drinking water source.

No guidelines exist concerning the maximum allowable or recommended pollutant concentrations in soils for protection of human health and the environment. Table 4.1-3 lists the ranges of metal concentrations in United States soils. However, natural occurrences of metals can be far above or below the normal range, depending on local geologic conditions.

#### 4.1.2 Quality Assurance and Quality Control

The objective of quality assurance and quality control (QA/QC) efforts associated with Carswell AFB Stage 2 activities was to ensure that data collected were of known and sufficient quality to qualitatively and quantitatively characterize the sites of interest. Two primary aspects of the overall QA/QC effort are related to achievement of this objective. First, the QA/QC program forms a framework for controlling data quality within pre-established limits during execution of the sampling and analytical efforts.

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TABLE 4.1-3. BACKGROUND CONCENTRATIONS FOR SELECTED METALS  
IN UNITED STATES SOILS<sup>a</sup>

Metal	Concentration (mg/kg)		
	Mean	Geometric Deviation	Range
Aluminum	47,000	2.48	5,000 - > 100,000
Antimony	0.48	2.27	< 1 - 8.8
Arsenic	5.2	2.23	< 0.1 - 97
Barium	440	2.14	10 - 5,000
Beryllium <sup>b</sup>	0.63	2.38	< 1 - 15
Cadmium <sup>b</sup>	< 1	--	< 1 - 10
Chromium	37	2.37	1 - 2,000
Cobalt	6.7	1.97	< 3 - 50
Copper	17	2.44	< 1 - 700
Iron	18,000	2.38	100 - > 100,000
Lead	16	1.86	< 10 - 700
Manganese	330	2.77	< 2 - 7,000
Mercury	0.058	2.52	< 0.01 - 4.6
Molybdenum	0.59	2.72	< 3 - 15
Nickel	13	2.31	< 5 - 700
Selenium	0.26	2.46	< 0.1 - 4.3
Silver <sup>b</sup>	< 0.5	--	< 0.5 - 5
Thallium	8.6	1.53	2.2 - 31
Vanadium	58	2.25	< 7 - 500
Zinc	48	1.91	< 5 - 2, 900

<sup>a</sup> Shacklette, H. T., and J. G. Boerngen, USGS Professional Paper 1270 (1984).  
<sup>b</sup> Conner, J. J., and H. T. Shacklette, USGS Professional Paper 574-F (1975).

Second, the QA/QC program forms the basis for estimating uncertainty in the measurement data by identifying and defining qualitative and quantitative limitations associated with these data.

The overall QA/QC program for the Stage 2 study was designed to fulfill two related purposes. First, it provided an organized framework for the sampling and analytical efforts which was designed to control data quality within preestablished limits to ensure that it achieved the objectives of the site characterization program. This framework was established by setting data quality objectives for the parameters of interest and defining protocols for critical aspects of the measurement effort, including:

- Sample collection, preservation, and storage;
- Sample analysis;
- Calibration of instrumentation and apparatus;
- Data reduction, validation, and reporting;
- Documentation and sample custody; and
- Internal quality control.

The protocols were tailored to both the site characterization objectives and the data quality objectives so that careful adherence to the prescribed protocols would, in most cases, result in achievement of both sets of objectives.

The second purpose of the QA/QC program was to provide a mechanism for data quality assessment. Quality control data were used to identify and define qualitative and quantitative limitations associated with the measurement data. Following are the key types of QA/QC procedures which provided the primary basis for quantitatively evaluating the data:

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- Field and laboratory blank samples;
- Spiked samples;
- Duplicate samples;
- Duplicate analyses; and
- Quality control check samples;

Blank samples play an especially important role in investigation programs. They provide qualitative assurance that analytes detected in the samples are actually characteristic of the media sampled and are not artifacts of the sampling and/or analytical process. Results of the analysis of laboratory blanks, field blanks and trip blanks are presented in the following sections.

Laboratory (reagent) blanks address only the analytical measurement process. Typically included with each batch of samples analyzed, they provide an ongoing check of the analytical system for systematic sample contamination by contaminated reagents or preservatives. When evidence of contamination is indicated by blank values above preestablished levels, corrective action is taken to identify and eliminate the source of contamination. If possible, the affected samples may be reanalyzed.

Field blanks reflect the combined effects of sample collection, handling, transportation, storage, and analysis. Since often it is not possible to resample when field blanks indicate possible sample contamination, field blank data are used to define qualitative limitations of the associated measurement data. The presence of analytes of interest in either the field or laboratory blanks suggests that corresponding field samples may have been similarly contaminated and that results for these analytes should be considered suspect. If the blank data show a given analyte at widely varying concentrations, or at concentrations comparable to those for field samples, then the field sample results should be viewed as possible false positives for that analyte. If, on the other hand, blank data indicate a given analyte at concentrations much lower than typical sample concentrations, then the sample data may usually be viewed as qualitatively reliable, but as having greater than normal quantitative uncertainty.

Trip blanks are sealed VOA vials containing organic-free water which are prepared in the laboratory then shipped to the field with the empty sample containers. The trip blanks are not opened in the field but are returned to the laboratory with the field samples. Trip blank results are useful for determining whether volatile organic compounds diffused across the VOA septum into the sample during storage ( e.g., refrigerants) or during the collection/transportation part of sample handling.

Spiked samples are used as part of the QA/QC protocol for analysis of organic compounds by gas chromatography. Two special types of spiked samples are matrix spiked samples and surrogate spiked samples. Matrix spiked samples are field samples to which known amounts of the analytes of interest have been added. Typically, both a spiked and an unspiked aliquot of the sample are analyzed. The difference in results for the two analyses are calculated and compared to the amount of spike added. Since actual samples are used for the determination, any matrix effects are taken into consideration. Usually expressed as a percentage of the spike amount, spike recovery also measures the accuracy of the analysis. For a single sample, this includes the combined effects of bias, or systematic error, and variability due to imprecision. Averaging spike recoveries for multiple samples tends to "average out" the random error caused by imprecision and gives an estimate of analytical bias.

Surrogate spiked samples are similar to normal spiked samples except that an unspiked aliquot is not analyzed. Samples are spiked with a mixture of surrogate compounds chemically similar to the species of interest but not expected to be present in actual field samples. Recovery of these surrogate compounds gives an estimate of method performance during that single analysis, and is considered to be indicative of recoveries for the target analytes.

Duplicate samples and duplicate analyses are used to indicate measurement data precision. Precision indicates the mutual agreement among individual measurements of the same constituents under prescribed similar conditions. Variability among the measurements is attributable to random

error due to imprecision. In the case of duplicate analyses, the analytical process is repeated for separate aliquots of a single sample while prescribed elements of the process are held constant. For example, duplicate analyses are usually performed on the same day, by the same analyst, using the same instrument and the same calibration. Differences in results for duplicate analyses are attributable to random variability in the analytical process and reflect analytical precision.

Duplicate samples provide another, different measure of precision. The collection of duplicate samples involves replicating sample collection (and associated sample handling activities). Thus, precision estimates based on duplicate sample results incorporate imprecision caused by sampling variability and analytical variability.

Both duplicate sample and duplicate analysis results yield data for estimating precision. Generally, however, duplicate sample data are used in a different way than are results for duplicate analyses. Since analytical precision is primarily a function of the analytical procedures used, results for duplicate analyses may be used as an ongoing quality control check. Corrective action can be taken when results indicate that analytical precision is not within acceptable limits. Results for duplicate samples, on the other hand, are more often used to assess data quality. Because of the lag between sample collection and the availability of analytical results, it is usually not possible to initiate corrective action based on duplicate sample data. Also, variability in duplicate sample results typically includes a component attributable to inherent non-homogeneity of the sample or sample matrix. Duplicate data of both types can indicate the degree to which chance may cause results to vary. This information is important whenever comparisons are made between measured values. Without it, it is difficult to know when to attribute observed differences to random measurement error and when to attribute them to actual differences.

Quality control check samples (QCCS) are used to assess analytical performance under a given set of standard conditions. These are synthetic samples prepared independently of calibration standards containing some or all of the analytes of interest at known concentrations. Typically analyzed with each set of analyses, QCCS results are often used as a real-time check of analytical system performance. By comparing measured results to known concentrations, QCCS results may also be used to estimate analytical bias and accuracy. Although they do not address matrix effects as do results for spiked samples, they allow day-to-day consideration of variability and are useful in identifying trends.

Quality control results are summarized and discussed in Section 4.5. Data for the summaries in Section 4.5 were obtained from the analytical data reports presented in Appendix G. The appendix contains tables of all the quality control information considered.

#### 4.2 Flightline Area Investigation

Stage 2 work performed in the vicinity of the flightline consisted of the installation of eleven upper zone monitor wells, drilling of twelve boreholes, sampling and analysis of soil and water, and performance of slug tests. Figure 4.2-1 shows the location of the Flightline Area wells and boreholes (except Site 3). Following an overview of the common features of the various sites, the hydrogeologic and chemical data for each of the sites are discussed.

##### Topography

The area in the vicinity of the flightline ranges from an essentially level surface near the main (north-south) runway to gently rolling land near tributaries of Farmers Branch at the golf course. All of the land is underlain by terrace deposits of the Trinity River and fill material associated with the construction of the base runway and taxiways. The terrace deposits have been moderately dissected by tributaries of Farmers Branch. Elevations in the area range from 625 feet MSL at Landfill 3 to 580 feet MSL at the northern end of Landfill 5 and at FDTA 1.

Drainage in the Flightline Area is generally to the north and east toward Farmers Branch. During the investigation, it was noted that water was present in tributaries to Farmers Branch at the southwest side of Landfill 4 and at the northern end of Landfill 5 and east of Cody Drive. Southwest of Landfill 4, the stream flows over limestone and shale outcrop, but becomes an influent stream as water percolates into terrace (upper zone) deposits south and east of the landfill. The other tributary west of Landfill 5 and Site 12 becomes effluent at Cody Drive where terrace deposits are relatively thin.

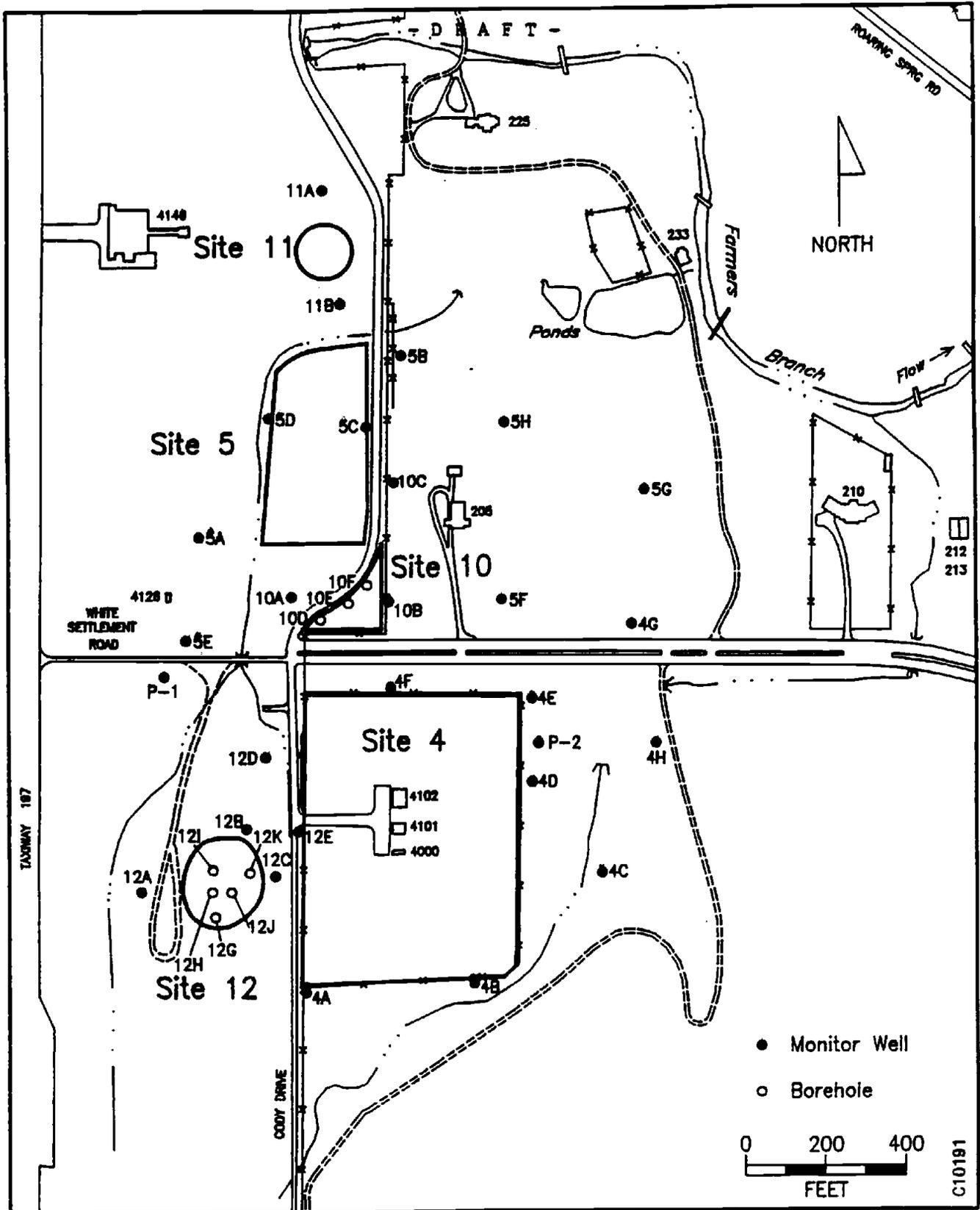


Figure 4.2-1. Monitor Wells and Boreholes at the Flightline Area Sites, Carswell AFB, TX

### Geology

Subsurface conditions in the Flightline Area have been revealed by direct sampling and observation through drilling operations during the RI/FS Stage 1 and Stage 2 studies. Methods of investigation are discussed in Chapter 3.

Upper zone deposits consist of unconsolidated alluvium and fill materials underlie the entire Flightline Area, with the exception of outcrops of limestone and shale southwest of Landfill 4 and south of FDTA 2. The alluvium consists of flood-plain and fluvial terrace deposits of gravel, sand, silt, and clay that occur as a veneer on the eroded surface of the Goodland Limestone.

The base of the upper zone deposits was encountered during both the RI/FS Stage 1 and Stage 2 drilling activities. Results of drilling indicate that the upper zone deposits in the Flightline Area range from 13 feet to greater than 40 feet of interbedded clay, silt, sand, and gravel. Plates 2 and 3 contain several hydrogeologic cross-sections based on drilling operations in the Flightline Area. In general, silt and clay with variable amounts of sand and gravel occur at the land surface down to depths of 5 to 10 feet. Underlying the silt and clay is a sand and gravel unit that normally increases in grain size with increasing depth. Based on the interpretations of cross-sections of Flightline Area materials (Plates 2 and 3), these strata appear to be relatively continuous across the area of investigation east of Taxiway 197. The sand deposits are fine to coarse grained, tan to rust in color, and composed dominantly of quartz grains. Gravel is mostly limestone and shell fragments ranging up in size from fine gravel to cobbles.

Limestone and shale of the Cretaceous-age Goodland and Walnut Formations (hereafter referred to as "bedrock") underlie the upper zone deposits. These formations were observed during drilling of the Paluxy wells for the Stage 1 study and were encountered at the base of several upper zone wells for both Stage 1 and Stage 2 studies. Both bedrock formations consist



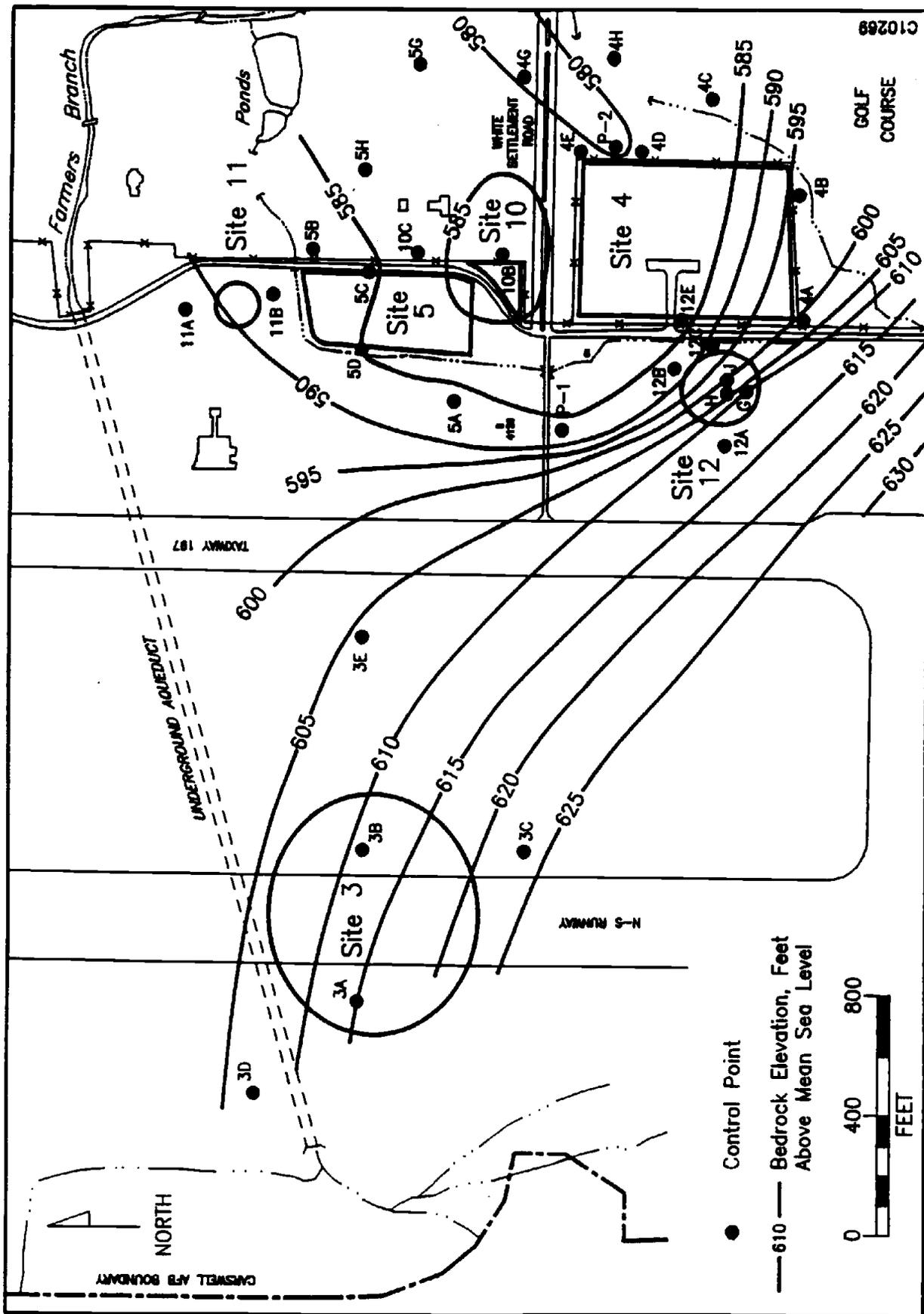


Figure 4.2-2. Contour Map of the Top of Bedrock, Flightline Area, Carswell AFB, Texas



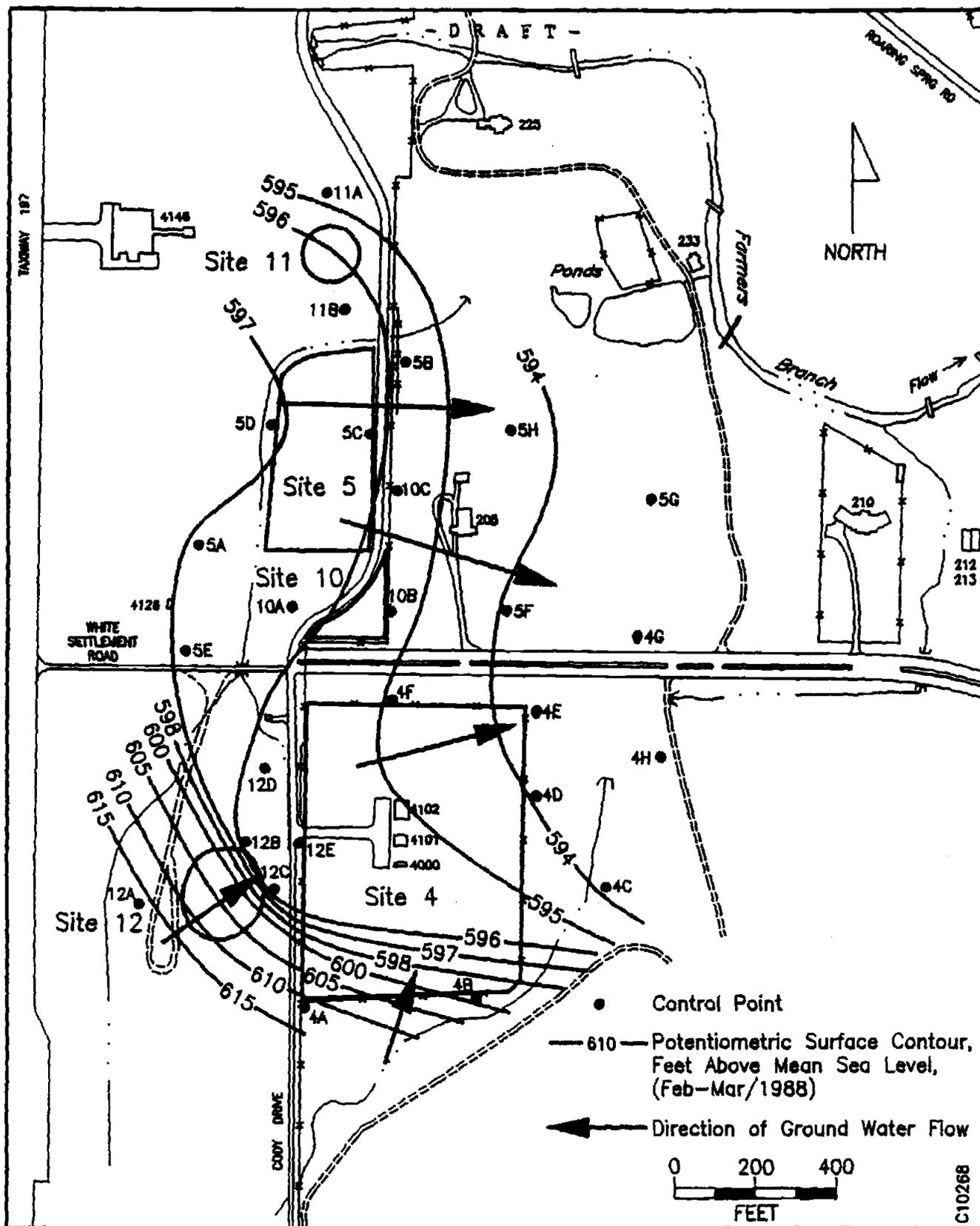


Figure 4.2-3. Potentiometric Surface Map of the Upper Zone, Flightline Area, Carswell AFB, Texas

The ability of the upper zone alluvial deposits to transmit ground water may be characterized based on the results of the single-well aquifer tests (slug tests) performed as described in Section 3.4.3. A summary of Flightline Area hydraulic conductivity values calculated from slug test results according to the Bouwer and Rice (1976) method is provided in Table 4.2-2.

Slug tests were performed at twelve Flightline Area wells in April 1988. The hydraulic conductivity values calculated range from  $7.98 \times 10^{-3}$  cm/sec at well 4D to  $4.1 \times 10^{-4}$  cm/sec at well 4A. These values are consistent with the expected ranges of hydraulic conductivities for alluvial deposits dominated by silt-sand-gravel mixtures.

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TABLE 4.2-2. SUMMARY OF UPPER ZONE HYDRAULIC CONDUCTIVITY VALUES, FLIGHTLINE AREA, CARSWELL AFB, TX

Location	Hydraulic Conductivity, <sup>1</sup> (cm/sec)
4A	$4.1 \times 10^{-4}$
4D	$8.0 \times 10^{-3}$
4E	$6.3 \times 10^{-3}$
4G	$4.0 \times 10^{-3}$
5A	$2.2 \times 10^{-3}$
5B	$3.7 \times 10^{-3}$
5C	$1.9 \times 10^{-3}$
5D	$1.8 \times 10^{-3}$
5E	$2.2 \times 10^{-3}$
12A	$5.7 \times 10^{-4}$
12B	$1.5 \times 10^{-3}$
12C	$2.7 \times 10^{-3}$

<sup>1</sup>Calculated from slug test results (see Appendix C).

4.2.1 Landfill 3 (Site 3)

Work performed at Landfill 3 (Site 3) consisted of drilling four boreholes, installing one upper zone monitor well, and sampling and analysis of soil and water. A geophysical survey was conducted at the site during the Stage 1 investigation. The results of the hydrogeologic and chemical data are discussed in the following sections. A baseline risk assessment for Landfill 3 is discussed in Section 4.2.1.4. Figure 4.2.1-1 shows the locations of the boreholes and the monitor well at Site 3.

4.2.1.1. Site Description

Topography

Based on the preliminary assessment (CH2M-Hill, 1984), Landfill 3 is believed to be located directly underneath and on both sides of the main runway. This site is immediately south of the underground aqueduct that carries the flow of Farmers Branch. The land surface ranges in elevation from 635 feet to 671 feet MSL. Evidence of past disposal activities is not visible on the surface. Surface drainage is generally to the east (toward Farmers Branch) and west (toward a closed depression between the runway and taxiway), with the main runway being the drainage divide.

Geology

Subsurface conditions at Site 3 have been investigated by direct sampling and observation through drilling. Cross-section C-C' (Plate 2) illustrates the geologic conditions at Site 3.

Drilling at Landfill 3 revealed slightly different geologic conditions than other sites in the Flightline Area. While Sites 4, 5, 10, 11, and 12 show a characteristic fining-upwards of grain size in the upper zone, typically from gravel at the base of the upper zone to clayey silt at the land

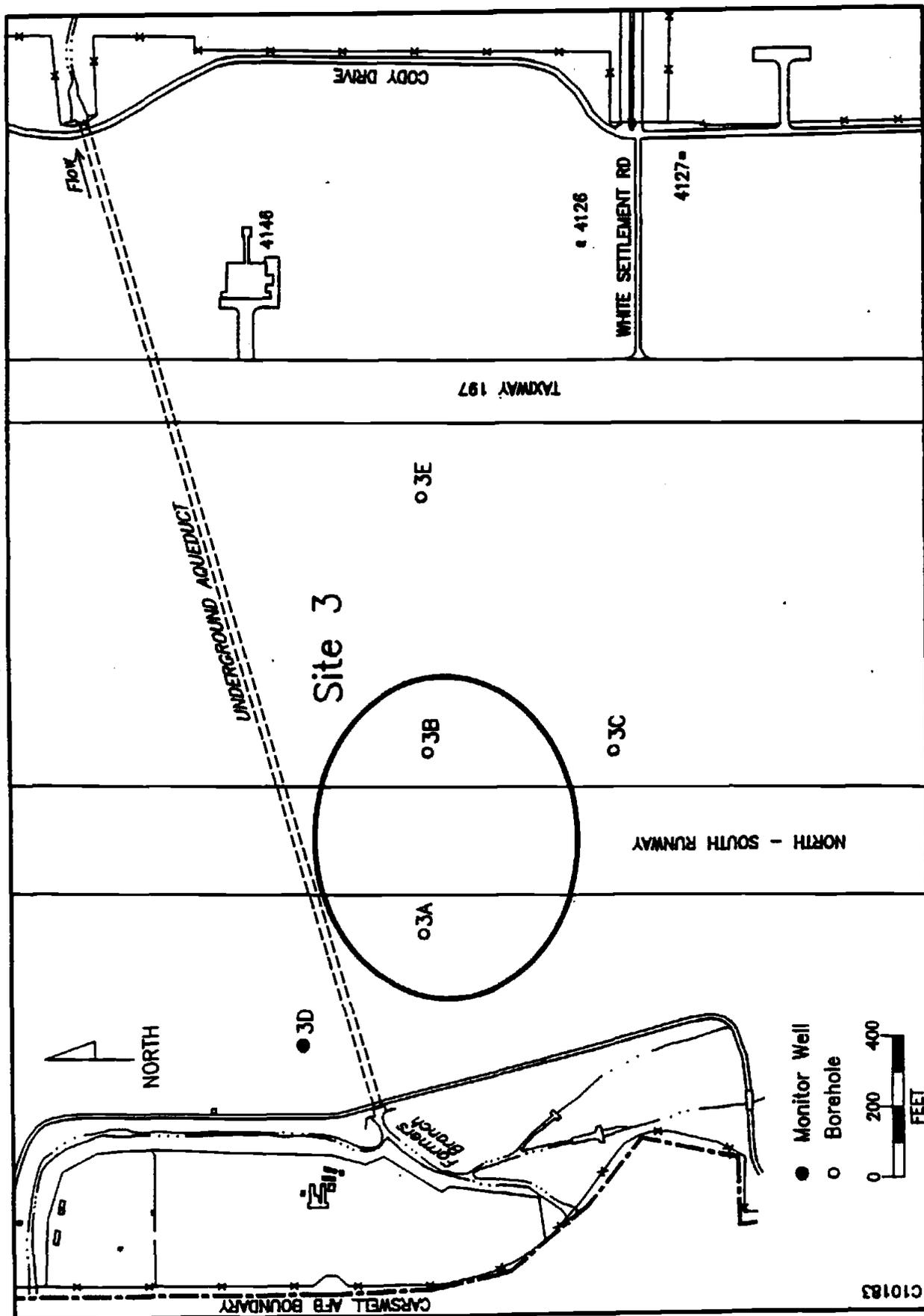


Figure 4.2.1-1. Location of Sampling Points at Site 3 (Landfill 3), Carswell AFB, Texas

surface, the Landfill 3 area is almost absent of sand and gravel deposits at depth. Instead upper zone deposits consist of clayey silt at the surface, grading into silty clay a few feet deep. This silty clay, possibly a fill material associated with runway construction, rests directly on bedrock without the sand and gravel deposits observed at the other Flightline sites east of the runway. Generally, the surficial clay and silt deposits are 10 to 20 feet thick. The shallowest depth to bedrock occurs at the southernmost borehole, 3C. The thinning of upper zone alluvial deposits at Site 3 toward the south is consistent with the trend observed at Sites 4 and 12 and the occurrence of bedrock outcrop south of the Flightline sites.

The bedrock encountered under these surficial deposits was shale and limestone of the Goodland Formation. This bedrock was encountered at less than 20 feet at all locations. Figure 4.2-2 illustrates the elevation of the contact between the upper zone materials and the underlying shale and limestone.

### Hydrogeology

Ground water was only encountered in the upper zone at one location at Site 3, monitor well 3D. Well 3D is in a topographic low, not far from Farmers Branch, suggesting a possible hydraulic connection between shallow ground water and surface water. With well 3D being the only control point of ground water flow east of Taxiway 197, contouring of water levels in the upper zone is not possible at Site 3. However, since the land surface at well 3D slopes towards a tributary of Farmers Branch at the west boundary of Carswell AFB, it is probable that ground water flows toward the same tributary.

#### 4.2.1.2 Chemical Analytical Results

##### Soil Chemistry

Split-spoon samples were collected and visually examined for evidence of contamination during drilling at Landfill 3. Five soil borings (3A-3E) were completed, with 3D completed as a monitor well. Based on the depth and location of the soil samples, as well as the presence of water, samples were selected for analysis of moisture content, metals, oil and grease, volatile organic compounds, and semivolatile organic compounds. Results of soil sample analyses are provided in Table 4.2.1-1 (inorganic parameters) and Table 4.2.1-2 (organic parameters).

Heavy Metals--Heavy metals were detected at normal ranges in soil samples from boreholes 3A-3E, with the exception of arsenic in 3B (from 19-21 feet). However, this value is noted as possibly having an interferent present. As expected in soils composed, in part, of weathered limestone, calcium values are high, averaging over 200,000 mg/kg in soils from Landfill 3.

Oil and Grease--Oil and grease were detected in soil samples from boreholes 3A and 3B. At 3A, an oil and grease concentration of 48 mg/kg was found at 14-18 feet. At 3B 32 mg/kg of oil and grease were measured at 19-21 feet. Oil and grease was not detected in soil samples from locations 3C-3F.

Volatile Organic Compounds--Toluene was detected in the soil sample from 3D at a value of 0.0076 mg/kg. It was the only purgeable aromatic detected at Site 3.

Semivolatile Organic Compounds--Various phthalate compounds were detected in the soil samples, along with acetone and methylene chloride. However, these compounds were also detected in the reagent blank and background subtraction was not performed.

TABLE 4.2.1-1 RESULTS OF INORGANIC ANALYSES FOR SOIL SAMPLES, SITE 3 (LANDFILL 3), CARSWELL AFB, TEXAS.

PARAMETER		Monitor Well	
		Sample ID	Date Sampled
		3B	3C
		3A-5	3C-4
		26-Jan-88	27-Jan-88
		(14 - 18)	(9 - 12)
Soil Moisture % MOISTURE	11.0	17.0	17.0
Dry Weight Determination			
Metals MC/KG			
Arsenic, Graphite AA	6.6	11.0R	5.2
Mercury	ND	ND (0.050)	ND (0.050)
Selenium, Graphite AA	ND	NDR (0.29)	NDE (1.2)
Metal Screen (ICP) MG/KG			
Ag Silver	ND	ND (0.87)	ND (0.81)
Al Aluminum	6600.0B	9500.0^	6500.0
As Arsenic	NDR	ND (29.0)	ND (27.0)
B Boron	NDR	ND (56.0)	ND (54.0)
Ba Barium	24.0	29.0E	20.0
Be Beryllium	0.1	0.5E	0.2
Ca Calcium	160000.0B	120000.0^	220000.0
Cd Cadmium	ND	ND (0.29)	ND (0.27)
Co Cobalt	ND	2.2	ND (0.90)
Cr Chromium	10.0	15.0E	32.0
Cu Copper	ND	5.2	ND (0.90)
Fe Iron	6700.0B	14000.0E	6500.0
K Potassium	700.0R	2200.0^	800.0

Q: Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.  
 B: Detected in Reagent Blank; background subtraction not performed.  
 E: The reported value is estimated due to the presence of an interferent.  
 R: Indicates that the matrix spike recovery for this analysis was not within acceptance limits indicating an interferent present.  
 ^: Indicates duplicate analysis is not within control limits.  
 \*E: Estimated value due to matrix interference. Duplicate analysis % difference outside control limits.  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

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TABLE 4.2.1.1-1 RESULTS OF INORGANIC ANALYSES FOR SOIL SAMPLES, SITE 3 (LANDFILL 3), CARSWELL AFB, TEXAS.

PARAMETER	Primary Results			
	Monitor Well		Date Sampled	
	Sample ID	Beg. Depth - End Depth	Sample ID	Date Sampled
Mg	2100.0R	(9.3)	2400.0	(9.6)
Mn	170.0	(0.28)	110.0^	(0.29)
Mo	ND	(19.0)	ND	(19.0)
Na	140.0	(7.4)	150.0E	(7.7)
Ni	6.0	(1.9)	11.0E	(1.9)
Pb	ND	(4.6)	10.0	(4.8)
Sb	40.0R	(22.0)	40.0	(23.0)
Se	ND	(28.0)	ND	(29.0)
Si	350.0R	(28.0)	360.0^	(29.0)
Tl	ND	(33.0)	ND	(35.0)
V	16.0	(1.9)	14.0^E	(1.9)
Zn	12.0	(0.56)	22.0^	(0.58)
			2300.0	(9.0)
			120.0	(0.27)
			ND	(18.0)
			230.0	(7.2)
			4.0	(1.8)
			5.0	(4.5)
			90.0	(22.0)
			ND	(27.0)
			260.0	(27.0)
			40.0	(32.0)
			22.0	(1.8)
			10.0	(0.54)

@: Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.  
 B: Detected in Reagent Blank; background subtraction not performed.  
 E: The reported value is estimated due to the presence of an interferent.  
 R: Indicates that the matrix spike recovery for this analysis was not within acceptance limits indicating an interferent present.  
 ^: Indicates duplicate analysis is not within control limits.  
 ^E: Estimated value due to matrix interference. Duplicate analysis % difference outside control limits.  
 ND: Not detected at specified detection limit  
 ( ): Detection limit



TABLE 4.2.1-1 RESULTS OF INORGANIC ANALYSES FOR SOIL SAMPLES, SITE 3 (LANDFILL 3), CARSMELL AFB, TEXAS.

PARAMETER	Primary Results	
	Monitor Well	Sample ID
	Date Sampled	Bag. Depth - End Depth
	3D	3E
	3D-4	3E-5
	27-Jan-88	27-Jan-88
	(9 - 15)	(14 - 16)
Sb	50.0 (23.0)	70.0 (22.0)
Se	ND (29.0)	ND (28.0)
Si	340.0 (29.0)	350.0 (28.0)
Tl	ND (34.0)	ND (33.0)
V	22.0 (1.9)	17.0 (1.8)
Zn	6.4 (0.57)	8.8 (0.55)

ND: Not detected at specified detection limit

( ): Detection limit





TABLE 4.2.1-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 3 (LANDFILL 3), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well		Date Sampled	Beg. Depth - End Depth	Sample ID
	Sample ID				
	3A	3B			
	26-Jan-88	26-Jan-88	19 - 19.5	27-Jan-88	
	14 - 18	19 - 19.5	9 - 12		
2-chlorophenol	ND (0.24)	ND (0.26)	ND (0.26)	ND (0.26)	ND (0.26)
2-methylnaphthalene	ND (0.74)	ND (0.80)	ND (0.80)	ND (0.80)	ND (0.80)
2-methylphenol	ND (0.74)	ND (0.80)	ND (0.80)	ND (0.80)	ND (0.80)
2-nitroaniline	ND (3.7)	ND (4.0)	ND (4.0)	ND (4.0)	ND (4.0)
2-nitrophenol	ND (0.27)	ND (0.29)	ND (0.29)	ND (0.29)	ND (0.29)
3,3'-dichlorobenzidine	ND (1.2)	ND (1.3)	ND (1.3)	ND (1.3)	ND (1.3)
3-nitroaniline	ND (3.7)	ND (4.0)	ND (4.0)	ND (4.0)	ND (4.0)
4,6-dinitro-2-methylphenol	ND (1.8)	ND (1.9)	ND (1.9)	ND (1.9)	ND (1.9)
4-bromophenyl-phenylether	ND (0.14)	ND (0.15)	ND (0.15)	ND (0.15)	ND (0.15)
4-chloro-3-methylphenol	ND (0.22)	ND (0.24)	ND (0.24)	ND (0.24)	ND (0.24)
4-chloroaniline	ND (0.74)	ND (0.80)	ND (0.80)	ND (0.80)	ND (0.80)
4-chlorophenyl-phenylether	ND (0.31)	ND (0.34)	ND (0.34)	ND (0.34)	ND (0.34)
4-methylphenol	ND (0.74)	ND (0.80)	ND (0.80)	ND (0.80)	ND (0.80)
4-nitroaniline	ND (3.7)	ND (4.0)	ND (4.0)	ND (4.0)	ND (4.0)
4-nitrophenol	ND (0.18)	ND (0.19)	ND (0.19)	ND (0.19)	ND (0.19)
acenaphthene	ND (0.14)	ND (0.15)	ND (0.15)	ND (0.15)	ND (0.15)
acenaphthylene	ND (0.26)	ND (0.28)	ND (0.28)	ND (0.28)	ND (0.28)
anthracene	ND (0.14)	ND (0.15)	ND (0.15)	ND (0.15)	ND (0.15)
benzo(a)anthracene	ND (0.58)	ND (0.63)	ND (0.63)	ND (0.63)	ND (0.63)
benzo(a)pyrene	ND (0.19)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
benzo(b)fluoranthene	ND (0.36)	ND (0.38)	ND (0.38)	ND (0.38)	ND (0.38)
benzo(k)fluoranthene	ND (0.19)	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
benzoic acid	ND (3.7)	ND (4.0)	ND (4.0)	ND (4.0)	ND (4.0)
benzyl alcohol	ND (3.7)	ND (4.0)	ND (4.0)	ND (4.0)	ND (4.0)
bis(2-chloroethoxy)methane	ND (0.39)	ND (0.43)	ND (0.43)	ND (0.43)	ND (0.43)

B: Detected in Reagent Blank; background subtraction not performed  
 BJ: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

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TABLE 4.2.1-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 3 (LANDFILL 3), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	Monitor Well	
	Sample ID	Date Sampled
phenol	3A	26-Jan-88
	3A-5	26-Jan-88
pyrene	3B	19 - 19.5
	3B-6	19 - 19.5
	3C	9 - 12
	3C-4	27-Jan-88

PARAMETER	14 - 18	19 - 19.5	9 - 12
phenol	ND (0.11)	ND (0.12)	ND (0.12)
pyrene	ND (0.14)	ND (0.15)	ND (0.15)

B: Detected in Reagent Blank; background subtraction not performed  
 BJ: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

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TABLE 4.2.1-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 3 (LANDFILL 3), CARSWELL AFB, TEXAS.

Primary Results		Monitor Well	
		Sample ID	
		Date Sampled	
		Beg. Depth - End Depth	
	3D	3E	
	3D-4	3E-5	
	27-Jan-88	27-Jan-88	
	9 - 15	14 - 16	
PARAMETER	MG/KG	MG/KG	MG/KG
Oil & Grease	(5.0)	ND	(5.0)
Oil and grease, infrared			
Volatle Organic Compounds	MG/KG		
1,1,1-trichloroethane	(0.0043)	ND	(0.0041)
1,1,2,2-tetrachloroethane	(0.0077)	ND	(0.0075)
1,1,2-trichloroethane	(0.0056)	ND	(0.0055)
1,2-dichloroethane	(0.0031)	ND	(0.0031)
1,2-dichloropropane	(0.0067)	ND	(0.0065)
2-butanone	(0.028)	ND	(0.027)
2-hexanone	(0.040)	ND	(0.039)
4-methyl-2-pentanone	(0.052)	ND	(0.050)
Benzene	(0.0049)	ND	(0.0048)
Ethylbenzene	(0.0081)	ND	(0.0078)
Toluene	(0.0067)	ND	(0.0065)
Trichloroethene	(0.0021)	ND	(0.0021)
acetone	(0.0084)	0.016	(0.0082)
bromodichloromethane	(0.0025)	ND	(0.0024)
bromoform	(0.0053)	ND	(0.0051)
bromomethane	(0.0056)	ND	(0.0055)
carbon disulfide	(0.0019)	ND	(0.0019)
carbon tetrachloride	(0.0031)	ND	(0.0031)
chlorobenzene	(0.0067)	ND	(0.0065)
chloroethane	(0.0056)	ND	(0.0055)
chloroform	(0.0018)	ND	(0.0017)
chloromethane	(0.0056)	ND	(0.0055)

B: Detected in Reagent Blank; background subtraction not performed

J: Estimated value (GC test codes)

ND: Not detected at specified detection limit

( ): Detection Limit

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### Water Quality

After installation of monitor well 3D, ground water was sampled for chemical analysis in February and April 1988. Results of analyses are provided in Table 4.2.1-3 (inorganic parameters) and Table 4.2.1-4 (organic parameters). Field chemistry results are given in Table 4.2.1-5. Samples were analyzed for water quality indicators, metals, oil and grease, petroleum hydrocarbons, phenols, purgeable halocarbons, purgeable aromatics, organochlorine pesticides, chlorinated phenoxy acid herbicides, and extractable priority pollutants. These data are summarized in the following paragraphs.

Water Quality Indicators--Water quality indicators remained fairly stable between the February and April sampling rounds. The only major change was an increase in sulfate concentration from 140 mg/L in Round 1 to 330 mg/L in Round 2.

Heavy Metals--Water samples from well 3D were found to exceed MCLs for two metals, chromium and arsenic. Chromium surpassed the MCL of 0.05 mg/L during both sampling rounds, detected at 0.13 mg/L in both rounds. Arsenic (0.060 mg/L) exceeded the MCL in the first round only. Iron and manganese exceeded MCLGs during both sampling rounds. There is no overall trend in metals concentrations between samplings.

Oil and Grease--Oil and grease was not detected in ground water from either sampling round at well 3D.

Petroleum Hydrocarbons--Petroleum hydrocarbons were detected at a concentration of 0.30 mg/L in the first round from monitor well 3D. In Round 2, however, no petroleum hydrocarbons were detected.

TABLE 4.2.1-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 3 (LANDFILL 3), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards,		Criteria		Monitor Well	
	3D	02-150	03-44	03-44	Sample ID	Date Sampled
Total Dissolved Solids MG/L				840.0 (1.0)	3D	04-01
Total Dissolved Solids					03-44	05-Apr-88
Fluoride MG/L						
Fluoride	4.0(M)	2.0(G)	0.40			
Chloride MG/L						
Chloride	250.0(G)		36.0			
Nitrate MG/L						
Nitrate, colorimetric			0.29			
Orthophosphate MG/L						
Orthophosphate			ND	(0.020)		(0.020)
Sulfate MG/L						
Sulfate, nephelometry	250.0(G)		140.0			330.0
Metals MG/L						
Arsenic, graphite AA	0.050(M)		0.060			0.046
Mercury	0.0020(M)		ND	(0.00012)		ND (0.00012)
Lead, graphite AA	0.050(M)		0.021			0.042
Selenium, graphite AA	0.010(M)		ND	(0.0050)		ND (0.0030)
Metal Screen (ICP) MG/L						
Ag Silver			ND	(0.0090)		ND (0.0090)
Al Aluminum			66.0	(0.20)		77.0 (0.20)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

(G) Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.

ND: Not detected at specified detection limit

( ) : Detection limit

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TABLE 4.2.1-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 3 (LANDFILL 3), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards, Criteria		Monitor Well	
	3D	3D	Sample ID	Date Sampled
As	0.050(M)	ND (0.30)	03-44	04-01
B		ND (0.50)		
Ba	1.0(M)	0.37 (0.0090)		0.46 (0.0090)
Be	0.0030	0.0030 (0.0010)		0.0090 (0.0010)
Ca	1100.0	1100.0 (0.12)		1300.0 (0.12)
Cd	0.010(M)	ND (0.0030)		ND (0.0030)
Co		ND (0.010)		ND (0.010)
Cr	0.050(M)	0.13 (0.0090)		0.13 (0.0090)
Cu	1.0(G)	0.020 (0.010)		0.010 (0.010)
Fe	0.30(G)	56.0 (0.030)		67.0 (0.030)
K		12.0 (0.30)		13.0 (0.30)
Mg		29.0 (0.10)		30.0 (0.10)
Mn		1.1 (0.0030)		1.6 (0.0030)
Mo	0.050(G)	ND (0.050)		ND (0.050)
Na		27.0 (0.080)		26.0 (0.080)
Ni		0.060 (0.020)		0.050 (0.020)
Pb	0.050(M)	ND (0.050)		ND (0.050)
Sb		0.18 (0.060)		ND (0.060)
Se	0.010(M)	ND (0.30)		ND (0.30)
Si		140.0 (0.30)		120.0 (0.30)
Tl		ND (0.090)		ND (0.090)
V		0.21 (0.020)		0.19 (0.020)
Zn	5.0(G)	0.11 (0.0060)		0.11 (0.0060)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

é: Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.

ND: Not detected at specified detection limit

( ): Detection limit

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TABLE 4.2.1-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 3 (LANDFILL 3), CARSWELL AFB, TEXAS.

Primary Results	EPA Standards,		Monitor Well	
	3D	3D	Sample ID	Date Sampled
PARAMETER	02-150	02-150	03-44	04-01
	Criteria	Criteria	05-Mar-88	05-Apr-88
PCB-1221	ND (0.20)	ND (5.4)		
PCB-1232	ND (0.20)	ND (5.4)		
PCB-1242	ND (0.10)	ND (2.7)		
PCB-1248	ND (0.10)	ND (0.54)		
PCB-1254	ND (0.20)	ND (1.1)		
PCB-1260	ND (0.20)	ND (1.1)		
aldrin	ND (0.010)	ND (0.27)		
alpha-BHC	ND (0.010)	ND (0.27)		
beta-BHC	ND (0.010)	ND (0.27)		
chlordane	ND (0.050)	ND (1.4)		
delta-BHC	ND (0.010)	ND (0.27)		
dieldrin	ND (0.010)	ND (0.054)		
endosulfan I	ND (0.010)	ND (0.054)		
endosulfan II	ND (0.030)	ND (0.16)		
endosulfan sulphate	ND (0.050)	ND (0.27)		
endrin	ND (0.010)	ND (0.054)		
endrin aldehyde	ND (0.020)	ND (0.11)		
endrin ketone	ND (0.050)	ND (0.27)		
gamma-BHC (lindane)	ND (0.010)	ND (0.27)		
heptachlor	ND (0.010)	ND (0.27)		
heptachlor epoxide	ND (0.010)	ND (0.27)		
methoxychlor	ND (0.050)	ND (0.27)		
	0.20(M)			
	100.0(M)			

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard

(Refer to Tables 4.1-1 and 4.1-2).

A: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

B: Detected in Reagent Blank; background subtraction not performed

BJ: Analyte detected in blank. Estimated value below detection limit.

C: Second Column Confirmed

NA: not analyzed

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ): Detection limit



TABLE 4.2.1-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 3 (LANDFILL 3), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards,		Monitor Well	
	Criteria	02-150	Sample ID	Date Sampled
2-methylphenol	ND (10.0)	3D	3D	04-01
2-nitroaniline	ND (50.0)	03-44		05-Apr-88
2-nitrophenol	ND (3.6)	24-Feb-88		
3,3'-dichlorobenzidine	ND (17.0)			
4,6-dinitro-2-methylphenol	ND (24.0)			
4-bromophenyl-phenylether	ND (1.9)			
4-chloro-3-methylphenol	ND (3.0)			
4-chloroaniline	ND (10.0)			
4-chlorophenyl-phenylether	ND (4.2)			
4-methylphenol	ND (10.0)			
4-nitroaniline	ND (50.0)			
4-nitrophenol	ND (2.4)			
acenaphthene	ND (1.9)			
acenaphthylene	ND (3.5)			
aniline	ND (10.0)			
anthracene	ND (1.9)			
benzidine	ND (44.0)			
benzo(a)anthracene	ND (7.8)			
benzo(a)pyrene	ND (2.5)			
benzo(b)fluoranthene	ND (4.8)			
benzo(g,h,i)perylene	ND (4.1)			
benzo(k)fluoranthene	ND (2.5)			

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), S-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

1: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

2: Detected in Reagent Blank; background subtraction not performed

BJ: Analyte detected in blank. Estimated value below detection limit.

C: Second Column Confirmed

NA: not analyzed

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ): Detection limit

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TABLE 4.2.1-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 3 (LANDFILL 3), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards, Criteria		3D		3D	
	02-150	24-Feb-88	02-150	24-Feb-88	03-44	04-01
benzoic acid		ND	ND	(50.0)	ND	(50.0)
benzyl alcohol		ND	ND	(50.0)	ND	(50.0)
bis(2-chloroethoxy)methane		ND	ND	(5.3)	ND	(5.3)
bis(2-chloroethyl) ether		ND	ND	(5.7)	ND	(5.7)
bis(2-chloroisopropyl)ether		ND	ND	(5.7)	ND	(5.7)
bis(2-ethylhexyl)phthalate	15000.0(G)	118.08	ND	(2.5)	190.0	(2.5)
butylbenzylphthalate	940.0(G)	ND	ND	(2.5)	2.9	(2.5)
chrysene		ND	ND	(2.5)	ND	(2.5)
di-n-butylphthalate		ND	ND	(2.5)	ND	(2.5)
di-n-octyl phthalate	35000.0(G)	1.68J	ND	(2.5)	ND	(2.5)
dibenzo(a,h)anthracene		1.58J	ND	(2.5)	ND	(2.5)
dibenzofuran		ND	ND	(2.5)	ND	(2.5)
diethylphthalate		ND	ND	(10.0)	ND	(10.0)
dimethyl phthalate		ND	ND	(1.9)	ND	(1.9)
fluoranthene	0.030(G)	ND	ND	(1.6)	ND	(1.6)
fluorene	0.030(G)	ND	ND	(2.2)	ND	(2.2)
hexachlorobenzene		ND	ND	(1.9)	ND	(1.9)
hexachlorobutadiene		ND	ND	(1.9)	ND	(1.9)
hexachlorocyclopentadiene		ND	ND	(0.90)	ND	(0.90)
hexachloroethane		ND	ND	(6.0)	ND	(6.0)
Indeno(1,2,3-cd)pyrene		ND	ND	(1.6)	ND	(1.6)
isophorone	5200.0(G)	ND	ND	(3.7)	ND	(3.7)
		ND	ND	(2.2)	ND	(2.2)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

- I: cis-1,3-Dichloropropene cannot be quantitated due to coelution.
- B: Detected in Reagent Blank; background subtraction not performed
- BJ: Analyte detected in blank. Estimated value below detection limit.
- C: Second Column Confirmed
- NA: not analyzed
- Q: Daily EPA QC recovery outside 95% confidence limit.
- ND: Not detected at specified detection limit
- ( ): Detection limit

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TABLE 4.2.1-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 3 (LANDFILL 3), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards,		Monitor Well	
	Criteria	Sample ID	Date Sampled	3D
n-nitroso-di-n-propylamine	ND (12.0)	02-150	03-44	04-01
n-nitrosodimethylamine	ND (10.0)			
n-nitrosodiphenylamine	ND (1.9)			
naphthalene	620.0(G)			
nitrobenzene	ND (1.9)			
pentachlorophenol	200.0(G)			
phenanthrene	0.030(G)			
phenol	3500.0(G)			
pyrene	0.030(G)			

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), C-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

- I: cis-1,3-Dichloropropene cannot be quantitated due to coelution.
- B: Detected in Reagent Blank; background subtraction not performed
- BJ: Analyte detected in blank. Estimated value below detection limit.
- C: Second Column Confirmed
- MA: not analyzed
- Q: Daily EPA QC recovery outside 95% confidence limits.
- ND: Not detected at specified detection limit
- ( ): Detection limit

TABLE 4.2.1-5. RESULTS OF FIELD ANALYSES FOR WATER SAMPLES, SITE 3 (LANDFILL 3), CARSWELL AFB, TEXAS

Analyte	Unit of Measure	3D	Monitor Well
		04-01	Sample ID
		05-Apr-88	Date Sampled
Specific Conductance	uMHO/CM	1040.0	(10.0)
Temperature	C	17.0	(1.0)
pH	S.U.	6.8	(0.010)

( ) : Detection Limit

Environmental Health

Phenols--Phenol (0.58 µg/L) and 2-chlorophenol (0.25 µg/L) were detected in the second round sample from 3D. Both of these findings were confirmed by second column analysis.

Purgeable Halocarbons--Trichloroethene (TCE) was detected in low levels (0.70 µg/L) in both water samples taken at 3D. This level is below the MCL for TCE but above the MCLG, which is zero. It was the only detection of purgeable halocarbon in water or soil at Site 3.

Purgeable Aromatics--Toluene was detected during both sample rounds at 3D, ranging from 0.6 µg/L to 1.5 µg/L. These levels are below the MCLG (2.0 mg/L) for toluene and may be due to sample vial contaminants (Section 4.5.2.2).

Organochlorine Pesticides and Chlorinated Phenoxy Acid Herbicides--Neither pesticides nor herbicides were detected in water from monitor well 3D.

Extractable Priority Pollutants--Bis(2-ethylhexyl)phthalate, butylbenzylphthalate, di-n-butylphthalate, and di-n-octylphthalate were detected in ground water from well 3D. With the exception of bis(2-ethylhexyl)phthalate, the concentrations were below 5 µg/L and were also usually detected in the reagent blank. Bis(2-ethylhexyl)phthalate ranged between 110-190 µg/L, with detection of this compound in the reagent blank during the first sampling round.

#### 4.2.1.3 Significance of Findings

The location of the Site 3 sampling points was determined on the basis of the Phase I location of Landfill 3, which was noted to be approximate due to the uncertainty of the Carswell AFB records. The geophysical investigation of this location during the Stage 1 study was inconclusive, providing neither confirming or refuting evidence of disposal activities at a location believed to be Landfill 3.

Based on the combination of drilling observations and chemical analyses at Stage 2 sampling points, Site 3 does not appear to be a source of contaminants in the subsurface. This finding is supported by several lines of evidence: the lack of waste materials in borehole samples; the absence of ground water at all locations, except well 3D; the "normal" levels of metals and sparse, low-level occurrences of volatile or halogenated organic compounds in soil; and the absence of organic contaminants (with a few minor exceptions attributable to laboratory contaminants) in ground water.

4.2.1.4 Baseline Risk Assessment

Summary of Indicator Chemicals

Results of the Stage 2 investigation indicate the presence of these indicator chemicals in at least one soil and/or ground water sample at the site:

<u>Metals</u>	<u>PNAs</u>	<u>VOCs</u>
Antimony	Bis(2-ethylhexyl)-	Methylene chloride
Arsenic	phthalate	Toluene
Barium		Trichloroethene
Beryllium		
Chromium		
Lead		
Nickel		

Tables 3.8-2, 3.8-3, and 3.8-4 in Section 3.8 present important physical, chemical, and biological characteristics for these and all other indicator chemicals.

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Some of the above indicator chemicals, particularly those at very low concentrations may be due in part to matrix interferences or sample vial contamination. Nevertheless, these chemicals were included in the risk assessment process in order to ensure a conservative (stringent-case) evaluation of possible health risks.

#### Source and Release Characterization

Possible sources of contaminant release from Landfill 3 include: 1) volatilization to the air, 2) fugitive dust generation, 3) recharge to ground water, 4) surface runoff, and 5) direct release to surface water.

Volatilization to the Air--VOCs present in the soil are subject to volatilization to the air by virtue of high vapor pressures. PNAs generally have very low vapor pressures and are not subject to volatilization. Most metals are nonvolatile as well. Indicator chemicals detected at the site which can volatilize include methylene chloride, toluene, and trichloroethene. Although Landfill 3 is located under the present runway which impedes releases to the air, it was assumed that releases to the air from the site will occur at the outer edges of the impervious material.

Estimated emission rates based conservatively on maximum concentrations detected in the soil or ground water at the site are:

<u>Indicator Chemical</u>	<u>Emission Rate</u> <u>(grams/second)</u>
Methylene chloride	$7.07 \times 10^{-6}$
Toluene	$1.58 \times 10^{-7}$
Trichloroethene	$4.44 \times 10^{-8}$

The methodology used to estimate emission rates is described in Section 3.8.

Fugitive Dust Generation--Contaminants must be present in surface soil uncovered by impervious materials or vegetation to be subject to fugitive dust generation. Because most of Landfill 3 is located under the present runway or is grass-covered, contaminants present in the soil at this site are not subject to fugitive dust generation.

Recharge to Ground Water--Indicator chemicals detected in the ground water at well 3D include: antimony, arsenic, barium, beryllium, chromium, lead, nickel, bis(2-ethylhexyl)phthalate, toluene, and trichloroethene. Section 4.2.1.3 summarizes and discusses the significance of the concentrations detected in the ground water at the site.

Surface Runoff--Contaminants must be present in surface soil uncovered by impervious materials to be subject to significant surface runoff during precipitation. Because Landfill 3 is located under a runway or is grass-covered, contaminants present in the soil at this site are not subject to surface runoff.

Discharge to Surface Water--Ground-water migration and surface runoff patterns eventually lead to either Farmers Branch west of the runway or to a closed topographic depression east of the runway. However, there is no avenue for direct discharge of contaminants from this site to surface water.

#### Transport and Fate of Contaminants

Landfill 3 potentially releases VOCs to the air via volatilization and VOCs, bis(2-ethylhexyl)phthalate, and metals to the ground water via site leaching. Potentially significant contaminant transport and fate mechanisms in the air and ground water media include: 1) air dispersion, 2) ground water migration, 3) transport in surface water, and 4) subsequent uptake by plants and animals.

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Air Dispersion--Emissions of VOCs from Landfill 3 occur at ground level in the gaseous phase. The gases disperse in the ambient atmosphere according to local meteorological conditions. Annual ambient air concentrations of methylene chloride, toluene, and trichloroethene resulting from Landfill 3 emissions were estimated using the ISCLT model. The dispersion modeling methodology is discussed in Section 3.8.

Ground Water Migration--At Landfill 3, ground water in the upper zones was discovered at one location (3D). Other borehole locations at or near the landfill were dry. The bed of Farmers Branch is cut into the same bedrock that forms the base of the upper zone; therefore any ground water would be expected to discharge directly to Farmers Branch or be discharged by evapotranspiration as it exits the upper zone materials near the creek. While ground-water flow directions cannot be determined on the basis of one well, it is likely that ground water flows to the west toward Farmers Branch. The probable path of ground-water flow precludes migration of contaminants from Landfill 3 to any domestic or agricultural use wells in the area.

Transport in Surface Water--Since VOCs remain in a gaseous state and do not deposit on the ground, surface water in the area is not subject to contamination via emissions to the air from Landfill 3. Contaminants which reach Farmers Branch via ground-water migration are subject to dilution and movement with the surface flow downstream to the West Fork of the Trinity River located east of the base. The West Fork of the Trinity River is downstream of Lake Worth, which is the source of drinking water for Fort Worth and Carswell AFB. Thus the path of surface water drainage precludes the transport of contaminants from Landfill 3 to the sole surface water source of drinking water in the area. Any VOCs present in surface water would probably volatilize to the air, thus leading to decreasing VOC concentrations with increasing distance downstream.



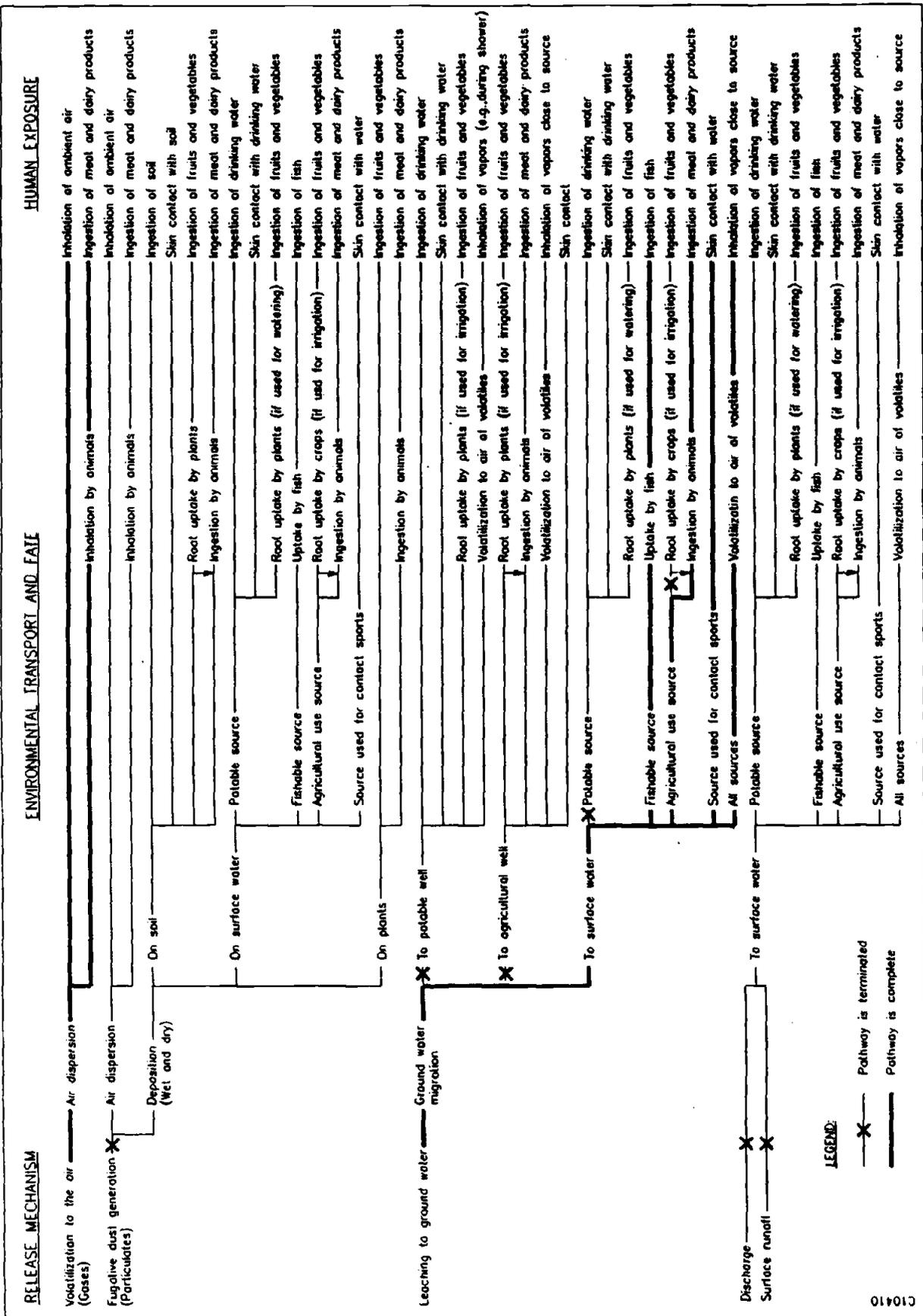


Figure 4.2.1-2. Potential Pathways to Human Exposure from Landfills 3 and 4 and the Waste Burial Area

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1. Volatilization to the air/air dispersion/inhalation of ambient air;
2. Volatilization to the air/air dispersion/inhalation by animals/ingestion of meat and dairy products;
3. Leaching to ground water/ground-water migration to surface water (fishable source)/uptake by fish and other aquatic organisms/ingestion of aquatic organisms;
4. Leaching to ground water/ground-water migration to surface water (agricultural use source)/ingestion by animals/ingestion of meat and dairy products;
5. Leaching to ground water/ground-water migration to surface water (source used for contact sports)/skin contact with water; and
6. Leaching to ground water/ground-water migration to surface water/volatilization of volatiles/inhalation of vapors close to source.

Identification of Receptors

Based on available exposure pathways, potential human receptors for exposure to contaminants originating from Landfill 3 include: 1) persons residing and/or working in nearby areas, particularly downwind of the site; 2) persons ingesting meat and dairy products from animals exposed to contaminants in the ambient air or contaminated surface water; 3) persons ingesting fish or other aquatic organisms exposed to contaminated surface water; and 4) persons swimming or participating in other contact sports in contaminated water.

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Potential wildlife receptors include: 1) terrestrial organisms with habitats close to Landfill 3 that inhale ambient air and ingest surface water, particularly from Farmers Branch, and 2) aquatic organisms in Farmers Branch and the West Fork of the Trinity River.

### Threat to Human Health

Inhalation Exposure--Inhalation of ambient air is the most direct exposure pathway for contaminants to move from Landfill 3 to human receptors. Table 4.2.1-6 presents the on-site maximum and off-site maximum predicted annual ambient air concentrations resulting from estimated Landfill 3 emissions, and predicted concentrations at several discrete locations: site of the proposed base day care center, which is central to the largest on-base residential area, the Fort Worth National Fish Hatchery, and the closest dairy and beef operations. The table also lists Texas Air Control Board (TACB) health Effects Screening Levels (ESLs) which the agency uses to evaluate the impacts of air contaminants. TACB screening levels are based on occupational exposure limits (American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs), Occupational Health and Safety Administration (OSHA) standards, or National Institute for Occupational Safety and Health (NIOSH) recommendations), odor nuisance potential, vegetation effects, or corrosion effects. Generally, the annual ESL corresponds to 0.1% of the lowest occupational exposure limit.

The maximum predicted annual average concentrations resulting from estimated Landfill 3 emissions for methylene chloride, toluene, and trichloroethene are lower than the conservative TACB Effects Screening Levels by 6, 8, and 9 orders of magnitude, respectively.

TABLE 4.2.1-6. PREDICTED ANNUAL AVERAGE AMBIENT AIR CONCENTRATIONS  
RESULTING FROM ESTIMATED LANDFILL 3 EMISSIONS

Contaminant	Predicted Annual Average Ambient Air Concentration (ug/m <sup>3</sup> )							TACB Annual Effects Screening Level (ug/m <sup>3</sup> )
	On-Site Maximum	Off-Site Maximum	Day Care	Fish Hatchery	Dairy Operation	Beef Operation		
Methylene chloride	8.3x10 <sup>-5</sup>	8.2x10 <sup>-6</sup>	7.7x10 <sup>-7</sup>	1.7x10 <sup>-7</sup>	5.5x10 <sup>-8</sup>	1.7x10 <sup>-8</sup>	26	
Toluene	1.9x10 <sup>-6</sup>	1.8x10 <sup>-7</sup>	1.7x10 <sup>-8</sup>	4.0x10 <sup>-9</sup>	1.0x10 <sup>-9</sup>	< 10 <sup>-9</sup>	375	
Trichloroethene	5.2x10 <sup>-7</sup>	5.1x10 <sup>-8</sup>	5.0x10 <sup>-9</sup>	1.0x10 <sup>-9</sup>	< 10 <sup>-9</sup>	< 10 <sup>-9</sup>	135	

APPENDIX 4

APPENDIX 4

Table 4.2.1-7 shows estimates of average daily inhalation exposure (in mg/kg body weight/day) at the location of the on-site and off-site maximum predicted annual average concentration, and at the proposed on-site day care facility, and compares these values with inhalation Acceptable Daily Intakes (ADIs) for chronic (long-term) exposure. An inhalation ADI is an estimate of the dose of a chemical that can be inhaled daily for a lifetime without producing adverse noncarcinogenic health effects. Section 3.8 discusses the derivation of ADIs used in this assessment.

Average daily inhalation exposures for methylene chloride, toluene, and trichloroethene are lower than pollutant-specific ADIs in all cases by more than 6 orders of magnitude.

Ingestion Exposure--Potential ingestion exposures include ingestion of meat and dairy products from animals exposed to contaminants in the ambient air or contaminated surface water and fish exposed to contaminated surface water.

Landfill 3 contributes very low concentrations of VOCs to the ambient air. At the sites of the nearest dairy and beef operations, concentrations are predicted on the order of  $10^{-8}$   $\mu\text{g}/\text{m}^3$  and lower (see Table 4.2.1-6). Although cows will absorb inhaled VOCs these compounds do not tend to accumulate in milk or edible tissues which humans might consume. Likewise, livestock consumption of surface water containing contaminants originating from Landfill 3 is theoretically possible, if livestock consumes water from the West Fork of the Trinity River; however, any exposure can be expected to be minimal due to the distance from Carswell AFB to the nearest dairy and beef operations. Consumption of locally produced beef and dairy products therefore does not represent a significant pathway of human exposure to contaminants originating from Landfill 3.

The most significant fishable resource in the vicinity of Carswell AFB is Lake Worth. The Fort Worth National Fish Hatchery is located at the western end of the lake. Since there is no available pathway for contaminants

TABLE 4.2.1-7. ESTIMATED ANNUAL AVERAGE DAILY INHALATION EXPOSURES FOR CONTAMINANTS ORIGINATING FROM LANDFILL 3

Contaminant	On-Site Maximum			Off-Site Maximum			Day Care		
	Inhalation Acceptable Daily Intake <sup>a</sup> (mg/kg/day)	Inhalation Exposure (mg/kg/day)	Safety Factor <sup>c</sup>						
Methylene chloride	$6.0 \times 10^{-2}$	$2.42 \times 10^{-8}$	$2.48 \times 10^6$	$2.22 \times 10^{-8}$	$2.7 \times 10^6$	$2.18 \times 10^{-10}$	$2.75 \times 10^8$		
Toluene	1.5	$5.42 \times 10^{-10}$	$2.77 \times 10^9$	$4.97 \times 10^{-10}$	$3.02 \times 10^9$	$4.88 \times 10^{-12}$	$3.08 \times 10^{11}$		
Trichloroethene	$2.46 \times 10^{-2}$	$1.52 \times 10^{-10}$	$1.62 \times 10^6$	$1.4 \times 10^{-10}$	$1.76 \times 10^6$	$1.37 \times 10^{-12}$	$1.8 \times 10^{10}$		

<sup>a</sup> Estimate of the dose of a chemical that can be inhaled daily for a lifetime without producing adverse noncarcinogenic health effects.

<sup>b</sup> Inhalation exposure assumes inhalation for 24 hours/day of predicted annual average ambient concentrations by an individual with an average body weight of 70 kg and with an average inhalation rate of 20 m<sup>3</sup>/day.

<sup>c</sup> Inhalation Acceptable Daily Intake/Inhalation Exposure

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to move from Landfill 3 to Lake Worth, there is no potential for human exposure to contaminants originating at Landfill 3 via ingestion of fish caught in the lake. There is some theoretical potential for fish in the West Fork of the Trinity River to accumulate contaminants from Landfill 3 in the area downstream of the intersection of Farmers Branch with the river. However, contaminant contributions to the river from Landfill 3 via ground-water migration to Farmers Branch are likely to be very minimal due to the distance between the site and the river (more than 1 mile), dilution, and the very low concentrations of contaminants in ground water. Since the ground-water contribution to Farmers Branch is unknown and the potential for significant contaminant contributions from Landfill 3 to the river is low, concentrations of contaminants in the river which originate from Landfill 3 were not estimated.

Dermal Exposure--The potential for skin contact with contaminants originating from Landfill 3 is limited to exposures while swimming in (or otherwise in contact with) contaminated surface water. Lake Worth is the most highly utilized surface water body for swimming and other water contact sports in the area. Again, since there is no available pathway for contaminants to move from Landfill 3 to Lake Worth, there is no potential for human exposure to contaminants originating from Landfill 3 via skin contact with lake water. As discussed above, contaminant contributions to the West Fork of the Trinity River from Landfill 3 are theoretically possible but likely to be very minimal; therefore, skin contact with river water is not considered a significant exposure pathway for this site. Skin contact with water in Farmers Branch, which is not amenable to swimming or other contact sports other than possibly wading, could contribute to dermal exposure. The exposure potential from this pathway was not quantified.

#### Carcinogenic Risks

Inhalation Risk--Of the three indicator chemicals which might be emitted to the air from Landfill 3, methylene chloride and trichloroethene are potential carcinogens. Cancer potency estimates developed by EPA were used in

conjunction with total daily contaminant doses to develop estimates of individual cancer risk:

$$\text{individual cancer risk} = \text{total daily dose} \times \text{cancer potency} \\ (\text{mg/kg/day}) \quad (\text{mg/kg/day})^{-1}$$

Individual cancer risk is the increased probability of getting cancer in one's lifetime.

Table 4.2.1-8 shows estimates of individual cancer risk for the maximum on-site and maximum off-site exposed individual and for an individual inhaling ambient concentrations in the immediate vicinity of the proposed day care facility continuously for a lifetime. These risks, the highest of which is 4 in 100 billion, can be completely dismissed.

Ingestion Risk--The potential for ingestion exposure to contaminants originating from Landfill 3 is remote and likely to be minimal. The risk of ingestion exposure was therefore not quantified.

Dermal Risk--The potential for dermal exposure to contaminants originating from Landfill 3 is also remote. Unless an individual immersed frequently in the waters of Farmers Branch for a long period of time, skin contact exposure can be considered insignificant. The risk of dermal exposure was therefore not quantified.

#### Threat to Wildlife

Contaminants originating from Landfill 3 pose some risk to terrestrial wildlife that use Farmers Branch as a source of drinking water as well as aquatic organisms in Farmers Branch. In the past, there have been some instances of fish kills in Farmers Branch. The potential contribution of Landfill 3 to contaminant concentrations in Farmers Branch was not estimated because neither the ground-water inflow to Farmers Branch nor existing contaminant concentrations in Farmers Branch is known. Sampling and analysis

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TABLE 4.2.1-8. ESTIMATED INDIVIDUAL CANCER RISK ASSOCIATED WITH INHALATION OF POTENTIAL CARCINOGENS ORIGINATING FROM LANDFILL 3

Contaminant	Potency Slope <sup>a</sup> (mg/kg/day)	Individual Cancer Risk <sup>b</sup>	
		On-Site Maximum Exposed Individual	Off-Site Maximum Exposed Individual at Day Care Facility
Methylene chloride	$1.65 \times 10^{-3}$	$4.0 \times 10^{-11}$	$3.7 \times 10^{-11}$
Trichloroethene	$4.6 \times 10^{-3}$	$7.0 \times 10^{-13}$	$6.4 \times 10^{-13}$
TOTAL 70 year risk		$4.07 \times 10^{-11}$	$3.76 \times 10^{-11}$

<sup>a</sup> See Section 3.8 for discussion and documentation.

<sup>b</sup> Risk calculation assumes inhalation for 24 hours/day for a 70 year lifetime of predicted annual average ambient concentrations by an individual with an average body weight of 70 kg and with an average inhalation rate of 20 m<sup>3</sup>/day.

I D P A M T I





#### 4.2.2 Landfill 4 (Site 4)

Activities conducted at Landfill 4 consisted of drilling and soil sampling, installation of three upper zone monitor wells, and collection of ground-water samples. Figure 4.2-1 shows the locations of the monitor wells. The results of the hydrogeologic investigation and chemical data for Site 4 are discussed in the following sections. A baseline risk assessment for Landfill 4 is discussed in Section 4.2.2.4.

##### 4.2.2.1 Site Description

###### Topography

Landfill 4 is located in the southern part of Carswell AFB at the intersection of White Settlement Road and Cody Drive. The land surface ranges in elevation from 625 feet to 615 feet MSL. The site is now occupied by the radar installation (Bldgs. 4100, 4101, and 4102). The disposal area is visible as a hummocky surface corresponding to the locations of trenches and filled areas. Surface drainage is generally to the east to an unnamed tributary of Farmers Branch.

###### Geology

Stage 2 geologic data developed for Landfill 4 resulted from geologic sampling during drilling operations, and observations of water levels during and after monitor well installation.

The geologic picture at Landfill 4 is consistent with the overall setting of the Flightline Area. Upper zone deposits consist of clayey silt with variable amounts of fine sand and gravel underlain by sand and gravel deposits. Cross-sections C-C' and D-D' (Plate 2) and E-E', F-F', and G-G' (Plate 3) illustrate the hydrogeologic conditions in the vicinity of Landfill 4. The thickness of the upper zone deposits increases to the north and east, ranging from 17 feet at monitor wells 4A and 4B to 39.5 feet at monitor well

4G. Generally, the surficial clay and silt deposits are 5 to 10 feet thick and the sand and gravel deposits are 10 to 30 feet thick. It was observed that in most borings in the vicinity of the flightline the grain size of the sand and gravel increases with depth. At the base of the upper zone, most borings east of the landfill (i.e., 4C, 4D, 4E, and 4G) encountered coarse gravel and cobbles.

With the exception of boring 4F, which was advanced to a depth of 35.5 feet without hitting bedrock, shale and limestone of the Goodland Formation was encountered at the base of the upper zone deposits at all locations. The top of the Goodland occurs at a maximum depth to the north and northeast of the site (4E, 4F, and 4G) and is shallowest in the south (4A and 4B). Limestone of the Goodland Formation crops out just south of the landfill in a stream that flows to Farmers Branch. The bedrock/upper zone contact slopes to the northeast under the landfill, particularly in the southwest quadrant of the landfill. Figure 4.2-2 illustrates the elevation of the contact between the upper zone materials and the underlying limestone and shale.

Stage 1 drilling at P2 just east of the landfill revealed that the Goodland and Walnut Formations are 40 feet thick. The Paluxy Formation underlies the Goodland and Walnut Formations and is composed of fine sand, with occasional lenses and layers of shale, lignite, and pyrite.

#### Hydrogeology

Ground water occurs in the upper zone materials underlying Landfill 4 at depths ranging from approximately 13 feet at 4A to 28 feet at 4E and 4F. The ground water exists under unconfined (water table) conditions in both the upper zone materials and in the Paluxy aquifer. The depth to ground water in the Paluxy aquifer ranges from 72 feet at P2 to 79 feet at P1. The two ground water bodies are separated by the Goodland/Walnut aquitard.

Figure 4.2-3 illustrates the potentiometric surface of the water table as determined in March, 1988. Comparison of the potentiometric surface map for the upper zone ground water and the contour map of the base of the upper zone (Figure 4.2-2) strongly suggests that the occurrence and direction of movement of ground water in the upper zone are related to the configuration of the bedrock surface.

Based on the hydraulic conductivity values calculated from slug test results at Landfill 4 and the hydraulic gradient of approximately 0.003 feet/feet (from Figure 4.2-3), the average ground-water flow velocity at Landfill 4 may be calculated to be approximately 0.2 feet per day. This velocity represents an average seepage velocity, as opposed to particle velocity that would be considered in contaminant transport evaluations. This estimate is derived from a simplification of Darcy's Law:

$$\bar{v} = \frac{k i}{\phi}$$

- where:  $\bar{v}$  - average ground-water flow velocity,  
k - hydraulic conductivity of upper zone deposits,  
(average  $4.7 \times 10^{-3}$  cm/sec or 13 feet/day)  
i - hydraulic gradient (0.003) in the upper zone; and  
 $\phi$  - estimated porosity of upper zone deposits  
(assume 0.20)

#### 4.2.2.2 Chemical Analytical Results

##### Soil Chemistry

In addition to the five RI/FS Stage 1 upper zone monitor wells at Site 4, three new wells were installed during Stage 2. Split-spoon samples collected during drilling were observed for any evidence of contamination. Based on the depth and location, as well as the presence of water, samples of soil were selected for analysis of moisture content, heavy metals, oil and

grease, and volatile and semivolatile organic compounds. Results of the analyses are provided in Table 4.2.2-1 (inorganic parameters) and Table 4.2.2-2 (organic parameters).

Heavy Metals--The chemical analyses performed on soils from 4F, 4G, and 4H showed metals concentrations within normal ranges (compared with values in Table 4.1-3), with the exception of silver in samples from boreholes 4F and 4H (1.9 mg/kg maximum).

Oil and Grease--No oil or grease was detected in the soil samples from boreholes 4F, 4G, and 4H.

Volatile Organic Compounds--With the exception of toluene, no purgeable halocarbons were detected in the soil samples from boreholes 4F, 4G, and 4H. Toluene was detected in low levels (less than 0.0088 mg/kg) in the soil samples at locations 4F and 4H. Low levels of 2-butanone, acetone, methylene chloride, were also detected in several soil samples.

Semivolatile Organic Compounds--Several phthalate compounds, were detected in the soil samples from Landfill 4. Most of the occurrences of the phthalate compounds were noted to coincide with phthalates in reagent blanks.

#### Water Quality

After installation of the three Stage 2 monitor wells, all upper zone wells were sampled for chemical analysis in February and April, 1988. In addition to the upper zone wells, Paluxy well P2 was included in the two rounds of sampling. Results of the two sampling rounds are shown in Table 4.2.2-3 (inorganic parameters) and Table 4.2.2-4 (organic parameters). Field

TABLE 4.2.2-1 RESULTS OF INORGANIC ANALYSES FOR SOIL SAMPLES, SITE 4 (LANDFILL 4), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	4F		4G		4B	
	10-Feb-88 (20 - 25)	10-Feb-88 (20 - 25)	10-Feb-88 (14 - 19)	10-Feb-88 (14 - 19)	10-Feb-88 (14 - 27)	10-Feb-88 (14 - 27)
Soil Moisture X MOISTURE	3.0	3.0	5.0	5.0	1.0	1.0
Dry Weight Determination						
Metals MC/KG						
Arsenic, graphite AA	0.9	0.9	0.7	0.8	0.8	0.8
Mercury	ND	ND	ND	ND	ND	ND
Selenium, graphite AA	ND	ND	ND	ND	ND	ND
Metal Screen (ICP) MC/KG						
Ag Silver	1.8	1.4	ND	ND	1.9	1.9
Al Aluminum	460.0	420.0	470.0E	470.0E	600.0	600.0
As Arsenic	ND	ND	ND	ND	ND	ND
B Boron	ND	ND	ND	ND	ND	ND
Ba Barium	3.3	3.2	2.9	2.9	6.3	6.3
Be Beryllium	0.2	0.2	ND	ND	0.2	0.2
Ca Calcium	13000.0	13000.0	360.0E	360.0E	3600.0	3600.0
Cd Cadmium	ND	ND	ND	ND	ND	ND
Co Cobalt	ND	ND	ND	ND	ND	ND
Cr Chromium	2.5E	2.5E	ND	ND	2.6E	2.6E
Cu Copper	1.6	1.6	ND	ND	ND	ND
Fe Iron	2700.0	2400.0	2300.0	2300.0	2200.0	2200.0
K Potassium	50.0	70.0	70.0	70.0	70.0	70.0
Mg Magnesium	130.0	120.0	87.0	87.0	100.0	100.0
Mn Manganese	32.0	29.0	22.0	22.0	42.0	42.0
Mo Molybdenum	ND	ND	ND	ND	ND	ND
Na Sodium	36.0E	51.0E	40.0	40.0	35.0E	35.0E
Ni Nickel	ND	ND	ND	ND	ND	ND

E: The reported value is estimated due to the presence of an interferant.

ND: Not detected at specified detection limit

( ): Detection limit

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TABLE 4.2.2-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 4 (LANDFILL 4), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well			
	Sample ID			
	Date Sampled			
	4F	4G	4B	4H-5
	10-Feb-88	02-Feb-88	10-Feb-88	10-Feb-88
	20 - 25	14 - 19	14 - 19	14 - 27
Oil & Grease MG/KG	ND	ND	ND	ND
Oil and grease, infrared	(5.0)	(5.0)	(5.0)	(5.0)
Volatile Organic Compounds MG/KG				
1,1,1-trichloroethane	ND (0.0039)	ND (0.0039)	ND (0.0039)	ND (0.0039)
1,1,2,2-tetrachloroethane	ND (0.0071)	ND (0.0071)	ND (0.0071)	ND (0.0071)
1,1,2-trichloroethane	ND (0.0052)	ND (0.0052)	ND (0.0052)	ND (0.0052)
1,2-dichloroethane	ND (0.0029)	ND (0.0029)	ND (0.0029)	ND (0.0029)
1,2-dichloropropane	ND (0.0062)	ND (0.0062)	ND (0.0062)	ND (0.0062)
2-butanone	ND (0.026)	ND (0.026)	0.018J	ND (0.026)
2-chloroethylvinyl ether	ND (0.0052)	ND (0.0052)	ND (0.0052)	ND (0.0052)
2-hexanone	ND (0.037)	ND (0.037)	ND (0.037)	ND (0.037)
4-methyl-2-pentanone	ND (0.047)	ND (0.047)	ND (0.047)	ND (0.047)
Benzene	ND (0.0045)	ND (0.0045)	ND (0.0045)	ND (0.0045)
Ethylbenzene	ND (0.0074)	ND (0.0074)	ND (0.0074)	ND (0.0074)
Toluene	0.0041J	0.0088	0.0062	0.0010J
Trichloroethene	ND (0.0020)	ND (0.0020)	ND (0.0020)	ND (0.0020)
acetone	ND (0.0077)	ND (0.0077)	0.023	ND (0.0077)
bromodichloromethane	ND (0.0023)	ND (0.0023)	ND (0.0023)	ND (0.0023)
bromoform	ND (0.0048)	ND (0.0048)	ND (0.0048)	ND (0.0048)
bromomethane	ND (0.0052)	ND (0.0052)	ND (0.0052)	ND (0.0052)
carbon disulfide	ND (0.0018)	ND (0.0018)	ND (0.0018)	ND (0.0018)
carbon tetrachloride	ND (0.0029)	ND (0.0029)	ND (0.0029)	ND (0.0029)
chlorobenzene	ND (0.0062)	ND (0.0062)	ND (0.0062)	ND (0.0062)
chloroethane	ND (0.0052)	ND (0.0052)	ND (0.0052)	ND (0.0052)

B: Detected in Reagent Blank; background subtraction not performed  
 BJ: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection Limit



TABLE 4.2-2-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 4 (LANDFILL 4), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	Monitor Well			
	Sample ID			
	Date Sampled			
	4F	4G	4H-5	
	4F-6	4G-5	4H-5	
	10-Feb-88	02-Feb-88	10-Feb-88	
	20 - 25	14 - 19	14 - 27	
chloroform	ND (0.0016)	ND (0.0016)	ND (0.0016)	ND (0.0016)
chloromethane	ND (0.0052)	ND (0.0051)	ND (0.0052)	ND (0.0051)
cis-1,3-Dichloropropene	ND (0.0052)	ND (0.0051)	ND (0.0052)	ND (0.0051)
dibromochloromethane	ND (0.0032)	ND (0.0032)	ND (0.0032)	ND (0.0032)
methylene chloride	0.0123 (0.0029)	0.00288J (0.0029)	0.00288J (0.0029)	0.087B (0.0029)
styrene	ND (0.0031)	ND (0.0031)	ND (0.0031)	ND (0.0031)
tetrachloroethane	ND (0.0042)	ND (0.0042)	ND (0.0042)	ND (0.0042)
total xylenes	ND (0.0047)	ND (0.0047)	ND (0.0047)	ND (0.0047)
trans-1,2-Dichloroethane	ND (0.0016)	ND (0.0016)	ND (0.0016)	ND (0.0016)
trans-1,3-Dichloropropene	ND (0.0052)	ND (0.0051)	ND (0.0052)	ND (0.0051)
trichlorofluoromethane	ND (0.0052)	ND (0.0051)	ND (0.0052)	ND (0.0051)
vinyl acetate	ND (0.0071)	ND (0.0070)	ND (0.0071)	ND (0.0070)
vinyl chloride	ND (0.0052)	ND (0.0051)	ND (0.0052)	ND (0.0051)
Semivolatiles Organic Compounds MC/KG				
1,2,4-trichlorobenzene	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)
1,2-dichlorobenzene	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)
1,3-dichlorobenzene	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)
1,4-dichlorobenzene	ND (0.30)	ND (0.30)	ND (0.31)	ND (0.29)
2,4,5-trichlorophenol	ND (0.69)	ND (0.69)	ND (0.70)	ND (0.67)
2,4,6-trichlorophenol	ND (0.18)	ND (0.19)	ND (0.19)	ND (0.18)
2,4-dichlorophenol	ND (0.18)	ND (0.19)	ND (0.19)	ND (0.18)
2,4-dimethylphenol	ND (0.18)	ND (0.19)	ND (0.19)	ND (0.18)
2,4-dinitrophenol	ND (2.9)	ND (2.9)	ND (2.9)	ND (2.8)
2,4-dinitrotoluene	ND (0.39)	ND (0.39)	ND (0.40)	ND (0.38)

B: Detected in Reagent Blank; background subtraction not performed  
 BJ: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

0.0016

0.0016  
 0.0051  
 0.0051  
 0.0032  
 0.0029  
 0.0031  
 0.0042  
 0.0047  
 0.0016  
 0.0051  
 0.0051  
 0.0070  
 0.0051  
 0.13  
 0.13  
 0.13  
 0.30  
 0.69  
 0.18  
 0.18  
 0.18  
 2.9  
 0.39  
 0.13  
 0.13  
 0.13  
 0.31  
 0.70  
 0.19  
 0.19  
 0.19  
 2.9  
 0.40  
 0.13  
 0.13  
 0.13  
 0.29  
 0.67  
 0.18  
 0.18  
 0.18  
 2.8  
 0.38

TABLE 4.2-2-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 4 (LANDFILL 4), CARSWELL AFB, TEXAS.

Primary Results	Monitor Well			
	Sample ID			
	Date Sampled			
	4F	4G	4H	4I
	10-Feb-88	02-Feb-88	10-Feb-88	10-Feb-88
	20 - 25	14 - 19	14 - 19	14 - 27
PARAMETER	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)
2,6-dinitrotoluene	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)
2-chloronaphthalene	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)
2-chlorophenol	ND (0.23)	ND (0.23)	ND (0.23)	ND (0.22)
2-methylnaphthalene	ND (0.69)	ND (0.69)	ND (0.70)	ND (0.67)
2-methylphenol	ND (0.69)	ND (0.69)	ND (0.70)	ND (0.67)
2-nitroaniline	ND (3.4)	ND (3.4)	ND (3.5)	ND (3.3)
2-nitrophenol	ND (0.25)	ND (0.25)	ND (0.25)	ND (0.24)
3,3'-dichlorobenzidine	ND (1.1)	ND (1.1)	ND (1.2)	ND (1.1)
3-nitroaniline	ND (3.4)	ND (3.4)	ND (3.5)	ND (3.3)
4,6-dinitro-2-methylphenol	ND (1.6)	ND (1.7)	ND (1.7)	ND (1.6)
4-bromophenyl-phenylether	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)
4-chloro-3-methylphenol	ND (0.21)	ND (0.21)	ND (0.21)	ND (0.20)
4-chloroaniline	ND (0.69)	ND (0.69)	ND (0.70)	ND (0.67)
4-chlorophenyl-phenylether	ND (0.29)	ND (0.29)	ND (0.29)	ND (0.28)
4-methylphenol	ND (0.69)	ND (0.69)	ND (0.70)	ND (0.67)
4-nitroaniline	ND (3.4)	ND (3.4)	ND (3.5)	ND (3.3)
4-nitrophenol	ND (0.16)	ND (0.17)	ND (0.17)	ND (0.16)
acensaphthene	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)
acensaphthylene	ND (0.24)	ND (0.24)	ND (0.24)	ND (0.23)
aniline	ND (0.69)	ND (0.69)	ND (0.70)	ND (0.67)
anthracene	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)
benzidine	ND (3.0)	ND (3.0)	ND (3.1)	ND (2.9)
benzo(a)anthracene	ND (0.53)	ND (0.54)	ND (0.54)	ND (0.52)
benzo(a)pyrene	ND (0.17)	ND (0.17)	ND (0.17)	ND (0.17)
benzo(b)fluoranthene	ND (0.33)	ND (0.33)	ND (0.33)	ND (0.32)

B: Detected in Reagent Blank; background subtraction not performed  
 BJ: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

TABLE 4.2.2-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 4 (LANDFILL 4), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well					
	Sample ID					
	Date Sampled					
	4F	4G	4H	4F-6	4G-5	4H-5
	10-Feb-88	02-Feb-88	10-Feb-88	10-Feb-88	02-Feb-88	10-Feb-88
	20 - 25	14 - 19	14 - 19	20 - 25	14 - 19	14 - 27
benzo(k)fluoranthene	ND (0.17)	ND (0.17)	ND (0.17)	ND (0.17)	ND (0.17)	ND (0.17)
benzoic acid	ND (3.4)	ND (3.4)	ND (3.4)	ND (3.4)	ND (3.5)	ND (3.3)
benzyl alcohol	ND (3.4)	ND (3.4)	ND (3.4)	ND (3.4)	ND (3.5)	ND (3.3)
bis(2-chloroethoxy)methane	ND (0.36)	ND (0.37)	ND (0.37)	ND (0.37)	ND (0.37)	ND (0.35)
bis(2-chloroethyl) ether	ND (0.39)	ND (0.39)	ND (0.39)	ND (0.39)	ND (0.40)	ND (0.38)
bis(2-chloroisopropyl) ether	ND (0.39)	ND (0.39)	ND (0.39)	ND (0.39)	ND (0.40)	ND (0.38)
bis(2-ethylhexyl)phthalate	0.448 (0.17)	0.258 (0.17)	0.168J (0.17)	0.258 (0.17)	0.168J (0.17)	0.328 (0.17)
butylbenzylphthalate	ND (0.17)	ND (0.17)	ND (0.17)	ND (0.17)	ND (0.17)	ND (0.17)
chrysene	ND (0.17)	ND (0.17)	ND (0.17)	ND (0.17)	ND (0.17)	ND (0.17)
di-n-butylphthalate	0.21 (0.17)	0.096J (0.17)	0.348 (0.17)	0.096J (0.17)	0.348 (0.17)	0.15J (0.17)
di-n-octyl phthalate	ND (0.17)	0.17J (0.17)	ND (0.17)	0.17J (0.17)	ND (0.17)	0.26 (0.17)
dibenzo(a,h)anthracene	ND (0.17)	ND (0.17)	ND (0.17)	ND (0.17)	ND (0.17)	ND (0.17)
dibenzofuran	ND (0.69)	ND (0.69)	ND (0.69)	ND (0.69)	ND (0.70)	ND (0.67)
diethylphthalate	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)
dimethyl phthalate	ND (0.11)	ND (0.11)	ND (0.11)	ND (0.11)	ND (0.11)	ND (0.11)
fluoranthene	ND (0.15)	ND (0.15)	ND (0.15)	ND (0.15)	ND (0.15)	ND (0.15)
fluorene	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)
hexachlorobenzene	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)	ND (0.13)
hexachlorobutadiene	ND (0.062)	ND (0.062)	ND (0.062)	ND (0.062)	ND (0.063)	ND (0.060)
hexachlorocyclopentadiene	ND (0.41)	ND (0.41)	ND (0.41)	ND (0.41)	ND (0.42)	ND (0.40)
hexachloroethane	ND (0.11)	ND (0.11)	ND (0.11)	ND (0.11)	ND (0.11)	ND (0.11)
indeno(1,2,3-cd)pyrene	ND (0.25)	ND (0.25)	ND (0.25)	ND (0.25)	ND (0.26)	ND (0.25)
isophorone	ND (0.15)	ND (0.15)	ND (0.15)	ND (0.15)	ND (0.15)	ND (0.15)
n-nitroso-di-n-propylamine	ND (0.82)	ND (0.82)	ND (0.82)	ND (0.82)	ND (0.84)	ND (0.80)
n-nitrosodimethylamine	ND (0.69)	ND (0.69)	ND (0.69)	ND (0.69)	ND (0.70)	ND (0.67)

B: Detected in Reagent Blank; background subtraction not performed  
 BJ: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit



TABLE 4.2.2-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 4 (LANDFILL 4), CARSHILL AFB, TEXAS.

PARAMETER	EPA Standards,		Criteria		Monitor Well	
	AA	AB	AA	AB	Sample ID	Date Sampled
Total Dissolved Solids	430.0	(1.0)	480.0	(1.0)	430.0	(1.0)
Total Dissolved Solids	430.0	(1.0)	480.0	(1.0)	430.0	(1.0)
Fluoride MG/L						
Fluoride	4.0(M)	2.0(G)	0.39	0.48	0.36	0.35
Chloride MG/L						
Chloride	250.0(G)		20.0	18.0	30.0	9.9
Nitrate MG/L						
Nitrate + Nitrite	10.0(M)		1.1		0.97	
Nitrate, colorimetric				0.29		0.65
Orthophosphate MG/L						
Orthophosphate	ND	(0.020)	0.090	(0.020)	ND	(0.020)
Sulfate MG/L						
Sulfate, nephelometry	250.0(G)		69.0E	110.0	61.0	75.0
Metals MG/L						
Arsenic, graphite AA	0.050(M)		0.015	0.056	0.0020	0.0080
Mercury	0.0020(M)		ND	(0.00012)	ND	(0.00012)
Lead, graphite AA	0.050(M)		0.015		0.0030	
Selenium, graphite AA	0.010(M)		ND	(0.0030)	MDR	(0.0030)
Metal Screen (ICP) MG/L						

D R A F T

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

Q: Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.

R: Indicates that the matrix spike recovery for this analysis was not within acceptance limits indicating an interferent present.

ND: Not detected at specified detection limit

( ): Detection limit

10/10/88

TABLE 4.2.2-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 4 (LANDFILL 4), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well			
	Sample ID			
	Date Sampled			
	4A	4A	4B	4B
EPA Standards,	02-157	04-06	02-156	04-09
Criteria	25-Feb-88	06-Apr-88	25-Feb-88	06-Apr-88
Ag Silver	ND (0.0090)	ND (0.0090)	ND (0.0090)	ND (0.0090)
Al Aluminum	15.0 (0.20)	120.0 (0.20)	1.9 (0.20)	14.0 (0.20)
As Arsenic	ND (0.30)	2.0 (0.015)	ND (0.30)	ND (0.015)
B Boron	ND (0.60)	ND (0.60)	ND (0.60)	ND (0.60)
Ba Barium	0.14 (0.0090)	0.46 (0.0090)	0.086 (0.0090)	0.16 (0.0090)
Be Beryllium	ND (0.0010)	0.0040 (0.0010)	ND (0.0010)	ND (0.0010)
Ca Calcium	270.0 (0.060)	1800.0 (0.60)	110.0 (0.060)	400.0 (0.060)
Cd Cadmium	ND (0.0030)	0.0040 (0.0030)	ND (0.0030)	ND (0.0030)
Co Cobalt	0.012 (0.010)	0.040 (0.010)	ND (0.010)	ND (0.010)
Cr Chromium	0.037 (0.0090)	0.21 (0.0090)	0.012 (0.0090)	0.038 (0.0090)
Cu Copper	0.044 (0.010)	0.090 (0.010)	ND (0.010)	ND (0.010)
Fe Iron	17.0 (0.030)	140.0 (0.030)	2.7 (0.030)	13.0 (0.030)
K Potassium	2.9 (0.30)	19.0 (0.30)	0.82 (0.30)	3.4 (0.30)
Mg Magnesium	8.0 (0.10)	37.0 (0.10)	4.0 (0.10)	8.5 (0.10)
Mn Manganese	0.72 (0.0030)	2.6 (0.0030)	0.27 (0.0030)	0.79 (0.0030)
Mo Molybdenum	ND (0.050)	ND (0.050)	ND (0.050)	ND (0.050)
Na Sodium	25.0 (0.080)	25.0 (0.080)	22.0 (0.080)	28.0 (0.080)
Ni Nickel	ND (0.020)	0.14 (0.020)	ND (0.020)	ND (0.020)
Pb Lead	ND (0.050)	0.16 (0.050)	ND (0.050)	ND (0.050)
Sb Antimony	0.11 (0.060)	0.25 (0.060)	0.094 (0.060)	ND (0.060)
Se Selenium	ND (0.30)	ND (0.30)	ND (0.30)	ND (0.30)
Si Silicon	39.0 (0.30)	82.0 (0.30)	7.5 (0.30)	29.0 (0.30)
Tl Thallium	ND (0.090)	ND (0.090)	ND (0.090)	ND (0.090)
V Vanadium	0.054 (0.020)	0.35 (0.020)	ND (0.020)	0.040 (0.020)
Zn Zinc	0.043 (0.0060)	0.21 (0.0060)	0.0080 (0.0060)	ND (0.0060)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

Q: Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.

R: Indicates that the matrix spike recovery for this analysis was not within acceptance limits indicating an interferent present.

ND: Not detected at specified detection limit

( ) : Detection limit

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TABLE 4.2.2-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 4 (LANDFILL 4), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well			
	Sample ID			
	Date Sampled			
	4C	4C	4D	4D
	02-164	04-26	03-33	04-36
EPA Standards,	08-Apr-88	04-Mar-88		12-Apr-88
Criteria	MD	MD	MD	MD
Selenium, graphite AA	0.010(M)	(0.0030)	(0.0050)	(0.020)
Metal Screen (ICP) MG/L				
Ag Silver	0.016	(0.0090)	ND	(0.0090)
Al Aluminum	82.0	(0.20)	34.0	(0.20)
As Arsenic	ND	(0.30)	ND	(0.30)
B Boron	ND	(0.60)	ND	(0.60)
Ba Barium	0.38	(0.0090)	0.33	(0.0090)
Be Beryllium	0.011	(0.0010)	0.0056	(0.0010)
Ca Calcium	2600.0	(0.60)	2500.0	(0.60)
Cd Cadmium	0.0080	(0.0030)	0.0060	(0.0030)
Co Cobalt	0.040	(0.010)	0.020	(0.010)
Cr Chromium	0.22	(0.0090)	0.17	(0.0090)
Cu Copper	0.12	(0.010)	0.080	(0.010)
Fe Iron	180.0	(0.030)	41.0	(0.030)
K Potassium	12.0	(0.30)	3.6	(0.30)
Mg Magnesium	35.0	(0.10)	29.0	(0.10)
Mn Manganese	4.5	(0.0030)	4.0	(0.0030)
Mo Molybdenum	ND	(0.050)	ND	(0.050)
Na Sodium	47.0	(0.080)	47.0	(0.080)
Ni Nickel	0.13	(0.020)	0.080	(0.020)
Pb Lead	0.21	(0.050)	0.10	(0.050)
Sb Antimony	0.38^	(0.060)	0.39	(0.060)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

Q: Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.

B: Detected in Reagent Blank; background subtraction not performed

R: Indicates that the matrix spike recovery for this analysis was not within acceptance limits indicating an interferent present.

R': Matrix spike and duplicate analysis results were not within control limits indicating potential matrix interference.

^: Indicates duplicate analysis is not within control limits.

ND: Not detected at specified detection limit

( ): Detection limit

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TABLE 4.2.2-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 4 (LANDFILL 4), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	Monitor Well			
	Sample ID			
	Date Sampled			
	4C	4C	4D	4D
	02-164	04-26	03-33	04-36
	29-Feb-88	08-Apr-88	04-Mar-88	12-Apr-88
EPA Standards, Criteria	0.40 (0.30)	0.40 (0.30)	0.34R (0.30)	MD (0.30)
Se	0.40	0.40	0.34R	MD
Si	81.0	58.0	130.0B	48.0
Tl	ND	ND	0.11R	0.090
V	0.56	0.28	0.91	0.25
Zn	0.24	0.14	0.34	0.094
	5.0(G)	5.0(G)	0.0060	0.0060

- D R A F T -

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

- @: Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.
- B: Detected in Reagent Blank; background subtraction not performed
- R: Indicates that the matrix spike recovery for this analysis was not within acceptance limits indicating an interferent present.
- R\*: Matrix spike and duplicate analysis results were not within control limits indicating potential matrix interference.
- ^: Indicates duplicate analysis is not within control limits.
- ND: Not detected at specified detection limit
- ( ): Detection limit

TABLE 4.2.2-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 4 (LANDFILL 4), CARSHILL AFB, TEXAS.

PARAMETER	Monitor Well			
	EPA Standards, Criteria	4E 03-32 04-Mar-88	4E 04-35 11-Apr-88	4E 03-31 04-Mar-88
Total Dissolved Solids MG/L	550.0 (1.0)	540.0 (1.0)	640.0 (1.0)	530.0 (1.0)
Fluoride MG/L	4.0(M)	2.0(G)	0.26@	0.31
Chloride MG/L	250.0(G)	18.0	30.0	21.0
Nitrate MG/L	10.0(M)	4.0	5.2	3.8
Orthophosphate MG/L	0.050 (0.020)	0.080 (0.020)	0.060 (0.020)	0.13 (0.020)
Sulfate MG/L	250.0(G)	50.0	54.0	47.0
Metals MG/L				
Arsenic, graphite AA	0.050(M)	0.0060	0.015	0.0060R
Mercury	0.0020(M)	ND (0.00012)	ND (0.00012)	ND (0.00012)
Selenium, graphite AA	0.010(M)	ND (0.0050)	ND (0.0050)	ND (0.0050)
Metal Screen (ICP) MG/L				

- D R A F T -

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

@: Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.

B: Detected in Reagent Blank; background subtraction not performed

R: Indicates that the matrix spike recovery for this analysis was not within acceptance limits indicating an interferent present.

ND: Not detected at specified detection limit

( ): Detection limit

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TABLE 4.2.2-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 4 (LANDFILL 4), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well			
	Sample ID			
	Date Sampled			
	4F	4C	4C	4C
	04-39	02-166	02-167	04-30
	12-Apr-88	29-Feb-88	29-Feb-88	11-Apr-88
EPA Standards, Criteria	0.050(M)	0.050(M)	0.050(M)	0.050(M)
As	ND	ND	ND	ND
B	0.84	ND	ND	ND
Ba	0.11	1.2	1.2	0.39
Be	ND	0.025	0.026	0.0030
Ca	240.0	4000.0	4100.0	1200.0
Cd	ND	0.013	0.025	ND
Co	ND	0.12	0.12	0.030
Cr	ND	0.41	0.44	0.12
Cu	0.041	0.26	0.27	0.060
Fe	8.5	340.0	360.0	55.0
K	2.5	32.0	36.0	6.1
Mg	6.5	57.0	61.0	19.0
Mn	0.14	9.1	9.3	2.2
Mo	ND	ND	ND	ND
Na	23.0	26.0	25.0	28.0
Ni	ND	0.34	0.38	0.080
Pb	ND	0.40	0.39	0.080
Sb	ND	0.50	0.50	0.14
Se	ND	1.0	0.90	ND
Si	18.0	67.0	47.0	50.0
Tl	ND	ND	ND	ND
V	0.036	0.95	1.0	0.20
Zn	0.021	0.54	0.53	0.12

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard

(Refer to Tables 4.1-1 and 4.1-2).

ND: Not detected at specified detection limit

( ): Detection limit

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TABLE 4.2.2-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 4 (LANDFILL 4), CARSWELL AFB, TEXAS.

PARAMETER	4E		4B		P2	
	EPA Standards, Criteria	02-165 29-Feb-88	04-27 11-Apr-88	02-155 25-Feb-88	04-11 06-Apr-88	
Total Dissolved Solids MG/L		660.0 (1.0)	600.0 (1.0)	390.0 (1.0)	350.0 (1.0)	
Fluoride MG/L						
Fluoride	4.0(M) 2.0(G)	0.28	0.27	0.14	0.13	
Chloride MG/L						
Chloride	250.0(G)	20.0	30.0	20.0	21.0	
Nitrate MG/L						
Nitrate + Nitrite	10.0(M)	1.3E		ND (0.020)	ND (0.020)	ND (0.020)
Nitrate, colorimetric			4.3			
Orthophosphate MG/L						
Orthophosphate		ND (0.020)	0.050 (0.020)	ND (0.020)	0.020 (0.020)	
Sulfate MG/L						
Sulfate, nephelometry	250.0(G)	59.0	55.0	46.0	49.0	
Metals MG/L						
Arsenic, graphite AA	0.050(M)	0.028R+	0.047	ND (0.0020)	ND (0.0020)	
Mercury	0.0020(M)	ND	ND (0.00012)	ND (0.00012)	ND (0.00012)	
Lead, graphite AA	0.050(M)	0.017		ND (0.0020)	ND (0.0020)	
Selenium, graphite AA	0.010(M)	RDR (0.0030)	ND (0.0050)	0.0040	ND (0.0030)	

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

E: Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.

R: Indicates that the matrix spike recovery for this analysis was not within acceptance limits indicating an interferent present.

R+: Matrix spike recovery and % difference (MS and MS dup) outside control limits.

ND: Not detected at specified detection limit

( ): Detection Limit

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TABLE 4.2.2-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 4 (LANDFILL 4), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards,		Criteria		4H		P2	
	02-165	29-Feb-88	11-Apr-88	04-27	02-155	25-Feb-88	04-11	06-Apr-88
Metal Screen (ICP) MG/L	0.013	(0.0090)	ND	(0.0090)	ND	(0.0090)	ND	(0.0090)
Ag Silver	37.0R	(0.20)	17.0	(0.20)	ND	(0.20)	ND	(0.20)
Al Aluminum	ND	(0.30)	ND	(0.30)	ND	(0.30)	ND	(0.15)
As Arsenic	ND	(0.60)	ND	(0.60)	ND	(0.60)	ND	(0.60)
B Boron	0.44	(0.0090)	0.38	(0.0090)	0.35	(0.0090)	0.028	(0.0090)
Ba Barium	0.0050	(0.0010)	0.0020	(0.0010)	ND	(0.0010)	ND	(0.0010)
Be Beryllium	720.0	(0.060)	660.0	(0.060)	11.0	(0.060)	13.0	(0.060)
Ca Calcium	ND	(0.0030)	ND	(0.0030)	ND	(0.0030)	ND	(0.0030)
Cd Cadmium	0.010	(0.010)	0.010	(0.010)	ND	(0.010)	ND	(0.010)
Co Cobalt	0.12	(0.0090)	0.079	(0.0090)	ND	(0.0090)	ND	(0.0090)
Cr Chromium	0.050	(0.010)	0.040	(0.010)	ND	(0.010)	ND	(0.010)
Cu Copper	73.0	(0.030)	26.0	(0.030)	ND	(0.030)	ND	(0.030)
Fe Iron	8.5	(0.30)	5.4	(0.30)	3.1	(0.30)	3.6	(0.30)
K Potassium	16.0	(0.10)	13.0	(0.10)	3.8	(0.10)	4.0	(0.10)
Mg Magnesium	3.6	(0.0030)	2.5	(0.0030)	0.0070	(0.0030)	0.0080	(0.0030)
Mn Manganese	ND	(0.050)	ND	(0.050)	ND	(0.050)	ND	(0.050)
Mo Molybdenum	30.0	(0.080)	28.0	(0.080)	110.0	(0.080)	110.0	(0.080)
Na Sodium	0.080	(0.020)	0.050	(0.020)	ND	(0.020)	ND	(0.020)
Ni Nickel	ND	(0.050)	ND	(0.050)	ND	(0.050)	ND	(0.050)
Pb Lead	0.15	(0.060)	0.10	(0.060)	0.11	(0.060)	ND	(0.060)
Sb Antimony	ND	(0.30)	ND	(0.30)	ND	(0.30)	ND	(0.30)
Se Selenium	57.0	(0.30)	35.0	(0.30)	6.0	(0.30)	5.4	(0.30)
Si Silicon	ND	(0.090)	0.10	(0.090)	ND	(0.090)	ND	(0.090)
Tl Thallium	0.20	(0.020)	0.12	(0.020)	ND	(0.020)	ND	(0.020)
V Vanadium								

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

R: Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.

R+: Indicates that the matrix spike recovery for this analysis was not within acceptance limits indicating an interferent present.

ND: Matrix spike recovery and % difference (MS and MS dup) outside control limits.

( ): Not detected at specified detection limit

( ): Detection Limit

TABLE 4.2.2-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 4 (LANDFILL 4), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	EPA Standards, Criteria	Monitor Well		Date Sampled	P2
		4H	4H		
Zn	5.0(G)	0.11	0.099	02-155	04-11
		(0.0060)	(0.0060)	25-Feb-88	06-Apr-88
				MD	(0.0060)
					0.026 (0.0060)

- D R A F T -

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

@: Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.

R: Indicates that the matrix spike recovery for this analysis was not within acceptance limits indicating an interferent present.

R+: Matrix spike recovery and % difference (MS and MS dup) outside control limits.

ND: Not detected at specified detection limit

( ): Detection limit

Approved: \_\_\_\_\_  
Date: \_\_\_\_\_

TABLE 4.2.2-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 4 (LANDFILL 4), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards, Criteria	Monitor Well			
		Sample ID			
		4A	4B	4B	4B
	02-157	04-06	02-156	04-09	
	25-Feb-88	06-Apr-88	25-Feb-88	06-Apr-88	
Purgeable Halocarbons UG/L					
1,1,1-Trichloroethane	200.0(M)	0.90	ND	ND	ND
1,1,2,2-Tetrachloroethane		ND	ND	ND	ND
1,1,2-Trichloroethane		ND	ND	ND	ND
1,1-Dichloroethane		1.5	1.1	ND	ND
1,1-Dichloroethene	7.0(M)	ND	0.40	ND	ND
1,2-Dichlorobenzene	620.0(G)	ND	ND	ND	ND
1,2-Dichloroethane	5.0(M)	ND	ND	ND	ND
1,2-Dichloropropane		ND	ND	ND	ND
1,3-Dichlorobenzene	400.0(G)	ND	ND	ND	ND
1,4-Dichlorobenzene	750.0(M)	ND	ND	ND	ND
2-Chloroethylvinyl ether		ND	ND	ND	ND
Bromodichloromethane		ND	ND	ND	ND
Bromoform		ND	ND	ND	ND
Bromomethane		ND	ND	ND	ND
Carbon tetrachloride	5.0(M)	ND	ND	ND	ND
Chlorobenzene	60.0(G)	ND	ND	ND	ND
Chloroethane		ND	ND	ND	ND
Chloroform		ND	0.30	ND	ND
Chloromethane		ND	ND	ND	ND
Dibromochloromethane		NDQ	ND	NDQ	ND
Methylene chloride		ND	ND	ND	ND
Tetrachloroethene	8.0(G)	ND	ND	ND	ND
Trichloroethane	5.0(M)	0.70	0.40	ND	ND
Trichlorofluoromethane		ND	ND	ND	ND

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), C-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

A: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

B: Detected in Reagent Blank; background subtraction not performed

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ): Detection limit

TABLE 4.2.2-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 4 (LANDFILL 4), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well			
	Sample ID			
	Date Sampled			
	4A	4A	4B	4B
	02-157	04-06	02-156	04-09
EPA Standards,	06-Apr-88	25-Feb-88	25-Feb-88	06-Apr-88
Criteria	2.0(M)	0.0(G)	ND (0.20)	ND (0.20)
Vinyl chloride	ND	ND	ND	ND
cis-1,3-Dichloropropene	ND	ND	ND	ND
trans-1,2-Dichloroethene	70.0(G)	ND	ND	ND
trans-1,3-Dichloropropene	ND	ND	ND	ND
Purgeable Aromatics UG/L				
1,2-Dichlorobenzene	620.0(G)	ND	ND	ND
1,3-Dichlorobenzene	400.0(G)	ND	ND	ND
1,4-Dichlorobenzene	750.0(M)	750.0(G)	ND	ND
Benzene	5.0(M)	0.0(G)	ND	ND
Chlorobenzene	60.0(G)	ND	ND	ND
Ethylbenzene	680.0(G)	ND	ND	ND
Toluene	2000.0(G)	4.5	5.8	11.0
m-Xylene		ND	ND	ND
o-Xylene		ND	ND	ND
p-Xylene		ND	ND	ND
Extractable Priority Pollutants UG/L				
1,2,4-trichlorobenzene			ND	ND
1,2-dichlorobenzene			ND	ND
1,3-dichlorobenzene			ND	ND
1,4-dichlorobenzene			ND	ND
2,4,5-trichlorophenol	750.0(G)		ND	ND
2,4,6-trichlorophenol			ND	ND
2,4-dichlorophenol	3090.0(G)		ND	ND

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

- S: cis-1,3-Dichloropropene cannot be quantitated due to coelution.
- B: Detected in Reagent Blank; background subtraction not performed
- Q: Daily EPA QC recovery outside 95% confidence limit.
- ND: Not detected at specified detection limit
- ( ): Detection limit

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TABLE 4.2.2-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 4 (LANDFILL 4), CARSWELL AFB, TEXAS.

- D R A F T -

PARAMETER	EPA Standards,		Criteria		Monitor Well	
	4A	4B	4A	4B	Sample ID	Date Sampled
	400.0(G)		06-Apr-88	25-Feb-88		06-Apr-88
2,4-dimethylphenol			ND (2.7)	ND (2.7)		
2,4-dinitrophenol			ND (42.0)	ND (42.0)		
2,4-dinitrotoluene			ND (5.7)	ND (5.7)		
2,6-dinitrotoluene			ND (1.9)	ND (1.9)		
2-chloronaphthalene			ND (1.9)	ND (1.9)		
2-chlorophenol			ND (3.3)	ND (3.3)		
2-methylnaphthalene			ND (10.0)	ND (10.0)		
2-methylphenol			ND (10.0)	ND (10.0)		
2-nitroaniline			ND (50.0)	ND (50.0)		
2-nitrophenol			ND (3.6)	ND (3.6)		
3,3'-dichlorobenzidine			ND (17.0)	ND (17.0)		
4,6-dinitro-2-methylphenol			ND (24.0)	ND (24.0)		
4-bromophenyl-phenylether			ND (1.9)	ND (1.9)		
4-chloro-3-methylphenol			ND (3.0)	ND (3.0)		
4-chloroaniline			ND (10.0)	ND (10.0)		
4-chlorophenyl-phenylether			ND (4.2)	ND (4.2)		
4-methylphenol			ND (10.0)	ND (10.0)		
4-nitroaniline			ND (50.0)	ND (50.0)		
4-nitrophenol			ND (2.4)	ND (2.4)		
acenaphthene	0.030(G)		ND (1.9)	ND (1.9)		
acenaphthylene			ND (3.5)	ND (3.5)		
aniline			ND (10.0)	ND (10.0)		
anthracene			ND (1.9)	ND (1.9)		
benzidine			ND (44.0)	ND (44.0)		
benzo(a)anthracene			ND (7.8)	ND (7.8)		

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

4: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

B: Detected in Reagent Blank; background subtraction not performed

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ): Detection limit

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TABLE 4.2.2-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 4 (LANDFILL 4), CARSWELL AFB, TEXAS.

- D R A F T -

PARAMETER	EPA Standards,		Monitor Well	
	4A	4A	4B	4B
	02-157	04-06	02-156	04-09
	25-Feb-88	06-Apr-88	25-Feb-88	06-Apr-88
	Criteria			
benzo(a)pyrene		ND	(2.5)	ND (2.5)
benzo(b)fluoranthene		ND	(4.8)	ND (4.8)
benzo(g,h,i)perylene		ND	(4.1)	ND (4.1)
benzo(k)fluoranthene		ND	(2.5)	ND (2.5)
benzoic acid		ND	(50.0)	ND (50.0)
benzyl alcohol		ND	(50.0)	ND (50.0)
bis(2-chloroethoxy)methane		ND	(5.3)	ND (5.3)
bis(2-chloroethyl) ether		ND	(5.7)	ND (5.7)
bis(2-chloroisopropyl) ether		ND	(5.7)	ND (5.7)
bis(2-ethylhexyl)phthalate	15000.0(G)	4.28	(2.5)	6.0 (2.5)
butylbenzylphthalate	940.0(G)	ND	(2.5)	ND (2.5)
chrysene	35000.0(G)	7.68	(2.5)	4.68 (2.5)
di-n-butylphthalate		ND	(2.5)	ND (2.5)
di-n-octyl phthalate		ND	(2.5)	ND (2.5)
dibenzo(a,h)anthracene		ND	(2.5)	ND (2.5)
dibenzofuran		ND	(10.0)	ND (10.0)
diethylphthalate		ND	(1.9)	ND (1.9)
dimethyl phthalate		ND	(1.6)	ND (1.6)
fluoranthene	0.030(G)	ND	(2.2)	ND (2.2)
fluorene	0.030(G)	ND	(1.9)	ND (1.9)
hexachlorobenzene		ND	(1.9)	ND (1.9)
hexachlorobutadiene		ND	(0.90)	ND (0.90)
hexachlorocyclopentadiene		ND	(6.0)	ND (6.0)
hexachloroethane		ND	(1.6)	ND (1.6)
Indeno(1,2,3-cd)pyrene		ND	(3.7)	ND (3.7)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

S: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

B: Detected in Reagent Blank; background subtraction not performed

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ): Detection limit

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TABLE 4.2.2-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 4 (LANDFILL 4), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	EPA Standards, Criteria		Monitor Well Sample ID		Date Sampled
	4A	4B	4A	4B	
isophorone	5200.0(G)		MD (2.2)	MD (2.2)	06-Apr-88
n-nitroso-di-n-propylamine			MD (12.0)	MD (12.0)	02-156
n-nitrosodimethylamine			MD (10.0)	MD (10.0)	04-09
n-nitrosodiphenylamine			MD (1.9)	MD (1.9)	06-Apr-88
naphthalene	620.0(G)		MD (1.6)	MD (1.6)	
nitrobenzene			MD (1.9)	MD (1.9)	
pentachlorophenol	200.0(G)		MD (3.6)	MD (3.6)	
phenanthrene	0.030(G)		MD (5.4)	MD (5.4)	
phenol	3500.0(G)		MD (1.5)	MD (1.5)	
pyrene	0.030(G)		MD (1.9)	MD (1.9)	

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

±: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

B: Detected in Reagent Blank; background subtraction not performed

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ) : Detection limit

TABLE 4.2.2-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 4 (LANDFILL 4), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well			
	Sample ID			
	Date Sampled			
	4C	4C	4D	4D
EPA Standards,	02-164	04-26	03-33	04-36
Criteria	29-Feb-88	08-Apr-88	04-Mar-88	12-Apr-88
Purgeable Halocarbons UC/L				
1,1,1-Trichloroethane	200.0(M)	200.0(G)	ND (0.45)	ND (45.0)
1,1,2,2-Tetrachloroethane			ND (0.60)	ND (60.0)
1,1,2-Trichloroethane			ND (0.35)	ND (35.0)
1,1-Dichloroethane			ND (0.45)	ND (45.0)
1,1-Dichloroethene	7.0(M)	7.0(G)	ND (0.50)	ND (50.0)
1,2-Dichlorobenzene	620.0(G)		ND (2.5)	ND (250.0)
1,2-Dichloroethane	5.0(M)	0.0(G)	ND (0.15)	ND (15.0)
1,2-Dichloropropane			ND (0.50)	ND (50.0)
1,3-Dichlorobenzene	400.0(G)		ND (1.5)	ND (150.0)
1,4-Dichlorobenzene	750.0(M)	750.0(G)	6.3 (2.0)	ND (200.0)
2-Chloroethylvinyl ether			ND (1.0)	ND (100.0)
Bromodichloromethane			ND (0.50)	ND (50.0)
Bromoform			ND (1.5)	ND (150.0)
Bromomethane			ND (6.0)	ND (600.0)
Carbon tetrachloride	5.0(M)	0.0(G)	ND (0.50)	ND (50.0)
Chlorobenzene	60.0(G)		ND (1.5)	ND (150.0)
Chloroethane			ND (2.5)	ND (250.0)
Chloroform			ND (0.25)	ND (25.0)
Chloromethane			ND (1.5)	ND (150.0)
Dibromochloromethane			ND (1.0)	ND (100.0)
Methylene chloride			ND (1.5)	ND (150.0)
Tetrachloroethene	8.0(G)		4.6 (0.15)	ND (15.0)
Trichloroethene	5.0(M)	0.0(G)	23.0 (1.0)	3300.0 (100.0)
Trichlorofluoromethane			ND (0.50)	ND (50.0)
Vinyl chloride	2.0(M)	0.0(G)	1.6 (1.0)	ND (100.0)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

±: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

@: Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.

ND: Not detected at specified detection limit

( ): Detection limit

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TABLE 4.2-2-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 4 (LANDFILL 4), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	EPA Standards, Criteria	Monitor Well			
		4C 02-164 29-Feb-88	4C 04-26 08-Apr-88	4D 03-33 04-Mar-88	4D 04-36 12-Apr-88
cis-1,3-Dichloropropene	70.0(G)	ND <sup>1</sup>	ND <sup>1</sup>	ND <sup>1</sup>	ND <sup>1</sup>
trans-1,2-Dichloroethene		ND (1.0)	ND (1.0)	ND (100.0)	ND (100.0)
trans-1,3-Dichloropropene		ND (1.5)	ND (1.5)	ND (150.0)	ND (150.0)
Purgeable Aromatics UG/L					
1,2-Dichlorobenzene	620.0(G)	0.70 (0.40)	ND (0.40)	ND (40.0)	ND (40.0)
1,3-Dichlorobenzene	400.0(G)	ND (0.40)	ND (0.40)	ND (40.0)	ND (40.0)
1,4-Dichlorobenzene	750.0(M)	5.8 (0.30)	5.0 (0.30)	ND (30.0)	ND (30.0)
Benzene	5.0(M)	19.0 (0.20)	ND (0.20)	ND (20.0)	ND (20.0)
Chlorobenzene	60.0(G)	2.2 (0.30)	2.8 (0.30)	ND (30.0)	ND (30.0)
Ethylbenzene	680.0(G)	ND (0.30)	ND (0.30)	ND (30.0)	ND (30.0)
Toluene	2000.0(G)	4.4 (0.20)	27.0 (0.20)	ND (20.0)	ND (20.0)
m-Xylene		ND (0.20)	ND (0.20)	ND (20.0)	ND (20.0)
o-Xylene		ND (0.10)	ND (0.10)	ND (10.0)	ND (10.0)
p-Xylene		ND (0.20)	ND (0.20)	ND <sup>2</sup> (20.0)	ND <sup>2</sup> (20.0)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

1: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

2: Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.

ND: Not detected at specified detection limit

( ): Detection limit

TABLE 4.2.2-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 4 (LANDFILL 4), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well			
	Sample ID			
	Date Sampled			
	4E	4E	4E	4F
	03-32	04-35	03-31	04-38
	04-Mar-88	11-Apr-88	04-Mar-88	12-Apr-88
EPA Standards,	4E	4E	4E	4E
Criteria	03-32	04-35	03-31	04-38
Purgeable Halocarbons UC/L				
1,1,1-Trichloroethane	200.0(M)	200.0(G)	ND (45.0)	ND (45.0)
1,1,2,2-Tetrachloroethane			ND (60.0)	ND (60.0)
1,1,2-Trichloroethane			ND (35.0)	ND (35.0)
1,1-Dichloroethane			ND (45.0)	ND (45.0)
1,1-Dichloroethene	7.0(M)	7.0(G)	ND (50.0)	ND (50.0)
1,2-Dichlorobenzene	620.0(G)		ND (250.0)	ND (250.0)
1,2-Dichloroethane	5.0(M)	0.0(G)	ND (15.0)	ND (15.0)
1,2-Dichloropropane			ND (50.0)	ND (50.0)
1,3-Dichlorobenzene	400.0(G)		ND (150.0)	ND (150.0)
1,4-Dichlorobenzene	750.0(M)	750.0(G)	ND (200.0)	ND (200.0)
2-Chloroethylvinyl ether			ND (100.0)	ND (100.0)
Bromodichloromethane			ND (50.0)	ND (50.0)
Bromoform			ND (150.0)	ND (150.0)
Bromomethane			ND (600.0)	ND (600.0)
Carbon tetrachloride	5.0(M)	0.0(G)	ND (50.0)	ND (50.0)
Chlorobenzene	60.0(G)		ND (150.0)	ND (150.0)
Chloroethane			ND (250.0)	ND (250.0)
Chloroform			ND (25.0)	ND (25.0)
Chloromethane			ND (150.0)	ND (150.0)
Dibromochloromethane			ND (100.0)	ND (100.0)
Methylene chloride			ND (150.0)	ND (150.0)
Tetrachloroethene	8.0(G)		ND (15.0)	ND (15.0)
Trichloroethene	5.0(M)	0.0(G)	4000.0 (100.0)	4200.0 (100.0)
Trichlorofluoromethane			ND (50.0)	ND (50.0)
Vinyl chloride	2.0(M)	0.0(G)	ND (100.0)	ND (100.0)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

†: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

‡: Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.

ND: Not detected at specified detection limit

( ): Detection limit

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TABLE 4.2.2-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 4 (LANDFILL 4), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards, Criteria	Monitor Well			
		Sample ID	Date Sampled	Sample ID	Date Sampled
		4E	4E	4E	4F
		03-32	04-35	03-31	04-38
		01-Mar-88	11-Apr-88	04-Mar-88	12-Apr-88
		NDL	NDL	NDL	NDL
cis-1,3-Dichloropropene		ND	ND	ND	ND
trans-1,2-Dichloroethene	70.0(G)	(100.0)	(100.0)	(100.0)	(100.0)
trans-1,3-Dichloropropene		(150.0)	(150.0)	(150.0)	(150.0)
Purgesble Aromatics UG/L					
1,2-Dichlorobenzene	620.0(G)	(40.0)	(40.0)	(40.0)	(40.0)
1,3-Dichlorobenzene	400.0(G)	(40.0)	(40.0)	(40.0)	(40.0)
1,4-Dichlorobenzene	750.0(M)	750.0(G)	(30.0)	(30.0)	(30.0)
Benzene	5.0(M)	0.0(G)	(20.0)	(20.0)	(20.0)
Chlorobenzene	60.0(G)	(30.0)	(30.0)	(30.0)	(30.0)
Ethylbenzene	680.0(G)	(30.0)	(30.0)	(30.0)	(30.0)
Toluene	2000.0(G)	(20.0)	(20.0)	(20.0)	(20.0)
m-Xylene		(20.0)	(20.0)	(20.0)	(20.0)
o-Xylene		(10.0)	(10.0)	(10.0)	(10.0)
p-Xylene		(20.0)	(20.0)	(20.0)	(20.0)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), C-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

Ⓢ: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

Ⓢ: Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.

ND: Not detected at specified detection limit

( ): Detection limit



TABLE 4.2.2-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 4 (LANDFILL 4), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well			
	Sample ID			
	Date Sampled			
	AF	AG	AG	AG
	04-39	02-166	02-167	04-30
	12-Apr-88	29-Feb-88	29-Feb-88	11-Apr-88
EPA Standards,	04-39	02-166	02-167	04-30
Criteria	12-Apr-88	29-Feb-88	29-Feb-88	11-Apr-88
Vinyl chloride	2.0(M)	0.0(G)	ND (100.0)	ND (100.0)
cis-1,3-Dichloropropene	ND	ND	ND	ND
trans-1,2-Dichloroethane	70.0(G)	ND (100.0)	ND	ND
trans-1,3-Dichloropropene	ND	ND (150.0)	ND	ND
Purgeable Aromatics UG/L				
1,2-Dichlorobenzene	620.0(G)	ND (40.0)	ND	ND
1,3-Dichlorobenzene	400.0(G)	ND (40.0)	ND	ND
1,4-Dichlorobenzene	750.0(M)	750.0(G)	ND	ND
Benzene	5.0(M)	0.0(G)	290.0	ND
Chlorobenzene	60.0(G)	ND (30.0)	ND	ND
Ethylbenzene	680.0(G)	ND (30.0)	ND	ND
Toluene	2000.0(G)	ND (20.0)	ND	ND
m-Xylene		ND (20.0)	ND	ND
o-Xylene		ND (10.0)	ND	ND
p-Xylene		ND (20.0)	NDQ	NDQ

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

±: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

ê: Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ): Detection limit

TABLE 4.2-2-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 4 (LANDFILL 4), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well			
	Sample ID			
	Data Sampled			
	4H	4H	P2	P2
	02-165	04-27	02-155	04-11
	29-Feb-88	11-Apr-88	25-Feb-88	06-Apr-88
EPA Standards,	4H	4H	P2	P2
Criteria	02-165	04-27	02-155	04-11
	29-Feb-88	11-Apr-88	25-Feb-88	06-Apr-88
Purgeable Halocarbons UG/L				
1,1,1-Trichloroethane	200.0(M)	200.0(G)	ND (45.0)	ND (0.090)
1,1,2,2-Tetrachloroethane			ND (60.0)	ND (0.12)
1,1,2-Trichloroethane			ND (35.0)	ND (0.070)
1,1-Dichloroethane			ND (45.0)	ND (0.090)
1,1-Dichloroethene	7.0(M)	7.0(G)	ND (50.0)	ND (0.10)
1,2-Dichlorobenzene	620.0(G)		ND (250.0)	ND (0.50)
1,2-Dichloroethane	5.0(M)	0.0(G)	ND (15.0)	ND (0.030)
1,2-Dichloropropane			ND (50.0)	ND (0.10)
1,3-Dichlorobenzene	400.0(G)		ND (150.0)	ND (0.30)
1,4-Dichlorobenzene	750.0(M)	750.0(G)	ND (200.0)	ND (0.40)
2-Chloroethylvinyl ether			ND (100.0)	ND (0.20)
Bromodichloromethane			ND (50.0)	ND (0.10)
Bromoform			ND (150.0)	ND (0.30)
Bromomethane			ND (600.0)	ND (1.2)
Carbon tetrachloride	5.0(M)	0.0(G)	ND (50.0)	ND (0.10)
Chlorobenzene	60.0(G)		ND (150.0)	ND (0.30)
Chloroethane			ND (250.0)	ND (0.50)
Chloroform			ND (25.0)	ND (0.050)
Chloromethane			ND (150.0)	ND (0.30)
Dibromochloromethane			ND (100.0)	ND (0.20)
Methylene chloride			ND (150.0)	ND (0.30)
Tetrachloroethane	8.0(G)		ND (15.0)	ND (0.30)
Trichloroethene	5.0(M)	0.0(G)	ND (100.0)	ND (0.030)
Trichlorofluoromethane			3300.0	ND (0.20)
			ND (50.0)	ND (0.10)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG), or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

‡: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

@: Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ): Detection limit

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TABLE 4.2.2-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 4 (LANDFILL 4), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well					
	4H		P2		P2	
	02-165	04-27	02-155	04-11	02-155	04-11
	EPA Standards,	11-Apr-88	25-Feb-88	06-Apr-88		
	Criteria	4H	P2	P2		
		02-165	04-27	02-155	04-11	
		29-Feb-88	11-Apr-88	25-Feb-88	06-Apr-88	
Vinyl chloride	2.0(M)	ND	ND (100.0)	ND (0.20)	ND (0.20)	
cis-1,3-Dichloropropene	ND	ND	ND	ND	ND	
trans-1,2-Dichloroethene	70.0(G)	ND	ND (100.0)	ND (0.20)	ND (0.20)	
trans-1,3-Dichloropropene	ND	ND	ND (150.0)	ND (0.30)	ND (0.30)	
Purgeable Aromatics UG/L						
1,2-Dichlorobenzene	620.0(G)	ND	ND (40.0)	ND (0.40)	ND (0.40)	
1,3-Dichlorobenzene	400.0(G)	ND	ND (40.0)	ND (0.40)	ND (0.40)	
1,4-Dichlorobenzene	750.0(H)	750.0(G)	ND (30.0)	ND (0.30)	ND (0.30)	
Benzene	5.0(M)	0.0(G)	ND (20.0)	ND (0.20)	ND (0.20)	
Chlorobenzene	60.0(G)	ND	1.9 (30.0)	ND (0.30)	ND (0.30)	
Ethylbenzene	680.0(G)	ND	ND (30.0)	ND (0.30)	ND (0.30)	
Toluene	2000.0(G)	ND	1.9 (20.0)	5.0 (0.20)	2.0 (0.20)	
m-Xylene		ND	ND (0.20)	ND (0.20)	ND (0.20)	
o-Xylene		ND	ND (0.10)	ND (0.10)	ND (0.10)	
p-Xylene		NDQ	ND (0.20)	NDQ	ND (0.20)	

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), C-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard

(Refer to Tables 4.1-1 and 4.1-2).

S: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

Q: Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.

ND: Not detected at specified detection limit.

( ): Detection limit

chemistry results are provided in Table 4.2.2-5. Samples were analyzed for water quality indicators, heavy metals, purgeable halocarbons, purgeable aromatics, and extractable priority pollutants. A summary of these results is provided in the following paragraphs.

Water Quality Indicators--Total dissolved solids (TDS) ranged from 430 mg/L to 920 mg/L, with the highest value in the first sampling round from well 4G. Paluxy well P2 averaged 370 mg/L TDS over the two sampling rounds. Fluoride, chloride, nitrate, and orthophosphate values varied slightly from the first to second sampling rounds. Sulfate concentrations increased in every well, except 4H, from the first to second sampling event.

Heavy Metals--Regulatory (MCL) standards (Table 4.1-1) were exceeded during Round 1 for lead (4C, 4D, 4G), chromium (4C, 4D, 4E, 4F, 4G, 4H), barium (4D, 4G), and cadmium (4D, 4G). Round 2 sampling results showed that arsenic (4A, 4C, 4G), lead (4A, 4C), chromium (4A, 4C, 4G, 4H), and barium (4D) concentrations surpassed MCLs. All water samples from the upper zone had concentrations of iron and manganese that exceeded MCLGs.

The metals concentrations in water at Site 4 shows definite patterns from the first to second sampling rounds. Upgradient wells, 4A and 4B, showed increases in metals concentrations for most parameters. Well 4E appeared to have fairly constant metals concentrations in the ground water. All other upper zone wells at Site 4 revealed decreasing metals concentrations from the first to the second sampling rounds.

Ground water sampled from Paluxy well P2 did not exceed MCLs or MCLGs for inorganic or organic constituents during either sampling round.

Purgeable Halocarbons--With the exception of well 4B, purgeable halocarbons were detected in every upper zone monitor well at Landfill 4. The principal halocarbon was TCE, with values ranging from not detected (ND) at 4B to 4,200 µg/L at 4F. There was no apparent trend in TCE concentrations from



TABLE 4.2.2-5. RESULTS OF FIELD ANALYSES FOR WATER SAMPLES, SITE 4 (LANDFILL 4), CARSWELL AFB, TEXAS

Monitor Well

Sample ID

Date Sampled

Analyte

Unit of Measure

4B

4C

4C

02-156

02-164

04-26

25-Feb-88

29-Feb-88

08-Apr-88

Alkalinity	mg/L	1225.0	(5.0)	3075.0	(5.0)
Specific Conductance	µMOS/CM	610.0	(1.0)	999.0	(1.0)
Temperature	C	16.0	(1.0)	18.0	(1.0)
pH	S.U.	7.2	(0.010)	6.8	(0.010)
		6.6	(0.010)	6.4	(0.010)

- D R A F T -



TABLE 4.2.2-5. RESULTS OF FIELD ANALYSES FOR WATER SAMPLES, SITE 4 (LANDFILL 4), CARSWELL AFB, TEXAS

Monitor Well  
Sample ID  
Date Sampled

Analyte	Unit of Measure	4C	4C	4H	4H
		02-166	04-30	02-165	04-27
		29-Feb-88	11-Apr-88	29-Feb-88	11-Apr-88

Alkalinity	mg/L	865.0	1375.0	817.0	965.0
Specific Conductance	uMDS/cm	18.0	800.0	18.5	790.0
Temperature	C	7.0	19.0	7.2	17.0
pH	S.U.	(0.010)	5.0	(0.010)	5.0
		(1.0)	(5.0)	(1.0)	(5.0)
		(1.0)	(10.0)	(1.0)	(1.0)
		(0.010)	(1.0)	(1.0)	(1.0)
		(0.010)	(0.010)	(0.010)	(2.0)

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TABLE 4.2.2-5. RESULTS OF FIELD ANALYSES FOR WATER SAMPLES, SITE 4 (LANDFILL 4), CARSWELL AFB, TEXAS

Analyte	Unit of Measure	Monitor Well	
		Sample ID	Date Sampled
		P2	P2
		04-11	02-155
		06-Apr-88	25-Feb-88
Alkalinity	mg/L	295.0	(5.0)
Specific Conductance	uMHO/cm	560.0	(10.0)
Temperature	C	20.0	(1.0)
pH	S.U.	7.8	(0.010)
			8.1 (0.010)

Lead level at 100 mg/L

( ) : Deter Limit

the first to the second sampling rounds. Wells 4A (< 1 µg/L), 4B (ND), and 4C (27 µg/L) are the southernmost wells, generally upgradient of the site, and had the lowest TCE values. All upper zone wells at Landfill 4 north (downgradient) of 4C had TCE concentrations greater than 2,000 µg/L, exceeding the MCL of 5 µg/L. The only other compound surpassing MCLs for purgeable halocarbons at Site 4 was vinyl chloride, detected in both sampling rounds at 4C (1.6 and 3.8 µg/L). Other compounds detected in amounts less than 10 µg/L included tetrachloroethane, 1,1-dichloroethane, 1,1-dichloroethene, chloroform, 1,4-dichlorobenzene, and chlorobenzene.

No purgeable halocarbons were detected in Paluxy well P2.

Purgeable Aromatics--Toluene was detected in low levels (mostly less than 10 µg/L, but up to 27 µg/L) from five of the wells, including P2. These concentrations may be due to sample vial contamination documented in Section 4.5.2.2. Benzene was found exceeding MCLs in the first sampling round at well 4C (19.0 µg/L) and 4G (280 µg/L). However, the Round 1 value at 4G is questionable because it was not detected in a duplicate sample, and neither 4C or 4G ground-water samples contained benzene in the second sampling round. Other purgeable aromatics were detected at low levels, in both sampling rounds, primarily at monitor well 4C.

Extractable Priority Pollutants--Extractable priority pollutants were analyzed in ground water at 4B (Round 1) and at 4A (Round 2). Bis(2-ethylhexyl)phthalate and di-n-butylphthalate were detected in both samples at levels less than 10 µg/L and in reagent blanks.

#### 4.2.2.3 Significance of Findings

The principal effort for the Stage 2 field program at Site 4 was to define the extent of contamination in ground water in the upper zone. The following paragraphs contain a discussion of the significance of the findings for soil and ground-water contamination at Site 4.

Soil--Analysis of soil samples from the Stage 2 monitor wells installed on the base golf course, which was not affected by waste disposal activities, did not yield any evidence of contaminants in the upper zone above the water table. Below the water table, soil samples did yield evidence of contaminants associated with the plume of halogenated organic compounds in the ground water. Therefore, the main concern regarding possible contaminated soils in the vadose zone would be focused directly on Landfill 4 itself, not at golf course locations outside the landfill boundary.

Ground Water--The Stage 1 findings regarding the nature and occurrence of ground-water contaminants are supported by the Stage 2 results. The main conclusions of the Stage 2 program are:

1. The principal ground-water contaminant in the upper zone is trichloroethene (TCE).
2. TCE occurs in upper zone wells downgradient (generally east) of the landfill, but not (or in concentrations much less than MCL values) in upgradient wells south of the landfill.
3. Ground water in the Paluxy aquifer contains no halogenated or aromatic organic compounds. Levels of toluene in P2 samples may be attributed to trace amounts of toluene in sample containers, based on trip blank and ambient conditions blank results.

Zones of Contamination--The ground-water contamination at Landfill 4, and other Flightline Area sites, is best described in terms of TCE, which has consistently been detected in the upper zone. Figure 4.2.2-1 is a contour map of TCE concentrations in the upper zone for Flightline Area sites, including Landfill 4. The contour map illustrates a plume of TCE outlined by, but not limited to, the 1,000  $\mu\text{g/L}$  TCE contour line that encompasses much of Landfill 4, all of Site 10, the southern portion of Landfill 5, areas west of Landfill 5 and Site 10, and the golf course area east of the Flightline sites.



The size and shape of the TCE plume was consistent between sampling rounds, and also with the Stage 1 data. The center (i.e., highest concentrations of TCE) of the plume is at well 10B, north of Landfill 4. The western limit of the plume is not completely defined, since ground water from wells 5A and 5E is upgradient of all IRP sites and is within the plume. The eastern limit of the plume is also not completely defined; wells 5H, 5G, 4G, and 4H are within the plume such that the contour lines can not be "closed" to define the limit of the TCE.

Contaminant Migration--The RI/FS Stage 2 results indicate the following conclusions regarding the source and migration of contaminants at Landfill 4.

1. The plume of TCE in ground water detected in Site 4 wells is due to multiple sources, probably including Landfill 4. The occurrence of relatively low levels (compared to other down-gradient wells) of TCE in well 4C may be due to infiltration of surface water from a nearby tributary to Farmers Branch, since ground-water flow lines under Landfill 4 probably do not lead directly to well 4C. Alternatively, dispersion of contaminants in ground water and/or changing ground-water flowline orientation may be responsible for the presence of TCE at well 4C.

Levels of TCE in wells 4D, 4E, 4F, and 4H are probably due primarily to Landfill 4, with possible contributions from other sites. The disposal methods and types of waste materials believed to be at Landfill 4 are consistent with the types and amounts of contaminants observed in downgradient wells. TCE in 4G may also be due to a Landfill 5 area source, based on a review of the upper zone potentiometric surface and consideration of probably ground-water flow paths.

2. Although the downgradient limit of the TCE plume has not been completely defined by the current well configuration, the occurrence of TCE at Site 4 wells nearly 400 feet east of the

east boundary of the landfill (4G and 4H) is reasonable considering the prevailing direction of ground-water flow and the estimated ground-water flow rate in the upper zone. Since the ground-water flow rate in the upper zone is estimated to be approximately 0.2 feet per day, contaminants entrained in ground-water flow in the center of Landfill 4 would be able to reach the Site 4 downgradient wells in several years. With disposal operations at Landfill 4 taking place from 1956 to 1975, ground-water contaminants may be expected east of the current well system, assuming that the direction and rate of ground-water flow has remained constant over the last 30 years.

3. Contaminants in the upper zone ground water would not be expected to move off-base, since ground-water in the upper zone flows toward Farmers Branch or its tributaries, which are completely on base property. To determine if ground-water discharge was visible at the surface near Farmers Branch, a field survey of upper zone and bedrock outcrop at Farmers Branch was conducted in August 1988. The year 1988 was an extremely dry year in the Fort Worth area, such that stream flow and spring flow amounts were lower than normal. The survey indicated that the creek flows over limestone, with the south cut bank of the creek exposed in limestone. No seeps or springs in the limestone were observed, although a zone (approximately 40 feet long, several feet wide) of moist soil and green grass (in a field of otherwise dead grass) was observed at the contact between alluvial (upper zone) and bedrock material at the south side of Farmers Branch above 400 feet south of Bldg. 233. Thus, upper zone ground water (and contaminants, if present) probably is discharged to the land surface within the base directly by evaporation or evapotranspiration in a diffuse seepage zone where the alluvial materials pinch out and disappear at Farmers Branch.

4.2.2.4 Baseline Risk Assessment

Summary of Indicator Chemicals

Results of the Stage 2 investigation indicate the presence of these indicator chemicals in at least one soil and/or ground water sample at the site:

<u>Metals</u>	<u>PNAs</u>	<u>VOCs</u>
Antimony	Bis(2-ethylhexyl)-	Benzene
Arsenic	phthalate	Chloroform
Barium		Methylene chloride
Beryllium		Tetrachloroethene
Cadmium		Toluene
Chromium		Trichloroethene
Lead		Vinyl chloride
Nickel		
Selenium		
Silver		

Tables 3.8-2, 3.8-3, and 3.8-4 in Section 3.8 present important physical, chemical, and biological characteristics for these and all other indicator chemicals.

Some of the above indicator chemicals, particularly those at very low concentrations, may be due in part to matrix interferences or sample vial contamination. Nevertheless, these chemicals were included in the risk assessment process in order to ensure a conservative (stringent-case) evaluation of possible health risks.

Source and Release Characterization

Possible sources of contaminant release from Landfill 4, as for Landfill 3, include: 1) volatilization to the air, 2) fugitive dust generation, 3) recharge to ground water, 4) surface runoff, and 5) direct release to surface water.

Volatilization to the Air--VOCs present in the soil are subject to volatilization to the air by virtue of high vapor pressures. PNAs generally have very low vapor pressures and are not subject to volatilization. Most metals are nonvolatile as well. Indicator chemicals detected at the site which can volatilize include benzene, chloroform, methylene chloride, tetrachloroethene, toluene, trichloroethene, and vinyl chloride.

Estimated emission rates based conservatively on maximum concentrations detected in the soil or ground water at the site are:

<u>Indicator Chemical</u>	<u>Emission Rate</u> <u>(grams/second)</u>
Benzene	$2.25 \times 10^{-5}$
Chloroform	$1.58 \times 10^{-6}$
Methylene chloride	$2.85 \times 10^{-5}$
Tetrachloroethene	$1.25 \times 10^{-7}$
Toluene	$6.79 \times 10^{-7}$
Trichloroethene	$3.22 \times 10^{-4}$
Vinyl chloride	$8.48 \times 10^{-6}$

The methodology used to estimate emission rates is described in Section 3.8.

Fugitive Dust Generation--Contaminants must be present in surface soil uncovered by impervious materials or vegetation to be subject to fugitive dust generation. Because wastes are buried at Landfill 4 and the surface is vegetated, contaminants present in the subsoil at this site are not subject to significant fugitive dust generation.

Recharge to Ground Water--Indicator chemicals detected in the ground water downgradient of Landfill 4 include: antimony, arsenic, barium, beryllium, cadmium, chromium, lead, nickel, selenium, silver, bis(2-ethylhexyl)phthalate, benzene, chloroform, toluene, trichloroethene, and vinyl chloride. Section 4.2.2.3 summarizes and discusses the significance of the concentrations detected in the ground water at the site.

Surface Runoff--Contaminants must be present in surface soil uncovered by impervious materials to be subject to significant surface runoff during precipitation. Because Landfill 4 was covered and vegetated after waste burial operations ceased and is flat, contaminants present in the subsoil at this site are not subject to surface runoff.

Discharge to Surface Water--There was no direct discharge of contaminants observed from this site to surface water.

#### Transport and Fate of Contaminants

Landfill 4 potentially releases VOCs to the air via volatilization and VOCs, bis(2-ethylhexyl)phthalate, and metals to the ground water via site leaching. Potentially significant contaminant transport and fate mechanisms in the air and ground water media include: 1) air dispersion, 2) ground water migration, 3) transport in surface water, and 4) subsequent uptake by plants and animals. The transport and fate of contaminants from Landfill 4 will follow the same pathways as described for Landfill 3 in Section 4.2.1.4 for air dispersion, transport in surface water, and uptake by plants and animals. Refer to this section for details on transport and fate for these pathways.

At Landfill 4, ground water in the upper zone occurs in sand and gravel deposits that are underlain by relatively impermeable and dry limestone/shale bedrock. Hydraulic head in the upper zone at these sites decreases toward Farmers Branch, indicating that ground-water flow is also directed toward Farmers Branch. The bed of Farmers Branch is cut into the same bedrock that forms the base of the upper zone; therefore ground water

would be expected to discharge directly to Farmers Branch or be discharged by evapotranspiration as it exits the upper zone materials near the creek. Ground-water flow is not in the direction of the base perimeter in this area. The evident path of ground-water flow precludes migration of contaminants from Landfill 4 to any domestic or agricultural use wells in the area.

### Exposure Pathways

Figure 4.2.2-1 in Section 4.2.1.4 depicts potential pathways for contaminants to move from Landfill 3 to human exposure points. These same pathways apply to Landfill 4. Pathways which are not complete have been crossed out. Remaining pathways include:

1. Volatilization to the air/air dispersion/inhalation of ambient air;
2. Volatilization to the air/air dispersion/inhalation by animals/ingestion of meat and dairy products;
3. Leaching to ground water/ground-water migration to surface water (fishable source)/uptake by fish and other aquatic organisms/ingestion of aquatic organisms;
4. Leaching to ground water/ground-water migration to surface water (agricultural use source)/ingestion by animals/ingestion of meat and dairy products;
5. Leaching to ground water/ground-water migration to surface water (source used for contact sports)/skin contact with water; and
6. Leaching to ground water/ground-water migration to surface water/volatilization of volatiles/inhalation of vapors close to source.

Identification of Receptors

Based on available exposure pathways, potential human receptors for exposure to contaminants originating from Landfill 4, as for Landfill 3, include: 1) persons residing and/or working in nearby areas, particularly downwind of the site; 2) persons ingesting meat and dairy products from animals exposed to contaminants in the ambient air or contaminated surface water; 3) persons ingesting fish or other aquatic organisms exposed to contaminated surface water; and 4) persons swimming or participating in other contact sports in contaminated water. Landfill 4 is located closer to residential areas of the base than is Landfill 3.

Potential wildlife receptors include: 1) terrestrial organisms with habitats close to Landfill 4 that inhale ambient air and ingest surface water, particularly from Farmers Branch, and 2) aquatic organisms in Farmers Branch and the West Fork of the Trinity River.

Threat to Human Health

Inhalation Exposure--Inhalation of ambient air is the most direct exposure pathway for contaminants to move from Landfill 4 to human receptors. Table 4.2.2-6 presents the on-site maximum and off-site maximum predicted annual ambient air concentrations resulting from estimated Landfill 4 emissions, and predicted concentrations at several discrete locations: site of the proposed base day care center, which is central to the largest on-base residential area, the Fort Worth National Fish Hatchery, and the closest dairy and beef operations. The table also lists Texas Air Control Board (TACB) health Effects Screening Levels (ESLs) which the agency uses to evaluate the impacts of air contaminants. TACB screening levels are based on occupational exposure limits (American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs), Occupational Health and Safety Administration (OSHA) standards, or National Institute for Occupational Safety and Health (NIOSH) recommendations), odor nuisance potential, vegetation effects, or corrosion effects. Generally, the annual ESL corresponds to 0.1% of the lowest occupational exposure limit.

TABLE 4.2.2-6. PREDICTED ANNUAL AVERAGE AMBIENT AIR CONCENTRATIONS RESULTING FROM ESTIMATED LANDFILL 4 EMISSIONS

Contaminant	Predicted Annual Average Ambient Air Concentration (ug/m <sup>3</sup> )							TACB Annual Effects Screening Level (ug/m <sup>3</sup> )
	On-Site Maximum	Off-Site Maximum	Day Care	Fish Hatchery	Dairy Operation	Beef Operation		
Benzene	1.2x10 <sup>-4</sup>	1.3x10 <sup>-5</sup>	3.5x10 <sup>-5</sup>	7.8x10 <sup>-7</sup>	1.6x10 <sup>-7</sup>	5.9x10 <sup>-6</sup>	3	
Chloroform	8.7x10 <sup>-6</sup>	8.8x10 <sup>-7</sup>	2.4x10 <sup>-6</sup>	5.5x10 <sup>-8</sup>	1.1x10 <sup>-8</sup>	4.0x10 <sup>-9</sup>	10	
Methylene chloride	1.6x10 <sup>-4</sup>	1.6x10 <sup>-5</sup>	4.4x10 <sup>-5</sup>	9.9x10 <sup>-7</sup>	2.8x10 <sup>-7</sup>	7.5x10 <sup>-8</sup>	26	
Tetrachloroethene	6.9x10 <sup>-7</sup>	6.9x10 <sup>-8</sup>	1.9x10 <sup>-7</sup>	4.0x10 <sup>-9</sup>	1.0x10 <sup>-9</sup>	< 10 <sup>-9</sup>	33.5	
Toluene	3.7x10 <sup>-6</sup>	3.8x10 <sup>-7</sup>	1.1x10 <sup>-6</sup>	2.4x10 <sup>-8</sup>	5.0x10 <sup>-9</sup>	2.0x10 <sup>-8</sup>	375	
Trichloroethene	1.8x10 <sup>-3</sup>	1.8x10 <sup>-4</sup>	5.0x10 <sup>-4</sup>	1.1x10 <sup>-5</sup>	2.3x10 <sup>-6</sup>	8.4x10 <sup>-7</sup>	135	
Vinyl chloride	4.7x10 <sup>-5</sup>	4.7x10 <sup>-6</sup>	1.3x10 <sup>-5</sup>	3.0x10 <sup>-7</sup>	6.1x10 <sup>-8</sup>	2.2x10 <sup>-8</sup>	10	

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The maximum predicted annual average concentrations resulting from estimated Landfill 4 emissions for benzene, chloroform, methylene chloride, tetrachloroethene, toluene, trichloroethene, and vinyl chloride are lower than the conservative TACB Effects Screening Levels by orders of magnitude ranging from 4 to 9.

Table 4.2.2-7 shows estimates of average daily inhalation exposure (in mg/kg body weight/day) at the location of the on-site and off-site maximum predicted annual average concentration, and at the proposed on-site day care facility, and compares these values with inhalation Acceptable Daily Intakes (ADIs) for chronic (long-term) exposure. An inhalation ADI is an estimate of the dose of a chemical that can be inhaled daily for a lifetime without producing adverse noncarcinogenic health effects. Section 3.8 discusses the derivation of ADIs used in this assessment.

Average daily inhalation exposures for benzene, chloroform, methylene chloride, tetrachloroethene, toluene, trichloroethene, and vinyl chloride are lower than pollutant-specific ADIs in all cases by more than 4 orders of magnitude.

Ingestion Exposure--Potential ingestion exposures include ingestion of meat and dairy products from animals exposed to contaminants in the ambient air or contaminated surface water and fish exposed to contaminated surface water. For the same reasons discussed in Section 4.2.1.4 for Landfill 3, exposure by these pathways is likely to be minimal and was not quantified.

Dermal Exposure--The potential for skin contact with contaminants originating from Landfill 4 is limited to exposures while swimming in (or otherwise in contact with) contaminated surface water. Again, for reasons discussed in Section 4.2.1.4 for Landfill 3, exposure by this pathway is also likely to be minimal and was not quantified.

TABLE 4.2.2-7. ESTIMATED ANNUAL AVERAGE DAILY INHALATION EXPOSURES FOR CONTAMINANTS ORIGINATING FROM LANDFILL 4

Contaminant	On-Site Maximum			Off-Site Maximum			Day Care		
	Inhalation Acceptable Daily Intake <sup>a</sup> (mg/kg/day)	Inhalation Exposure <sup>b</sup> (mg/kg/day)	Safety Factor <sup>c</sup>	Inhalation Exposure <sup>b</sup> (mg/kg/day)	Safety Factor <sup>c</sup>	Inhalation Exposure <sup>b</sup> (mg/kg/day)	Safety Factor <sup>c</sup>	Inhalation Exposure <sup>b</sup> (mg/kg/day)	Safety Factor <sup>c</sup>
Benzene	$1.9 \times 10^{-2}$	$3.54 \times 10^{-8}$	$3.37 \times 10^5$	$3.60 \times 10^{-9}$	$5.28 \times 10^6$	$9.90 \times 10^{-9}$	$1.92 \times 10^6$		
Chloroform	$1.0 \times 10^{-2}$	$2.48 \times 10^{-8}$	$4.03 \times 10^6$	$2.33 \times 10^{-10}$	$3.96 \times 10^7$	$6.95 \times 10^{-10}$	$1.44 \times 10^7$		
Methylene chloride	$6.0 \times 10^{-2}$	$4.48 \times 10^{-8}$	$1.36 \times 10^6$	$4.58 \times 10^{-9}$	$1.32 \times 10^7$	$1.25 \times 10^{-9}$	$4.78 \times 10^6$		
Tetrachloroethene	$2.0 \times 10^{-2}$	$1.96 \times 10^{-10}$	$1.02 \times 10^6$	$2.00 \times 10^{-11}$	$1.00 \times 10^9$	$5.50 \times 10^{-11}$	$3.64 \times 10^8$		
Toluene	1.5	$1.07 \times 10^{-9}$	$1.41 \times 10^9$	$1.09 \times 10^{-10}$	$1.38 \times 10^{10}$	$2.99 \times 10^{-10}$	$5.02 \times 10^9$		
Trichloroethene	$2.46 \times 10^{-2}$	$5.06 \times 10^{-7}$	$4.88 \times 10^4$	$5.15 \times 10^{-8}$	$4.77 \times 10^5$	$1.42 \times 10^{-7}$	$1.74 \times 10^5$		
Vinyl chloride	$1.3 \times 10^{-3}$	$1.33 \times 10^{-8}$	$9.76 \times 10^4$	$1.36 \times 10^{-9}$	$9.58 \times 10^5$	$3.73 \times 10^{-9}$	$3.48 \times 10^5$		

<sup>a</sup> Estimate of the dose of a chemical that can be inhaled daily for a lifetime without producing adverse noncarcinogenic health effects.  
<sup>b</sup> Inhalation exposure assumes inhalation for 24 hours/day of predicted annual average ambient concentrations by an individual with an average body weight of 70 kg and with an average inhalation rate of 20 m<sup>3</sup>/day.  
<sup>c</sup> Inhalation Acceptable Daily Intake/Inhalation Exposure

Environmental Health

Carcinogenic Risks

Inhalation Risk--Of the seven indicator chemicals that might be emitted to the air from Landfill 4, six are potential carcinogens. These are: benzene, chloroform, methylene chloride, tetrachloroethene, trichloroethene, and vinyl chloride. Cancer potency estimates developed by EPA were used in conjunction with total daily contaminant doses to develop estimates of individual cancer risk:

$$\text{individual cancer risk} = \frac{\text{total daily dose} \times \text{cancer potency}}{(\text{mg/kg/day}) \quad (\text{mg/kg/day})^{-1}}$$

Individual cancer risk is the increased probability of getting cancer in one's lifetime.

Table 4.2.2-8 shows estimates of individual cancer risk for the maximum on-site and maximum off-site exposed individual and for an individual inhaling ambient concentrations in the immediate vicinity of the proposed day care facility continuously for a lifetime. These risks, the highest of which is 4 in 1 billion, can be dismissed as inconsequential.

Ingestion Risk--The potential for ingestion exposure to contaminants originating from Landfill 4 is remote and likely to be minimal. The risk of ingestion exposure was therefore not quantified.

Dermal Risk--The potential for dermal exposure to contaminants originating from Landfill 4 is also remote. Unless an individual immersed frequently in the waters of Farmers Branch for a long period of time, skin contact exposure can be considered insignificant. The risk of dermal exposure was therefore not quantified.

TABLE 4.2.2-8. ESTIMATED INDIVIDUAL CANCER RISK ASSOCIATED WITH INHALATION OF POTENTIAL CARCINOGENS ORIGINATING FROM LANDFILL 4

Contaminant	Potency Slope <sup>a</sup> (mg/kg/day) <sup>-1</sup>	Individual Cancer Risk <sup>b</sup>		
		On-Site Maximum Exposed Individual	Off-Site Maximum Exposed Individual	Individual Exposed at Day Care Facility
Benzene	$2.6 \times 10^{-2}$	$9.2 \times 10^{-10}$	$9.4 \times 10^{-11}$	$2.6 \times 10^{-10}$
Chloroform	$8.10 \times 10^{-2}$	$2.0 \times 10^{-10}$	$2.0 \times 10^{-11}$	$5.6 \times 10^{-11}$
Methylene chloride	$1.65 \times 10^{-3}$	$7.4 \times 10^{-11}$	$7.5 \times 10^{-12}$	$2.1 \times 10^{-11}$
Tetrachloroethene	$1.7 \times 10^{-3}$	$3.3 \times 10^{-13}$	$3.4 \times 10^{-14}$	$9.3 \times 10^{-14}$
Trichloroethene	$4.6 \times 10^{-3}$	$2.3 \times 10^{-9}$	$2.4 \times 10^{-10}$	$6.5 \times 10^{-10}$
Vinyl chloride	$2.5 \times 10^{-2}$	$2.3 \times 10^{-10}$	$2.4 \times 10^{-11}$	$2.3 \times 10^{-11}$
TOTAL 70 year risk		$3.9 \times 10^{-9}$	$3.9 \times 10^{-10}$	$1.1 \times 10^{-9}$

<sup>a</sup> See Section 3.6 for discussion and documentation.

<sup>b</sup> Risk calculation assumes inhalation for 24 hours/day for a 70 year lifetime of predicted annual average ambient concentrations by an individual with an average body weight of 70 kg and with an average inhalation rate of 20 m<sup>3</sup>/day.

Threat to Wildlife

Contaminants originating from Landfill 4, as discussed previously for Landfill 3, pose some risk to terrestrial wildlife that use Farmers Branch as a source of drinking water as well as aquatic organisms in Farmers Branch. In the past, there have been some instances of fish kills in Farmers Branch and in the small ponds near Bldg. 233. The potential contribution of Landfill 4 to contaminant concentrations in Farmers Branch was not estimated because neither the ground-water inflow to Farmers Branch nor existing contaminant concentrations in Farmers Branch is known.

4.2.3 Landfill 5 (Site 5)

Work performed at Landfill 5 consisted of installation of upper zone monitor wells and collection and analysis of soil and ground-water samples. The results of the hydrogeologic and chemical data and a baseline risk assessment are discussed in the following sections. Figure 4.2-1 shows the locations of the monitor wells at Site 5.

4.2.3.1 Site Description

Topography

Landfill 5 is located in the southern part of Carswell AFB just north of the intersection of White Settlement Road and Cody Drive on land ranging in elevation from 595 to 620 feet MSL. The disposal area is visible as a slightly elevated and hummocky surface. Surface drainage is generally to the north to an unnamed tributary of Farmers Branch.

Geology

Geologic data developed for Landfill 5 resulted from two activities: geologic sampling during drilling operations, and observations of water levels during and after monitor well installation.

The geologic picture at Landfill 5 is based on an evaluation of drilling logs developed during the installation of eight upper zone monitor wells and one Paluxy monitor well. Data obtained from other nearby upper zone monitor wells installed at the Waste Burial Area (Site 10) were also useful in the interpretation of geologic conditions at the landfill. Cross-sections E-E' and F-F' (Plate 3) illustrate the hydrogeologic units at Site 5. Upper zone deposits consist of surficial deposits of clayey silt with variable amounts of fine sand and gravel, in turn underlain by sand and gravel deposits. The thickness of the upper zone ranges from 8 feet at monitor well 5B to at least 40 feet at monitor well 5E. The surficial clay and silt

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deposits are generally 5 to 10 feet thick, and the sand and gravel deposits are 10 to 30 feet thick. It was observed that in most borings the grain size of the sand and gravel increases with depth.

With the exception of borings 5E and 5F, which were not deep enough to encounter bedrock, shale and limestone of the Goodland Formation were encountered at all locations. The top of the Goodland is deepest at 5E and 5F and shallowest (8 feet) at 5B. The bedrock/upper zone contact is generally flat under Landfill 5, in contrast to the pronounced slope observed under the south portion Landfill 4. Figure 4.2-2 illustrates the contact relationship between the upper zone materials and the underlying limestone and shale.

Drilling during the Stage 1 program at P1, just southwest of the landfill, revealed that the Goodland and Walnut Formations are 30 feet thick. The thickness of these formations varies with the configuration of the eroded upper surface of the Goodland limestone. The Paluxy Formation underlies the Goodland and Walnut Formations and is composed of fine sand containing lignite and pyrite and interbedded with occasional lenses and layers of shale.

### Hydrogeology

Ground water occurs in the upper zone deposits in the vicinity of Landfill 5 at depths ranging from less than 2 feet at 5B to 27 feet at 5F. At Carswell AFB, the ground water exists under unconfined (water table) conditions in the upper zone materials. Results of drilling at Paluxy wells P1 and P2 showed that the upper portion of the Paluxy aquifer below the Goodland/Walnut formations is partly saturated, and not a confined aquifer in this area. The depth to ground water in the Paluxy aquifer ranges from 72 feet below land surface at P2 to 79 feet below land surface at P1.

Figure 4.2-3 illustrates the potentiometric surface of the upper zone water table as determined in March, 1988. Hydraulic head in the upper zone decreases slightly to the east, indicating that ground-water flow is to the east. Comparison of the potentiometric surface map for the upper zone ground water and the contour map of the base of the upper zone (Figure 4.2-2)

strongly suggests that the occurrence and direction of movement of ground water in the upper zone is closely related to the configuration of the bedrock surface.

Based on the hydraulic conductivity values calculated from slug test results at Landfill 5 and the hydraulic gradient of approximately 0.005 feet/foot (from Figure 4.2-3), the average ground-water flow velocity at Landfill 5 may be calculated to be approximately 0.2 feet per day. This velocity represents an average seepage velocity, as opposed to particle velocity that would be considered in contaminant transport evaluations. This estimate is derived from a simplification of Darcy's Law:

$$\bar{v} = \frac{k i}{\phi}$$

- where:  $\bar{v}$  = average ground-water flow velocity,  
k = hydraulic conductivity of upper zone deposits,  
(average  $2.4 \times 10^{-3}$  cm/sec or 6.8 feet/day)  
i = hydraulic gradient (0.005) in the upper zone; and  
 $\phi$  = estimated porosity of upper zone deposits  
(assume 0.20)

#### 4.2.3.2 Chemical Analytical Results

##### Soil Chemistry

Split-spoon samples collected in the installation of monitor wells 5D-5H were retained and examined for any evidence of contamination. Based on the depth and appearance of samples, soils were selected for examination of moisture content, heavy metals, oil and grease, and volatile and semivolatile organic compounds. Results of the analyses are provided in Table 4.2.3-1 (inorganic parameters) and Table 4.2.3-2 (organic parameters).

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TABLE 4.2.3-1 RESULTS OF INORGANIC ANALYSES FOR SOIL SAMPLES, SITE 5 (LANDFILL 5), CARSWELL AFB, TEXAS.

PARAMETER		5F		5G		5H	
		09-Feb-88 (19 - 24)		08-Feb-88 (8 - 14)		09-Feb-88 (9 - 14)	
		5F-6		5G-4		5H-4	
		Beg. Depth - End Depth		Beg. Depth - End Depth		Beg. Depth - End Depth	
Soil Moisture & MOISTURE		11.0		4.0		9.0	
Dry Weight Determination							
Primary Results							
Monitor Well							
Sample ID							
Date Sampled							
Beg. Depth - End Depth							
5F							
5G-4							
09-Feb-88							
(19 - 24)							
5G							
08-Feb-88							
(8 - 14)							
5H							
5H-4							
09-Feb-88							
(9 - 14)							
Metal Screen (ICP) MG/KG							
Ag	Silver	1.3	(0.87)	ND	(0.87)	ND	(0.88)
Al	Aluminum	470.0	(19.0)	1900.0	(19.0)	8000.0	(20.0)
As	Arsenic	ND	(29.0)	ND	(29.0)	ND	(29.0)
B	Boron	ND	(58.0)	ND	(58.0)	ND	(59.0)
Ba	Barium	3.1	(0.87)	13.0	(0.87)	46.0	(0.88)
Be	Beryllium	0.2	(0.097)	ND	(0.097)	0.2	(0.098)
Ca	Calcium	7700.0	(5.8)	6000.0	(5.8)	89000.0	(12.0)
Cd	Cadmium	ND	(0.29)	ND	(0.29)	ND	(0.29)
Co	Cobalt	ND	(0.97)	ND	(0.97)	1.7	(0.98)
Cr	Chromium	2.5E	(0.87)	5.2E	(0.87)	24.0E	(0.88)
Cu	Copper	ND	(0.97)	1.6	(0.97)	9.8	(0.98)
Fe	Iron	2200.0	(2.9)	4600.0	(2.9)	11000.0	(2.9)
K	Potassium	50.0	(29.0)	200.0	(29.0)	950.0	(29.0)
Mg	Magnesium	130.0	(9.7)	700.0	(9.7)	1700.0	(9.8)
Mn	Manganese	34.0	(0.29)	82.0	(0.29)	240.0	(0.29)
Mo	Molybdenum	ND	(4.9)	ND	(4.9)	ND	(4.9)
Na	Sodium	56.0E	(7.8)	70.0E	(7.8)	290.0E	(7.8)

E: The reported value is estimated due to the presence of an interferant.  
R: Indicates that the matrix spike recovery for this analysis was not within acceptance limits indicating an interferant present.  
ND: Not detected at specified detection limit  
( ): Detection limit

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TABLE 4.2.3-1 RESULTS OF INORGANIC ANALYSES FOR SOIL SAMPLES, SITE 5 (LANDFILL 5), CARSMELL AFB, TEXAS.

Primary Results		Monitor Well
PARAMETER	Sample ID	Sample ID
	Date Sampled	Date Sampled
	Reg. Depth - End Depth	Reg. Depth - End Depth
	5F	5H
	5F-6	5H-4
	09-Feb-88	09-Feb-88
	(19 - 24)	(9 - 14)
Ni	ND (1.9)	4.0 (1.9)
Pb	ND (4.9)	ND (4.9)
Sb	ND (5.8)	14.0 (5.8)
Se	ND (29.0)	ND (29.0)
Si	150.0 (29.0)	260.0 (29.0)
Tl	10.0 (8.7)	11.0 (8.7)
V	8.0E (1.9)	11.0E (1.9)
Zn	2.3 (0.58)	6.0 (0.58)

E: The reported value is estimated due to the presence of an interferant.  
 R: Indicates that the matrix spike recovery for this analysis was not within acceptance limits indicating an interferant present.  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

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TABLE 4.2.3-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 5 (LANDFILL 5), CARSMELL AFB, TEXAS.

Primary Results

PARAMETER	5D		5E		5F	
	30-Jan-88	01-Feb-88	01-Feb-88	01-Feb-88	01-Feb-88	09-Feb-88
	14 - 19	9 - 14	29 - 33	4 - 9		
	5D-5	5E-4	5E-8	5F-3		
	14 - 19	9 - 14	29 - 33	4 - 9		
	5D-5	5E-4	5E-8	5F-3		
	14 - 19	9 - 14	29 - 33	4 - 9		
benzo(k)fluoranthene	ND (0.19)	ND (0.19)	ND (0.20)	ND (0.20)	ND (0.18)	ND (0.18)
benzoic acid	ND (3.8)	ND (3.8)	ND (4.1)	ND (4.1)	ND (3.6)	ND (3.6)
benzyl alcohol	ND (3.8)	ND (3.8)	ND (4.1)	ND (4.1)	ND (3.6)	ND (3.6)
bis(2-chloroethoxy)methane	ND (0.40)	ND (0.40)	ND (0.43)	ND (0.43)	ND (0.39)	ND (0.39)
bis(2-chloroethyl) ether	ND (0.43)	ND (0.43)	ND (0.46)	ND (0.46)	ND (0.42)	ND (0.42)
bis(2-chloroisopropyl) ether	ND (0.43)	ND (0.43)	ND (0.46)	ND (0.46)	ND (0.42)	ND (0.42)
bis(2-ethylhexyl) phthalate	0.188J (0.19)	0.148J (0.19)	0.23B (0.20)	0.44B (0.20)	0.44B (0.18)	0.44B (0.18)
butylbenzylphthalate	ND (0.19)	ND (0.19)	ND (0.20)	ND (0.20)	ND (0.18)	ND (0.18)
chrysene	ND (0.19)	ND (0.19)	ND (0.20)	ND (0.20)	ND (0.18)	ND (0.18)
di-n-butylphthalate	ND (0.19)	ND (0.19)	ND (0.20)	ND (0.20)	ND (0.18)	ND (0.18)
di-n-octyl phthalate	0.188J (0.19)	0.128J (0.19)	0.118J (0.20)	0.118J (0.20)	ND (0.18)	ND (0.18)
dlbenzo(a,h)anthracene	0.084J (0.19)	0.35 (0.19)	0.11J (0.20)	0.18J (0.20)	0.18J (0.18)	0.18J (0.18)
dibenzofuran	ND (0.19)	ND (0.19)	ND (0.20)	ND (0.20)	ND (0.18)	ND (0.18)
diethylphthalate	ND (0.76)	ND (0.76)	ND (0.81)	ND (0.81)	ND (0.73)	ND (0.73)
dimethyl phthalate	ND (0.14)	ND (0.14)	ND (0.15)	ND (0.15)	ND (0.14)	ND (0.14)
fluoranthene	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.13)	ND (0.12)	ND (0.12)
fluorene	ND (0.17)	ND (0.17)	ND (0.18)	ND (0.18)	ND (0.16)	ND (0.16)
hexachlorobenzene	ND (0.14)	ND (0.14)	ND (0.15)	ND (0.15)	ND (0.14)	ND (0.14)
hexachlorobutadiene	ND (0.14)	ND (0.14)	ND (0.15)	ND (0.15)	ND (0.14)	ND (0.14)
hexachlorocyclopentadiene	ND (0.068)	ND (0.068)	ND (0.073)	ND (0.073)	ND (0.066)	ND (0.066)
hexachloroethane	ND (0.45)	ND (0.45)	ND (0.49)	ND (0.49)	ND (0.44)	ND (0.44)
indeno(1,2,3-cd)pyrene	ND (0.12)	ND (0.12)	ND (0.13)	ND (0.13)	ND (0.12)	ND (0.12)
isophorone	ND (0.28)	ND (0.28)	ND (0.30)	ND (0.30)	ND (0.27)	ND (0.27)
n-nitroso-di-n-propylamine	ND (0.17)	ND (0.17)	ND (0.18)	ND (0.18)	ND (0.16)	ND (0.16)
n-nitrosodimethylamine	ND (0.91)	ND (0.91)	ND (0.97)	ND (0.97)	ND (0.87)	ND (0.87)
	ND (0.76)	ND (0.76)	ND (0.81)	ND (0.81)	ND (0.73)	ND (0.73)

B: Detected in Reagent Blank; background subtraction not performed  
 BJ: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

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TABLE 4.2.3-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 5 (LANDFILL 5), CARLSWELL AFB, TEXAS.

Primary Results

PARAMETER	Monitor Well		Date Sampled		Beg. Depth - End Depth		SF
	Sample ID	Sample ID	Date	Date	Depth	Depth	
n-nitrosodiphenylamine	5D	5E	30-Jan-88	01-Feb-88	14 - 19	29 - 33	4 - 9
naphthalene	ND	ND	(0.14)	ND	(0.14)	ND	ND (0.14)
nitrobenzene	ND	ND	(0.12)	ND	(0.12)	ND	ND (0.12)
pentachlorophenol	ND	ND	(0.14)	ND	(0.14)	ND	ND (0.14)
phenanthrene	ND	ND	(0.27)	ND	(0.27)	ND	ND (0.26)
phenol	ND	ND	(0.41)	ND	(0.41)	ND	ND (0.39)
pyrene	ND	ND	(0.11)	ND	(0.11)	ND	ND (0.11)
	ND	ND	(0.14)	ND	(0.14)	ND	ND (0.14)

DRAFT -

B: Detected in Reagent Blank; background subtraction not performed  
 BJ: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

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TABLE 4.2.3-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 5 (LANDFILL 5), CARSWELL AFB, TEXAS.

PARAMETER	SF		5G		5H	
	19 - 24	09-Feb-88	8 - 14	08-Feb-88	9 - 14	09-Feb-88
Oil & Grease MG/KG	ND	(5.0)	ND	(5.0)	ND	15.0
Oil and grease, infrared						
Volatille Organic Compounds MG/KG						
1,1,1-trichloroethane	ND	(0.0043)	ND	(0.0039)	ND	(0.0043)
1,1,2,2-tetrachloroethane	ND	(0.0081)	ND	(0.0071)	ND	(0.0077)
1,1,2-trichloroethane	ND	(0.0039)	ND	(0.0052)	ND	(0.0056)
1,2-dichloroethane	ND	(0.0033)	ND	(0.0029)	ND	(0.0031)
1,2-dichloropropane	ND	(0.0071)	ND	(0.0062)	ND	(0.0067)
2-butanone	ND	(0.030)	ND	(0.026)	ND	(0.028)
2-chloroethylvinyl ether	ND	(0.0059)	ND	(0.0052)	ND	(0.0056)
2-hexanone	ND	(0.042)	ND	(0.037)	ND	(0.040)
4-methyl-2-pentanone	ND	(0.054)	ND	(0.047)	ND	(0.052)
Benzene	ND	(0.0052)	ND	(0.0045)	ND	(0.0049)
Ethylbenzene	ND	(0.0085)	ND	(0.0074)	ND	(0.0081)
Toluene	0.031	(0.0071)	ND	(0.0062)	ND	(0.0067)
Trichloroethene	ND	(0.0022)	ND	(0.0020)	ND	(0.0021)
acetone	0.018	(0.0089)	0.016	(0.0077)	0.0064J	(0.0084)
bromodichloromethane	ND	(0.0026)	ND	(0.0023)	ND	(0.0025)
bromoform	ND	(0.0055)	ND	(0.0048)	ND	(0.0053)
bromomethane	ND	(0.0059)	ND	(0.0052)	ND	(0.0056)
carbon disulfide	ND	(0.0020)	ND	(0.0018)	ND	(0.0019)
carbon tetrachloride	ND	(0.0033)	ND	(0.0029)	ND	(0.0031)
chlorobenzene	ND	(0.0071)	ND	(0.0062)	ND	(0.0067)
chloroethane	ND	(0.0059)	ND	(0.0052)	ND	(0.0056)
chloroform	ND	(0.0019)	ND	(0.0016)	ND	(0.0018)

B: Detected in Reagent Blank; background subtraction not performed  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

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TABLE 4.2.3-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 5 (LANDFILL 5), CARSWELL AFB, TEXAS.

PARAMETER	5F		5G		5H	
	09-Feb-88		08-Feb-88		09-Feb-88	
	Beg. Depth	End Depth	Beg. Depth	End Depth	Beg. Depth	End Depth
chloromethane	ND	(0.0059)	ND	(0.0052)	ND	(0.0056)
cis-1,3-Dichloropropene	ND	(0.0059)	ND	(0.0052)	ND	(0.0056)
dibromochloromethane	ND	(0.0037)	ND	(0.0032)	ND	(0.0035)
methylene chloride	0.0178	(0.0033)	ND	(0.0029)	0.00518	(0.0031)
styrene	ND	(0.0035)	ND	(0.0031)	ND	(0.0034)
tetrachloroethene	ND	(0.0048)	ND	(0.0042)	ND	(0.0046)
total xylenes	ND	(0.0054)	ND	(0.0047)	ND	(0.0052)
trans-1,2-Dichloroethene	ND	(0.0019)	ND	(0.0016)	ND	(0.0018)
trans-1,3-Dichloropropene	ND	(0.0059)	ND	(0.0052)	ND	(0.0056)
trichlorofluoromethane	ND	(0.0059)	ND	(0.0052)	ND	(0.0056)
vinyl acetate	ND	(0.0081)	ND	(0.0071)	ND	(0.0077)
vinyl chloride	ND	(0.0059)	ND	(0.0052)	ND	(0.0056)
Semi-volatile Organic Compounds MG/KG						
1,2,4-trichlorobenzene	ND	(0.14)	ND	(0.13)	ND	(0.14)
1,2-dichlorobenzene	ND	(0.14)	ND	(0.13)	ND	(0.14)
1,3-dichlorobenzene	ND	(0.14)	ND	(0.13)	ND	(0.14)
1,4-dichlorobenzene	ND	(0.33)	ND	(0.30)	ND	(0.32)
2,4,5-trichlorophenol	ND	(0.75)	ND	(0.69)	ND	(0.73)
2,4,6-trichlorophenol	ND	(0.20)	ND	(0.19)	ND	(0.20)
2,4-dichlorophenol	ND	(0.20)	ND	(0.19)	ND	(0.20)
2,4-dimethylphenol	ND	(0.20)	ND	(0.19)	ND	(0.20)
2,4-dinitrophenol	ND	(3.1)	ND	(2.9)	ND	(3.1)
2,4-dinitrotoluene	ND	(0.43)	ND	(0.39)	ND	(0.42)
2,6-dinitrotoluene	ND	(0.14)	ND	(0.13)	ND	(0.14)
2-chloronaphthalene	ND	(0.14)	ND	(0.13)	ND	(0.14)

B: Detected in Reagent Blank; background subtraction not performed

J: Estimated value (GC test codes)

ND: Not detected at specified detection limit

( ) : Detection limit

TABLE 4.2.3-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 5 (LANDFILL 5), CARSWELL AFB, TEXAS.

Primary Results	Monitor Well		Date Sampled		Beg. Depth - End Depth	
	Sample ID		5G	5H	5G-4	5H-4
			08-Feb-88	09-Feb-88	8 - 14	9 - 14
	5F					
	5F-6					
	09-Feb-88					
	19 - 24					
PARAMETER	ND	(0.25)	ND	(0.23)	ND	(0.24)
2-chlorophenol	ND	(0.75)	ND	(0.69)	ND	(0.73)
2-methylnaphthalene	ND	(0.75)	ND	(0.69)	ND	(0.73)
2-methylphenol	ND	(3.7)	ND	(3.5)	ND	(3.7)
2-nitroaniline	ND	(0.27)	ND	(0.25)	ND	(0.26)
2-nitrophenol	ND	(1.2)	ND	(1.1)	ND	(1.2)
3,3'-dichlorobenzidine	ND	(3.7)	ND	(3.5)	ND	(3.7)
3-nitroaniline	ND	(1.8)	ND	(1.7)	ND	(1.8)
4,6-dinitro-2-methylphenol	ND	(0.14)	ND	(0.13)	ND	(0.14)
4-bromophenyl-phenylether	ND	(0.22)	ND	(0.21)	ND	(0.22)
4-chloro-3-methylphenol	ND	(0.75)	ND	(0.69)	ND	(0.73)
4-chloroaniline	ND	(0.31)	ND	(0.29)	ND	(0.31)
4-chlorophenyl-phenylether	ND	(0.75)	ND	(0.69)	ND	(0.73)
4-methylphenol	ND	(3.7)	ND	(3.5)	ND	(3.7)
4-nitroaniline	ND	(0.18)	ND	(0.17)	ND	(0.18)
4-nitrophenol	ND	(0.14)	ND	(0.13)	ND	(0.14)
acenaphthene	ND	(0.26)	ND	(0.24)	ND	(0.26)
acenaphthylene	ND	(0.75)	ND	(0.69)	ND	(0.73)
aniline	ND	(0.14)	ND	(0.13)	ND	(0.14)
anthracene	ND	(3.3)	ND	(3.0)	ND	(3.2)
benzidine	ND	(0.58)	ND	(0.54)	ND	(0.57)
benzo(a)anthracene	ND	(0.19)	ND	(0.17)	ND	(0.18)
benzo(a)pyrene	ND	(0.36)	ND	(0.33)	ND	(0.35)
benzo(b)fluoranthene	ND	(0.19)	ND	(0.17)	ND	(0.18)
benzo(k)fluoranthene	ND	(3.7)	ND	(3.5)	ND	(3.7)
benzoic acid	ND	(3.7)	ND	(3.5)	ND	(3.7)
benzyl alcohol	ND	(3.7)	ND	(3.5)	ND	(3.7)

B: Detected in Reagent Blank; background subtraction not performed

J: Estimated value (GC test codes)

ND: Not detected at specified detection limit

( ) : Detection Limit

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TABLE 4.2.3-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 5 (LANDFILL 5), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	Monitor Well		Beg. Depth - End Depth	5F	5G	5H
	Sample ID	Date Sampled				
bis(2-chloroethoxy)methane	5F-6	08-Feb-88	5G-4	ND (0.40)	ND (0.37)	ND (0.39)
bis(2-chloroethyl) ether	5F-6	08-Feb-88	5G-4	ND (0.43)	ND (0.39)	ND (0.42)
bis(2-chloroisopropyl) ether	5F-6	08-Feb-88	5G-4	ND (0.43)	ND (0.39)	ND (0.42)
bis(2-ethylhexyl)phthalate	5F-6	08-Feb-88	5G-4	0.49B (0.19)	0.83B (0.17)	0.63B (0.18)
butylbenzylphthalate	5F-6	08-Feb-88	5G-4	ND (0.19)	ND (0.17)	ND (0.18)
chrysene	5F-6	08-Feb-88	5G-4	ND (0.19)	ND (0.17)	ND (0.18)
di-n-butylphthalate	5F-6	08-Feb-88	5G-4	0.28 (0.19)	ND (0.17)	ND (0.18)
di-n-octyl phthalate	5F-6	08-Feb-88	5G-4	0.26 (0.19)	ND (0.17)	ND (0.18)
dibenzo(a,h)anthracene	5F-6	08-Feb-88	5G-4	ND (0.19)	ND (0.17)	ND (0.18)
dibenzofuran	5F-6	08-Feb-88	5G-4	ND (0.75)	ND (0.69)	ND (0.73)
diethylphthalate	5F-6	08-Feb-88	5G-4	ND (0.14)	ND (0.13)	ND (0.14)
dimethyl phthalate	5F-6	08-Feb-88	5G-4	ND (0.12)	ND (0.11)	ND (0.12)
fluoranthene	5F-6	08-Feb-88	5G-4	ND (0.16)	ND (0.15)	ND (0.16)
fluorene	5F-6	08-Feb-88	5G-4	ND (0.14)	ND (0.13)	ND (0.14)
hexachlorobenzene	5F-6	08-Feb-88	5G-4	ND (0.14)	ND (0.13)	ND (0.14)
hexachlorobutadiene	5F-6	08-Feb-88	5G-4	ND (0.067)	ND (0.062)	ND (0.066)
hexachlorocyclopentadiene	5F-6	08-Feb-88	5G-4	ND (0.45)	ND (0.42)	ND (0.44)
hexachloroethane	5F-6	08-Feb-88	5G-4	ND (0.12)	ND (0.11)	ND (0.12)
indeno(1,2,3-cd)pyrene	5F-6	08-Feb-88	5G-4	ND (0.28)	ND (0.26)	ND (0.27)
isophorone	5F-6	08-Feb-88	5G-4	ND (0.16)	ND (0.15)	ND (0.16)
n-nitroso-di-n-propylamine	5F-6	08-Feb-88	5G-4	ND (0.90)	ND (0.83)	ND (0.88)
n-nitrosodimethylamine	5F-6	08-Feb-88	5G-4	ND (0.75)	ND (0.69)	ND (0.73)
n-nitrosodiphenylamine	5F-6	08-Feb-88	5G-4	ND (0.14)	ND (0.13)	ND (0.14)
naphthalene	5F-6	08-Feb-88	5G-4	ND (0.12)	ND (0.11)	ND (0.12)
nitrobenzene	5F-6	08-Feb-88	5G-4	ND (0.14)	ND (0.13)	ND (0.14)
pentachlorophenol	5F-6	08-Feb-88	5G-4	ND (0.27)	ND (0.25)	ND (0.26)

B: Detected in Reagent Blank; background subtraction not performed

J: Estimated value (GC test codes)

ND: Not detected at specified detection limit

( ) : Detection limit

TABLE 4.2.3-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 5 (LANDFILL 5), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well	
	Sample ID	Date Sampled
phenanthrene	5F	09-Feb-88
	5G-4	08-Feb-88
phenol	5F	09-Feb-88
	5G-4	08-Feb-88
pyrene	5F	09-Feb-88
	5G-4	08-Feb-88
	19 - 24	8 - 14
	ND (0.40)	ND (0.37)
	ND (0.11)	ND (0.10)
	ND (0.14)	ND (0.13)
		9 - 14
		ND (0.40)
		ND (0.11)
		ND (0.14)

Primary Results

B: Detected in Reagent Blank; background subtraction not performed  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection Limit

50004-143

Heavy Metals--Soil analyses for heavy metals resulted in most samples being within normal ranges (compared with Table 4.1-3). Arsenic (13 mg/kg) and silver (1.8 mg/kg) concentrations in borehole 5F (4-7 feet) were above normal ranges. In a sand sample from 5F (19 to 22 feet), arsenic was below normal ranges but silver exceeded the normal range with a 1.3 mg/kg value.

Oil and Grease--Soil samples from borings 5D-5H were analyzed for the presence of oil and grease. Samples from 5E were evaluated at two different depths to determine vertical distribution. The only detection was at 5H (9-12 feet) with a value of 15.0 mg/kg.

Volatile Organic Compounds--Soil samples collected from boreholes 5D through 5H revealed TCE only at 5E (0.022 mg/kg). Soil from 5E (9-12 feet) also had trans-1,2-dichloroethene (0.014 mg/kg). Soil samples contained toluene (up to 0.031 mg/kg) in 5 of the 7 samples analyzed. The highest concentrations occurred at 5D and 5F, at depths from 14 to 20 feet.

Semivolatile Organic Compounds--Several phthalate compounds and acetone were detected in many of the soil samples. These compounds occurred in various concentrations (typically 0.1-0.8 mg/kg) and usually were estimated values or were noted in reagent blanks.

#### Water Quality

The Stage 2 monitor wells, as well as Stage 1 wells and the Paluxy (P1) well, were sampled for chemical analysis in two rounds. Results of the two sampling events are provided in Table 4.2.3-3 (inorganic parameters) and Table 4.2.3-4 (organic parameters). Field chemistry results are provided in Table 4.2.3-5. Samples were analyzed for water quality parameters, heavy metals, purgeable halocarbons, purgeable aromatics, and extractable priority pollutants.



TABLE 4.2.3-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 5 (LANDFILL 5), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	EPA Standards, Criteria	Monitor Well					
		5A		5A		5B	
		03-16 02-Mar-88	04-46 12-Apr-88	04-47 12-Apr-88	03-30 03-Mar-88	04-47 12-Apr-88	03-30 03-Mar-88
As	0.050(M)	ND	ND	ND	ND	ND	(0.30)
B		ND	1.0	0.85	0.85	ND	(0.60)
Ba	1.0(M)	0.72	0.36	0.33	0.33	0.70	(0.0090)
Be		0.0050	0.0020	0.0010	0.0010	ND	(0.0010)
Ca		480.0	320.0	290.0	290.0	300.0	(0.060)
Cd	0.010(M)	ND	ND	ND	ND	ND	(0.0030)
Co		0.010	0.014	0.013	0.013	0.010	(0.010)
Cr	0.050(M)	0.12	0.013	0.011	0.011	0.060	(0.0090)
Cu	1.0(G)	0.060	0.053	0.060	0.060	ND	(0.010)
Fe	0.30(G)	90.0	19.0	19.0	19.0	52.0	(0.030)
K		9.9	4.4	4.2	4.2	6.0	(0.30)
Mg		16.0	8.6	8.4	8.4	14.0	(0.10)
Mn		5.7	2.4	2.1	2.1	2.2	(0.0030)
Mo	0.050(G)	ND	ND	ND	ND	ND	(0.050)
Na		25.0	29.0	29.0	29.0	21.0	(0.080)
Ni		0.070	0.035	0.041	0.041	0.090	(0.020)
Pb	0.050(M)	0.080	ND	ND	ND	ND	(0.050)
Sb		ND	0.066	ND	ND	0.17	(0.060)
Se	0.010(M)	ND	ND	ND	ND	ND	(0.30)
Si		120.0	32.0	31.0	31.0	84.0	(0.30)
Tl		0.22	ND	ND	ND	ND	(0.090)
V		0.21	0.065	0.063	0.063	0.090	(0.020)
Zn	5.0(G)	0.15	0.066	0.066	0.066	0.099	(0.0060)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

@: Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.

ND: Not detected at specified detection limit

( ): Detection limit

TABLE 4.2.3-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 5 (LANDFILL 5), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards, Criteria		Monitor Well Sample ID	
	5B 04-44 12-Apr-88	5C 03-15 02-Mar-88	5C 04-49 13-Apr-88	5D 03-19 02-Mar-88
Total Dissolved Solids MG/L	560.0 (1.0)	380.0 (2.0)	550.0 (1.0)	640.0 (2.0)
Fluoride MG/L	4.0(M)	2.0(G)	0.28	0.21
Chloride MG/L	250.0(G)	18.0	2.3	15.0
Nitrate MG/L	10.0(M)	0.24	1.3	0.60
Orthophosphate MG/L	ND	(0.020)	0.030 (0.020)	0.070 (0.020)
Sulfate MG/L	250.0(G)	40.0	24.0	64.0
Metals MG/L				
Arsenic, graphite AA	0.050(M)	0.021R	0.021R	0.027R
Mercury	0.0020(M)	ND	ND	ND#
Lead, graphite AA	0.050(M)	0.022R+	0.022R+	0.068

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

- #: Matrix spike outside control limits.
- B: Detected in Reagent Blank; background subtraction not performed
- B+: Analyte detected in Reagent Blank. % Difference (MS and MS duplicate) outside control limits.
- R: Indicates that the matrix spike recovery for this analysis was not within acceptance limits indicating an interferent present.
- R+: Matrix spike recovery and % difference (MS and MS dup) outside control limits.
- ^: Indicates duplicate analysis is not within control limits.
- ND: Not detected at specified detection limit
- ( ): Detection limit

50310

TABLE 4.2.3-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 5 (LANDFILL 5), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well			
	Sample ID	Date Sampled	Sample ID	Date Sampled
Selenium, graphite AA	5B 04-44	5C 03-15	5C 04-49	5D 03-19
EPA Standards,	12-Apr-88	02-Mar-88	13-Apr-88	02-Mar-88
Criteria	ND (0.0030)	NDR (0.0050)	MDE (0.0030)	MD (0.0050)
0.010(M)	ND	ND	MD	MD
Metal Screen (ICP) MG/L				
Ag Silver	ND (0.0090)	ND (0.0090)	MD (0.0090)	MD (0.0090)
Al Aluminum	11.0 (0.20)	24.0 (0.20)	46.0B+ (0.20)	72.0 (0.20)
As Arsenic	ND (0.30)	ND (0.30)	MDF (0.30)	ND (0.30)
B Boron	0.91 (0.60)	ND (0.60)	MD (0.60)	MD (0.60)
Ba Barium	0.52 (0.0090)	0.29 (0.0090)	0.40 (0.0090)	0.53 (0.0090)
Be Beryllium	0.0010 (0.0010)	0.0020 (0.0010)	0.0010 (0.0010)	0.0060 (0.0010)
Ca Calcium	230.0 (0.060)	190.0 (0.060)	260.0B (0.060)	690.0 (0.060)
Cd Cadmium	ND (0.0030)	ND (0.0030)	MD (0.0030)	MD (0.0030)
Co Cobalt	0.010 (0.010)	0.010 (0.010)	0.030 (0.010)	0.050 (0.010)
Cr Chromium	0.050(M)	0.039 (0.0090)	0.060 (0.0090)	0.15 (0.0090)
Cu Copper	1.0(G)	0.020 (0.010)	0.030 (0.010)	0.060 (0.010)
Fe Iron	0.30(G)	19.0 (0.030)	62.0B (0.030)	110.0 (0.030)
K Potassium	2.3 (0.30)	4.9 (0.30)	7.3 (0.30)	13.0 (0.30)
Mg Magnesium	8.8 (0.10)	10.0 (0.10)	14.0 (0.10)	23.0 (0.10)
Mn Manganese	1.8 (0.0030)	0.97 (0.0030)	1.3 (0.0030)	4.2 (0.0030)
Mo Molybdenum	ND (0.050)	ND (0.050)	MD (0.050)	MD (0.050)
Na Sodium	24.0 (0.080)	20.0 (0.080)	21.0 (0.080)	12.0 (0.080)
Ni Nickel	ND (0.020)	MD (0.020)	0.080 (0.020)	0.060 (0.020)
Pb Lead	0.050(M)	ND (0.050)	0.060 (0.050)	MD (0.050)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

# : Matrix spike outside control limits.

B : Detected in Reagent Blank; background subtraction not performed

B+ : Analyte detected in Reagent Blank. X Difference (MS and MS duplicate) outside control limits.

R : Indicates that the matrix spike recovery for this analysis was not within acceptance limits indicating an interferent present.

R+ : Matrix spike recovery and X difference (MS and MS dup) outside control limits.

^ : Indicates duplicate analysis is not within control limits.

ND : Not detected at specified detection limit

( ) : Detection limit

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TABLE 4.2.3-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 5 (LANDFILL 5), CASSELL AFB, TEXAS.

Primary Results

PARAMETER	Monitor Well					
	EPA Standards,		5C		5D	
	Criteria	02-Mar-88	03-15	04-49	03-19	02-Mar-88
Sb		ND (0.060)	ND (0.060)	MDR (0.060)	ND (0.060)	ND (0.060)
Se	0.010(M)	ND (0.30)	ND (0.30)	ND (0.30)	0.40 (0.30)	0.40 (0.30)
Si		27.0 (0.30)	57.0 (0.30)	89.08 (0.30)	120.0 (0.30)	120.0 (0.30)
Tl		ND (0.090)	0.13 (0.090)	ND (0.090)	0.16 (0.090)	0.16 (0.090)
V		0.040 (0.020)	0.080 (0.020)	0.11 (0.020)	0.23 (0.020)	0.23 (0.020)
Zn	5.0(G)	0.036 (0.0060)	0.054^ (0.0060)	0.091 (0.0060)	0.21 (0.0060)	0.21 (0.0060)

- D R A F T -

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

- # : Matrix spike outside control limits.
- B : Detected in Reagent Blank; background subtraction not performed
- Bt : Analyte detected in Reagent Blank. X Difference (MS and MS duplicate) outside control limits.
- R : Indicates that the matrix spike recovery for this analysis was not within acceptance limits indicating an interferent present.
- R+ : Matrix spike recovery and X difference (MS and MS dup) outside control limits.
- ^ : Indicates duplicate analysis is not within control limits.
- ND : Not detected at specified detection limit
- ( ) : Detection Limit

TABLE 4.2.3-3

TABLE 4.2.3-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 5 (LANDFILL 5), CARSWELL AFB, TEXAS.

PARAMETER	5D		5E		5F	
	12-Apr-88	04-43	02-Mar-88	03-21	12-Apr-88	04-Mar-88
Total Dissolved Solids MG/L	650.0	(1.0)	470.0	(2.0)	650.0	(1.0)
Total Dissolved Solids					600.0	(1.0)
Fluoride MG/L	4.0(M)	2.0(G)	0.23		0.26	0.30
Chloride MG/L	250.0(G)	14.0	18.0		28.0	21.0
Nitrate MG/L	10.0(M)	0.56	0.46		0.95@	1.6
Orthophosphate MG/L						
Orthophosphate	ND	(0.020)	ND	(0.020)	ND	(0.020)
Sulfate MG/L	65.0		29.0		72.0	55.0
Sulfate, nephelometry						
Metals MG/L						
Arsenic, graphite AA	0.029	0.061	0.038		0.0060	
Mercury	0.0020(M)	ND	(0.00012)		0.00020	(0.00012)
Lead, graphite AA	0.050(M)	0.066			ND	(0.00012)
Selenium, graphite AA	0.010(M)	ND	(0.0030)		ND	(0.0030)
Metal Screen (ICP) MG/L						
Ag Silver	ND	(0.0090)	ND	(0.0090)	ND	(0.0090)
Al Aluminum	18.0	(0.20)	52.0	(0.20)	22.0	(0.20)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

@: Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.

ND: Not detected at specified detection limit

( ): Detection limit





TABLE 4.2.3-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 5 (LANDFILL 5), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well					
	Sample ID					
	Date Sampled					
	5F		5G		5G	
	03-38		02-168		04-32	
	04-Mar-88		29-Feb-88		11-Apr-88	
EPA Standards, Criteria	ND	(0.0090)	ND	(0.0090)	0.019	(0.0090)
Ag Silver	ND	(0.0090)	ND	(0.0090)	0.019	(0.0090)
Al Aluminum	69.0	(0.20)	96.0	(0.20)	35.0	(0.20)
As Arsenic	ND	(0.30)	ND#	(0.30)	ND	(0.30)
B Boron	ND	(0.60)	ND	(0.60)	ND	(0.60)
Ba Barium	0.75	(0.0090)	1.0	(0.0090)	0.42	(0.0090)
Be Beryllium	0.0010	(0.0010)	0.0020	(0.0010)	0.0040	(0.0010)
Ca Calcium	2100.0	(0.24)	1600.0	(0.060)	640.0	(0.060)
Cd Cadmium	ND	(0.0030)	0.0070	(0.0030)	ND	(0.0030)
Co Cobalt	0.076	(0.010)	0.080	(0.010)	0.020	(0.010)
Cr Chromium	0.21	(0.0090)	0.23	(0.0090)	0.11	(0.0090)
Cu Copper	0.099	(0.010)	0.12	(0.010)	0.040	(0.010)
Fe Iron	170.0	(0.030)	190.0	(0.030)	59.0	(0.030)
K Potassium	12.0	(0.30)	16.0	(0.30)	11.0	(0.30)
Mg Magnesium	28.0	(0.10)	28.0	(0.10)	17.0	(0.10)
Mn Manganese	4.9	(0.0030)	5.5	(0.0030)	2.2	(0.0030)
Mo Molybdenum	ND	(0.050)	ND	(0.050)	ND	(0.050)
Na Sodium	19.0	(0.080)	20.0	(0.080)	19.0	(0.080)
Ni Nickel	0.18	(0.020)	0.19	(0.020)	0.10	(0.020)
Pb Lead	0.18	(0.050)	0.15	(0.050)	0.090	(0.050)
Sb Antimony	0.35	(0.060)	0.14	(0.060)	0.12	(0.060)
Se Selenium	ND	(0.30)	0.40	(0.30)	ND	(0.30)
Si Silicon	120.0	(0.30)	110.0	(0.30)	50.0	(0.30)
Tl Thallium	ND	(0.090)	ND	(0.090)	ND	(0.090)
V Vanadium	0.38	(0.020)	0.41	(0.020)	0.17	(0.020)
Zn Zinc	0.29	(0.0060)	0.32	(0.0060)	0.089	(0.0060)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

# : Matrix spike outside control limits.

@ : Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.

ND: Not detected at specified detection limit

( ) : Detection limit

6-11-88

TABLE 4.2.3-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 5 (LANDFILL 5), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	EPA Standards, Criteria		5H		Monitor Well	
	02-169 29-Feb-88	04-31 11-Apr-88	04-31 11-Apr-88	02-153 24-Feb-88	Sample ID Date Sampled	P1 04-05 06-Apr-88
Total Dissolved Solids MG/L	660.0 (1.0)	580.0 (1.0)	380.0 (1.0)	370.0 (1.0)		
Fluoride MG/L						
Fluoride	4.0(M)	2.0(G)	0.30	0.27	0.17	0.17
Chloride MG/L						
Chloride	250.0(G)	21.0	26.0	25.0	18.0	18.0
Nitrate MG/L						
Nitrate + Nitrite	10.0(M)	0.65	1.6	0.020	0.060	0.060
Nitrate, colorimetric						
Orthophosphate MG/L						
Orthophosphate	ND	(0.020)	0.050	(0.020)	ND	(0.020)
Sulfate MG/L						
Sulfate, nephelometry	250.0(G)	27.0	46.0	48.0	52.0	52.0
Metals MG/L						
Arsenic, graphite AA	0.050(M)	0.040	0.011	ND	ND	(0.0020)
Mercury	0.0020(M)	ND	(0.00012)	ND	ND	(0.00012)
Lead, graphite AA	0.050(M)	0.022	ND	(0.0020)	ND	(0.00012)
Selenium, graphite AA	0.010(M)	ND	(0.0030)	ND	ND	(0.0050)
Metal Screen (ICP) MG/L						
Ag Silver	0.019	(0.0090)	ND	(0.0090)	0.020	(0.0090)
Al Aluminum	51.0	(0.20)	8.4	(0.20)	ND	(0.20)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

ND: Not detected at specified detection limit

( ): Detection limit

4-1-54



TABLE 4.2.3-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 5 (LANDFILL 5), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	Monitor Well							
	Sample ID							
	Date Sampled		Date Sampled		Date Sampled			
	5A	5A	5A	5A	5B			
	03-16	04-16	04-17	04-17	03-30			
	02-Mar-88	12-Apr-88	12-Apr-88	12-Apr-88	03-Mar-88			
Purgeable Halocarbons UG/L								
1,1,1-Trichloroethane	200.0(M)	200.0(G)	ND	(45.0)	ND	(45.0)	ND	(23.0)
1,1,2,2-Tetrachloroethane			ND	(60.0)	ND	(60.0)	ND	(30.0)
1,1,2-Trichloroethane			ND	(35.0)	ND	(35.0)	ND	(18.0)
1,1-Dichloroethane			ND	(45.0)	ND	(45.0)	ND	(23.0)
1,1-Dichloroethene	7.0(M)	7.0(G)	ND	(50.0)	ND	(50.0)	ND	(25.0)
1,2-Dichlorobenzene	620.0(G)		ND	(250.0)	ND	(250.0)	ND	(130.0)
1,2-Dichloroethane	5.0(M)	0.0(G)	ND	(15.0)	ND	(15.0)	ND	(7.5)
1,2-Dichloropropane			ND	(50.0)	ND	(50.0)	ND	(25.0)
1,3-Dichlorobenzene	400.0(G)		ND	(150.0)	ND	(150.0)	ND	(75.0)
1,4-Dichlorobenzene	750.0(M)	750.0(G)	ND	(200.0)	ND	(200.0)	ND	(100.0)
2-Chloroethylvinyl ether			ND	(100.0)	ND	(100.0)	ND	(50.0)
Bromodichloromethane			ND	(50.0)	ND	(50.0)	ND	(25.0)
Bromoform			ND	(150.0)	ND	(150.0)	ND	(75.0)
Bromomethane			ND	(600.0)	ND	(600.0)	ND	(300.0)
Carbon tetrachloride	5.0(M)	0.0(G)	ND	(50.0)	ND	(50.0)	ND	(25.0)
Chlorobenzene	60.0(G)		ND	(150.0)	ND	(150.0)	ND	(75.0)
Chloroethane			ND	(250.0)	ND	(250.0)	ND	(130.0)
Chloroform			ND	(25.0)	ND	(25.0)	ND	(13.0)
Chloromethane			ND	(150.0)	ND	(150.0)	ND	(75.0)
Dibromochloromethane			ND	(100.0)	ND	(100.0)	ND	(50.0)
Methylene chloride			ND	(150.0)	ND	(150.0)	ND	(75.0)
Tetrachloroethane	8.0(G)		ND	(15.0)	ND	(15.0)	ND	(7.5)
Trichloroethene	5.0(M)	0.0(G)	2600.0	(100.0)	3200.0	(100.0)	ND	(50.0)
Trichlorofluoromethane			ND	(50.0)	ND	(50.0)	ND	(25.0)
Vinyl chloride	2.0(M)	0.0(G)	ND	(100.0)	ND	(100.0)	ND	(50.0)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

1: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

2: Detected in Reagent Blank; background subtraction not performed

ND: Not detected at specified detection limit

( ): Detection limit

TABLE 4.2.3-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 5 (LANDFILL 5), GARSWELL AFB, TEXAS.

PARAMETER	EPA Standards, Criteria	Monitor Well					
		5A		5A		5B	
		Date Sampled					
		03-16	04-46	04-47	03-30		
		02-Mar-88	12-Apr-88	12-Apr-88	03-Mar-88		
		MD%	MD%	MD%	MD%		
cis-1,3-Dichloropropene		ND					
trans-1,2-Dichloroethene	70.0(G)	ND (100.0)	ND (100.0)	ND (100.0)	ND (50.0)		
trans-1,3-Dichloropropene		ND (150.0)	ND (150.0)	ND (150.0)	ND (75.0)		
Purgeable Aromatics UG/L							
1,2-Dichlorobenzene	620.0(G)	ND (40.0)	ND (40.0)	ND (40.0)	ND (40.0)		
1,3-Dichlorobenzene	400.0(G)	ND (40.0)	ND (40.0)	ND (40.0)	ND (40.0)		
1,4-Dichlorobenzene	750.0(M)	750.0(G)	750.0(G)	750.0(G)	750.0(G)		
Benzene	5.0(M)	0.0(G)	0.0(G)	0.0(G)	0.0(G)		
Chlorobenzene	60.0(G)	ND (30.0)	ND (30.0)	ND (30.0)	ND (30.0)		
Ethylbenzene	680.0(G)	ND (30.0)	ND (30.0)	ND (30.0)	ND (30.0)		
Toluene	2000.0(G)	ND (20.0)	ND (20.0)	ND (20.0)	ND (20.0)		
m-Xylene		ND (20.0)	ND (20.0)	ND (20.0)	ND (20.0)		
o-Xylene		ND (10.0)	ND (10.0)	ND (10.0)	ND (10.0)		
p-Xylene		ND (20.0)	ND (20.0)	ND (20.0)	ND (20.0)		
Extractable Priority Pollutants UG/L							
1,2,4-trichlorobenzene		ND (1.9)					
1,2-dichlorobenzene		ND (1.9)					
1,3-dichlorobenzene		ND (1.9)					
1,4-dichlorobenzene		ND (4.4)					
2,4,5-trichlorophenol		ND (10.0)					
2,4,6-trichlorophenol		ND (2.7)					
2,4-dichlorophenol	3090.0(G)	ND (2.7)					
2,4-dimethylphenol	400.0(G)	ND (2.7)					
2,4-dinitrophenol		ND (42.0)					

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

A: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

B: Detected in Reagent Blank; background subtraction not performed

ND: Not detected at specified detection limit

( ) : Detection limit

Garswell AFB, Texas

TABLE 4.2.3-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 5 (LANDFILL 5), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards, Criteria		Monitor Well	
	5A	03-16	5A	5B
2,4-dinitrotoluene	ND	(5.7)	5A	5B
2,6-dinitrotoluene	ND	(1.9)	04-46	03-30
2-chloronaphthalene	ND	(1.9)	04-47	03-30
2-chlorophenol	ND	(3.3)	12-Apr-88	03-Mar-88
2-methylnaphthalene	ND	(10.0)		
2-methylphenol	ND	(10.0)		
2-nitroaniline	ND	(50.0)		
2-nitrophenol	ND	(3.6)		
3,3'-dichlorobenzidine	ND	(17.0)		
4,6-dinitro-2-methylphenol	ND	(24.0)		
4-bromophenyl-phenylether	ND	(1.9)		
4-chloro-3-methylphenol	ND	(3.0)		
4-chloroaniline	ND	(10.0)		
4-chlorophenyl-phenylether	ND	(4.2)		
4-methylphenol	ND	(10.0)		
4-nitroaniline	ND	(50.0)		
4-nitrophenol	ND	(2.4)		
acenaphthene	0.030(G)	(1.9)		
acenaphthylene	ND	(3.5)		
anthracene	ND	(1.9)		
benzo(a)anthracene	ND	(7.8)		
benzo(a)pyrene	ND	(2.5)		
benzo(b)fluoranthene	ND	(4.8)		
benzo(g,h,i)perylene	ND	(4.1)		
benzo(k)fluoranthene	ND	(2.5)		
benzoic acid	ND	(50.0)		

- D R A F T -

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

A: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

B: Detected in Reagent Blank; background subtraction not performed

ND: Not detected at specified detection limit

( ) : Detection limit

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TABLE 4.2.3-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 5 (LANDFILL 5), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards, Criteria	Monitor Well	
		Sample ID	Date Sampled
		5A	5B
		03-16	04-47
		02-Mar-88	12-Apr-88
benzyl alcohol		ND (50.0)	ND (50.0)
bis(2-chloroethoxy)methane		ND (5.3)	ND (5.3)
bis(2-chloroethyl) ether		ND (5.7)	ND (5.7)
bis(2-chloroisopropyl) ether		ND (5.7)	ND (5.7)
bis(2-ethylhexyl) phthalate	15000.0(G)	5.28	(2.5)
butylbenzylphthalate	940.0(G)	ND (2.5)	ND (2.5)
chrysene		ND (2.5)	ND (2.5)
di-n-butylphthalate	35000.0(G)	ND (2.5)	ND (2.5)
di-n-octyl phthalate		ND (2.5)	ND (2.5)
dibenzo(a,h)anthracene		ND (2.5)	ND (2.5)
dibenzofuran		ND (10.0)	ND (10.0)
diethylphthalate		ND (1.9)	ND (1.9)
dimethyl phthalate		ND (1.6)	ND (1.6)
fluoranthene	0.030(G)	ND (2.2)	ND (2.2)
fluorene	0.030(G)	ND (1.9)	ND (1.9)
hexachlorobenzene		ND (1.9)	ND (1.9)
hexachlorobutadiene		ND (0.90)	ND (0.90)
hexachlorocyclopentadiene		ND (6.0)	ND (6.0)
hexachloroethane		ND (1.6)	ND (1.6)
indeno(1,2,3-cd)pyrene		ND (3.7)	ND (3.7)
isophorone	5200.0(G)	ND (2.2)	ND (2.2)
n-nitroso-di-n-propylamine		ND (12.0)	ND (12.0)
n-nitrosodiphenylamine		ND (1.9)	ND (1.9)
naphthalene	620.0(G)	ND (1.6)	ND (1.6)
nitrobenzene		ND (1.9)	ND (1.9)
pentachlorophenol	200.0(G)	ND (3.6)	ND (3.6)

- D R A F T -

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

†: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

‡: Detected in Reagent Blank; background subtraction not performed

ND: Not detected at specified detection limit

( ): Detection limit

TABLE 4.2.3-4

TABLE 4.2.3-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 5 (LANDFILL 5), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	EPA Standards, Criteria	Monitor Well	
		Sample ID	Date Sampled
phenanthrene	0.030(G)	5A 03-16 02-Mar-88	5A 04-47 12-Apr-88
phenol	3500.0(G)	(5.4)	5B 03-30 03-Mar-88
pyrene	0.030(G)	(1.5)	
		(1.9)	

- DRAFT -

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), C-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

t: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

B: Detected in Reagent Blank; background subtraction not performed

ND: Not detected at specified detection limit

( ): Detection Limit

TABLE 4.2.3-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 5 (LANDFILL 5), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	Monitor Well			
	Sample ID			
	Date Sampled			
	5B	5C	5C	5D
EPA Standards,	04-44	03-15	04-49	03-19
Criteria	12-Apr-88	02-Mar-88	13-Apr-88	02-Mar-88
Purgeable Halocarbons UG/L				
1,1,1-Trichloroethane	200.0(M) 200.0(G)	ND (23.0)	ND (45.0)	67.0 (4.5)
1,1,2,2-Tetrachloroethane		ND (30.0)	ND (60.0)	ND (6.0)
1,1,2-Trichloroethane		ND (18.0)	ND (35.0)	ND (3.5)
1,1-Dichloroethane		ND (23.0)	ND (45.0)	ND (4.5)
1,1-Dichloroethene	7.0(M) 7.0(G)	ND (25.0)	ND (50.0)	ND (5.0)
1,2-Dichlorobenzene	620.0(G)	ND (130.0)	ND (250.0)	ND (25.0)
1,2-Dichloroethane	5.0(M) 0.0(G)	ND (7.5)	ND (15.0)	ND (1.5)
1,2-Dichloropropane		ND (25.0)	ND (50.0)	ND (5.0)
1,3-Dichlorobenzene	400.0(G)	ND (75.0)	ND (150.0)	ND (15.0)
1,4-Dichlorobenzene	750.0(M) 750.0(G)	ND (100.0)	ND (200.0)	ND (20.0)
2-Chloroethylvinyl ether		ND (50.0)	ND (100.0)	ND (10.0)
Bromodichloromethane	*	ND (25.0)	ND (50.0)	ND (5.0)
Bromoform		ND (75.0)	ND (150.0)	ND (15.0)
Bromomethane		ND (300.0)	ND (600.0)	ND (60.0)
Carbon tetrachloride	5.0(M) 0.0(G)	ND (25.0)	ND (50.0)	ND (5.0)
Chlorobenzene	60.0(G)	ND (75.0)	ND (150.0)	ND (15.0)
Chloroethane		ND (130.0)	ND (250.0)	ND (25.0)
Chloroform		ND (13.0)	ND (25.0)	ND (2.5)
Chloroethane		ND (75.0)	ND (150.0)	ND (15.0)
Dibromochloromethane		ND (50.0)	ND (100.0)	ND (10.0)
Methylene chloride		ND (75.0)	ND (150.0)	ND (15.0)
Tetrachloroethane	8.0(G)	ND (7.5)	ND (15.0)	ND (1.5)
Trichloroethane	5.0(M) 0.0(G)	ND (50.0)	1800.0 (100.0)	170.0 (10.0)
Trichlorofluoromethane		ND (25.0)	ND (50.0)	ND (5.0)
Vinyl chloride	2.0(M) 0.0(G)	110.0 (50.0)	ND (100.0)	ND (10.0)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

±: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

⊖: Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.

ND: Not detected at specified detection limit

( ): Detection limit

TABLE 4.2.3-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 5 (LANDFILL 5), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well			
	Sample ID			
	Date Sampled			
	58	5C	5C	5D
EPA Standards,	04-44	03-15	04-49	03-19
Criteria	12-Apr-88	02-Mar-88	13-Apr-88	02-Mar-88
cis-1,3-Dichloropropene	MDL	MDL	MDL	MDL
trans-1,2-Dichloroethane	MD (50.0)	MD (100.0)	MD (50.0)	MD (10.0)
trans-1,3-Dichloropropene	MD (75.0)	MD (150.0)	MD (75.0)	MD (15.0)
Purgeable Aromatics UG/L				
1,2-Dichlorobenzene	MD (40.0)	MD (40.0)	MD (40.0)	MD (10.0)
1,3-Dichlorobenzene	MD (40.0)	MD (40.0)	MD (40.0)	MD (10.0)
1,4-Dichlorobenzene	750.0(M)	750.0(G)	MD (30.0)	MD (8.0)
Benzene	5.0(M)	0.0(G)	MD (20.0)	MD (5.0)
Chlorobenzene	60.0(G)	MD (30.0)	MD (30.0)	MD (8.0)
Ethylbenzene	680.0(G)	MD (30.0)	MD (30.0)	MD (8.0)
Toluene	2000.0(G)	MD (20.0)	MD (20.0)	MD (5.0)
m-Xylene	MD (10.0)	MD (10.0)	MD (10.0)	MD (3.0)
o-Xylene	MD (20.0)	MD (20.0)	MD (20.0)	MD (5.0)
p-Xylene	MD (20.0)	MD (20.0)	MD (20.0)	MD (5.0)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

6: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

8: Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.

MD: Not detected at specified detection limit

( ): Detection limit

TABLE 4.2.3-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 5 (LANDFILL 5), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well				
	Sample ID				
	50	5E	5E	5P	
EPA Standards, Criteria	04-43 12-Apr-88	03-21 02-Mar-88	04-45 12-Apr-88	03-37 04-Mar-88	
Purgeable Halocarbons (UG/L)					
1,1,1-Trichloroethane	200.0(M)	200.0(G)	ND (2.3)	ND (23.0)	ND (45.0)
1,1,2,2-Tetrachloroethane			ND (3.0)	ND (30.0)	ND (60.0)
1,1,2-Trichloroethane			ND (1.8)	ND (18.0)	ND (35.0)
1,1-Dichloroethane			ND (2.3)	ND (23.0)	ND (45.0)
1,1-Dichloroethene	7.0(M)	7.0(G)	ND (2.5)	ND (25.0)	ND (50.0)
1,2-Dichlorobenzene	620.0(G)		ND (13.0)	ND (130.0)	ND (250.0)
1,2-Dichloroethane	5.0(M)	0.0(G)	ND (0.75)	ND (7.5)	ND (15.0)
1,2-Dichloropropane			ND (2.5)	ND (25.0)	ND (50.0)
1,3-Dichlorobenzene	400.0(G)		ND (7.5)	ND (75.0)	ND (150.0)
1,4-Dichlorobenzene	750.0(M)	750.0(G)	ND (10.0)	ND (100.0)	ND (200.0)
2-Chloroethylvinyl ether			ND (5.0)	ND (50.0)	ND (100.0)
Bromodichloromethane			ND (2.5)	ND (25.0)	ND (50.0)
Bromoform			ND (7.5)	ND (75.0)	ND (150.0)
Bromomethane			ND (30.0)	ND (300.0)	ND (600.0)
Carbon tetrachloride	5.0(M)	0.0(G)	ND (2.5)	ND (25.0)	ND (50.0)
Chlorobenzene	60.0(G)		ND (7.5)	ND (75.0)	ND (150.0)
Chloroethane			ND (13.0)	ND (130.0)	ND (250.0)
Chloroform			ND (1.3)	ND (13.0)	ND (25.0)
Chloromethane			ND (7.5)	ND (75.0)	ND (150.0)
Dibromochloromethane			ND (5.0)	ND (50.0)	ND (100.0)
Methylene chloride			ND (7.5)	ND (75.0)	ND (150.0)
Tetrachloroethene	8.0(G)		ND (0.75)	ND (7.5)	ND (15.0)
Trichloroethene	5.0(M)	0.0(G)	52.0 (5.0)	770.0 (50.0)	3700.0 (100.0)
Trichlorofluoromethane			ND (2.5)	ND (25.0)	ND (50.0)
Vinyl chloride	2.0(M)	0.0(G)	ND (5.0)	ND (50.0)	ND (100.0)
cis-1,3-Dichloropropene			ND	ND	ND

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

±: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

ND: Not detected at specified detection limit

( ): Detection Limit

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TABLE 4.2.3-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 5 (LANDFILL 5), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well			
	Sample ID			
	Date Sampled			
	SF	5F	5G	5G
	03-38	04-66	02-168	04-32
	04-Mar-88	14-Apr-88	29-Feb-88	11-Apr-88
EPA Standards,	5F	5F	5G	5G
Criteria	03-38	04-66	02-168	04-32
Purgeable Halocarbons UG/L				
1,1,1-Trichloroethane	200.0(M)	200.0(G)	ND	(45.0)
1,1,2,2-Tetrachloroethane			ND	(60.0)
1,1,2-Trichloroethane			ND	(35.0)
1,1-Dichloroethane			ND	(45.0)
1,1-Dichloroethene	7.0(M)	7.0(G)	ND	(50.0)
1,2-Dichlorobenzene	620.0(G)		ND	(250.0)
1,2-Dichloroethane	5.0(M)	0.0(G)	ND	(15.0)
1,2-Dichloropropane			ND	(50.0)
1,3-Dichlorobenzene	400.0(G)		ND	(150.0)
1,4-Dichlorobenzene	750.0(M)	750.0(G)	ND	(200.0)
2-Chloroethylvinyl ether			ND	(100.0)
Bromodichloromethane			ND	(50.0)
Bromoform			ND	(150.0)
Bromomethane			ND	(600.0)
Carbon tetrachloride	5.0(M)	0.0(G)	ND	(50.0)
Chlorobenzene	60.0(G)		ND	(150.0)
Chloroethane			ND	(250.0)
Chloroform			ND	(25.0)
Chloromethane			ND	(150.0)
Dibromochloromethane			ND	(100.0)
Methylene chloride			ND	(150.0)
Tetrachloroethane			ND	(150.0)
Trichloroethene	8.0(G)		ND	(15.0)
Trichlorofluoromethane	5.0(M)	0.0(G)	3800.0	(100.0)
			1200.0	(100.0)
			ND	(50.0)
			ND	(23.0)
			ND	(30.0)
			ND	(18.0)
			ND	(23.0)
			ND	(25.0)
			ND	(130.0)
			ND	(7.5)
			ND	(25.0)
			ND	(75.0)
			ND	(100.0)
			ND	(50.0)
			ND	(75.0)
			ND	(7.5)
			1000.0	(50.0)
			ND	(25.0)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

†: cis-1,3-Dichloropropene cannot be quantitated due to coelution.  
 @Q: Analytical spike and daily EPA control sample recovery were outside 95% confidence limits.  
 Q: Daily EPA QC recovery outside 95% confidence limit.  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

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TABLE 4.2.3-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 5 (LANDFILL 5), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well			
	Sample ID		Date Sampled	
	5H	P1	5H	P1
	EPA Standards, 02-169	04-31	02-153	04-05
	Criteria 29-Feb-88	11-Apr-88	24-Feb-88	06-Apr-88
Purgeable Halocarbons UG/L				
1,1,1-Trichloroethane	200.0(M)	ND (23.0)	ND (0.090)	ND (0.090)
1,1,2,2-Tetrachloroethane		ND (30.0)	ND (0.12)	ND (0.12)
1,1,2-Trichloroethane		ND (18.0)	ND (0.070)	ND (0.070)
1,1-Dichloroethane		ND (23.0)	ND (0.090)	ND (0.090)
1,1-Dichloroethene	7.0(M)	ND (25.0)	ND (0.10)	ND (0.10)
1,2-Dichlorobenzene	620.0(G)	ND (130.0)	ND (0.50)	ND (0.50)
1,2-Dichloroethane	5.0(M)	ND (7.5)	ND (0.030)	ND (0.030)
1,2-Dichloropropane		ND (25.0)	ND (0.10)	ND (0.10)
1,3-Dichlorobenzene	400.0(G)	ND (75.0)	ND (0.30)	ND (0.30)
1,4-Dichlorobenzene	750.0(M)	ND (100.0)	ND (0.40)	ND (0.40)
2-Chloroethylvinyl ether		ND (50.0)	ND (0.20)	ND (0.20)
Bromo-dichloromethane		ND (25.0)	ND (0.10)	ND (0.10)
Bromoform		ND (75.0)	ND (0.30)	ND (0.30)
Bromomethane		ND (300.0)	ND (1.2)	ND (1.2)
Carbon tetrachloride	5.0(M)	ND (25.0)	ND (0.10)	ND (0.10)
Chlorobenzene	60.0(G)	ND (75.0)	ND (0.30)	ND (0.30)
Chloroethane		ND (130.0)	ND (0.50)	ND (0.50)
Chloroform		ND (13.0)	ND (0.30)	ND (0.30)
Chloromethane		ND (75.0)	ND (0.30)	ND (0.30)
Dibromochloromethane		ND (50.0)	ND (0.20)	ND (0.20)
Methylene chloride		ND (75.0)	ND (0.30)	ND (0.30)
Tetrachloroethene	8.0(G)	ND (7.5)	ND (0.030)	ND (0.030)
Trichloroethane	5.0(M)	2600.0 (50.0)	ND (0.20)	ND (0.20)
Trichlorofluoromethane		ND (25.0)	ND (0.10)	ND (0.10)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

- A: cis-1,3-Dichloropropene cannot be quantitated due to coelution.
- B: Detected in Reagent Blank; background subtraction not performed
- Q: Daily EPA QC recovery outside 95% confidence limit.
- ND: Not detected at specified detection limit
- ( ): Detection limit

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TABLE 4.2.3-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 5 (LANDFILL 5), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well			
	Sample ID		Date Sampled	
	SH	SH	P1	P1
	02-169	04-31	02-153	04-05
	29-Feb-88	11-Apr-88	24-Feb-88	06-Apr-88
	EPA Standards,	Criteria		
Vinyl chloride	2.0(M)	0.0(G)	ND (50.0)	ND (0.20)
cis-1,3-Dichloropropene	ND	ND	ND	ND
trans-1,2-Dichloroethene	ND	70.0(G)	ND	ND
trans-1,3-Dichloropropene	ND	75.0(G)	ND	ND
Purgeable Aromatics UG/L				
1,2-Dichlorobenzene	620.0(G)		ND (40.0)	ND (0.40)
1,3-Dichlorobenzene	400.0(G)		ND	ND
1,4-Dichlorobenzene	750.0(M)	750.0(G)	ND (30.0)	ND (0.30)
Benzene	5.0(M)	0.0(G)	ND (20.0)	ND (0.20)
Chlorobenzene	60.0(G)		ND (30.0)	ND (0.30)
Ethylbenzene	680.0(G)		ND (30.0)	ND (0.30)
Toluene	2000.0(G)		ND (20.0)	0.60 (0.20)
m-Xylene			ND (20.0)	NDQ (0.20)
o-Xylene			ND (10.0)	ND (0.10)
p-Xylene			NDQ (20.0)	ND (0.20)
Extractable Priority Pollutants UG/L				
1,2,4-trichlorobenzene				ND (2.1)
1,2-dichlorobenzene				ND (2.1)
1,3-dichlorobenzene				ND (2.1)
1,4-dichlorobenzene	750.0(G)			ND (4.8)
2,4,5-trichlorophenol				ND (11.0)
2,4,6-trichlorophenol				ND (3.0)
2,4-dichlorophenol	3090.0(G)			ND (3.0)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG), C-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

A: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

B: Detected in Reagent Blank; background subtraction not performed

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ): Detection limit

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TABLE 4.2.3-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 5 (LANDFILL 5), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards, Criteria		Monitor Well	
	SH	SH	Sample ID	Date Sampled
Isophorone	5200.0(G)			
n-nitroso-di-n-propylamine				
n-nitrosodimethylamine				
n-nitrosodiphenylamine				
naphthalene	620.0(G)			
nitrobenzene				
pentachlorophenol	200.0(G)			
phenanthrene	0.030(G)			
phenol	3500.0(G)			
pyrene	0.030(G)			
			5H	P1
			04-31	04-05
			11-Apr-88	06-Apr-88
			29-Feb-88	
			02-153	
			24-Feb-88	
				ND (2.4)
				ND (13.0)
				ND (11.0)
				ND (2.1)
				ND (1.8)
				ND (2.1)
				ND (4.0)
				ND (5.9)
				ND (1.7)
				ND (2.1)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

- A: cis-1,3-Dichloropropene cannot be quantitated due to coelution.
- B: Detected in Reagent Blank; background subtraction not performed.
- Q: Daily EPA QC recovery outside 95% confidence limit.
- ND: Not detected at specified detection limit
- ( ): Detection limit

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TABLE 4.2.3-5. RESULTS OF FIELD ANALYSES FOR WATER SAMPLES, SITE 5 (LANDFILL 5), CARSWELL AFB, TEXAS

Monitor Well  
Sample ID  
Date Sampled

Analyte	Unit of Measure	5A	5B
		03-16	03-30
		02-Mar-88	03-Mar-88
		04-46	04-64
		12-Apr-88	12-Apr-88
Alkalinity	mg/L	575.0	535.0
Specific Conductance	uMOS/CM	870.0	890.0
Temperature	C	18.0	16.0
pH	S.U.	6.7	7.0
		(1.0)	(5.0)
		(1.0)	(10.0)
		(0.010)	(1.0)
		(0.010)	(0.010)

- DRAFT -

( ): Detec Limit

TABLE 4.2.3-5. RESULTS OF FIELD ANALYSES FOR WATER SAMPLES, SITE 5 (LANDFILL 5), CARSWELL AFB, TEXAS

Monitor Well  
Sample ID  
Date Sampled

Analyte	Unit of Measure	5C 03-15 02-Mar-88	5C 04-49 13-Apr-88	5D 03-19 02-Mar-88	5D 04-43 12-Apr-88
Alkalinity	mg/L	440.0 (5.0)	790.0 (10.0)	979.0 (1.0)	880.0 (5.0)
Specific Conductance	µMOS/CM	981.0 (1.0)	16.0 (1.0)	18.0 (1.0)	940.0 (10.0)
Temperature	C	6.7 (0.010)	6.8 (0.010)	6.6 (0.010)	17.0 (1.0)
pH	S.U.				7.6 (0.010)

- D R A F T -

TABLE 4.2.3-5. RESULTS OF FIELD ANALYSES FOR WATER SAMPLES, SITE 5 (LANDFILL 5), CARSWELL AFB, TEXAS

Monitor Well  
Sample ID  
Date Sampled

Analyte	Unit of Measure	5E 03-21 02-Mar-88	5E 04-45 12-Apr-88	5F 03-37 04-Mar-88	5F 04-66 14-Apr-88
Alkalinity	mg/L	3440.0	(5.0)	15000.0	(5.0)
Specific Conductance	uMHOS/CM	833.0	(10.0)	764.0	(10.0)
Temperature	C	18.5	(1.0)	19.0	(1.0)
pH	S. U.	6.9	(0.010)	6.6	(0.010)

- DRAFT -

( ): Detec Limit

TABLE 4.2.3-5. RESULTS OF FIELD ANALYSES FOR WATER SAMPLES, SITE 5 (LANDFILL 5), CARSWELL AFB, TEXAS

Monitor Well  
Sample ID  
Date Sampled

Analyte	Unit of Measure	SG 02-168 29-Feb-88	SG 04-32 11-Apr-88	5B 02-169 29-Feb-88	5B 04-31 11-Apr-88
Alkalinity	mg/L	799.0	740.0	795.0	875.0
Specific Conductance	µMHOS/CM	19.0	710.0	19.0	750.0
Temperature	C	7.1	17.5	19.0	17.0
pH	S.U.	(0.010)	(0.010)	(0.010)	(0.010)

- D R A F T -

TABLE 4.2.3-5. RESULTS OF FIELD ANALYSES FOR WATER SAMPLES, SITE 5 (LANDFILL 5), CARSWELL AFB, TEXAS

Analyte	Unit of Measure	Monitor Well Sample ID	Date Sampled
Alkalinity	mg/L	P1	04-05
Specific Conductance	µMOS/CM		06-Apr-88
Temperature	C		
pH	S.U.		

280.0 (5.0)  
560.0 (10.0)  
20.0 (1.0)  
7.7 (0.010)

( ): Date Limit

Water Quality Indicators--Total dissolved solids (TDS) ranged from 380 mg/L to 770 mg/L in the upper zone monitor wells and averaged about 375 mg/L in the Paluxy well (P1). Except for wells 5G and 5H, there was a noticeable increase in TDS values in upper zone wells between the two sampling events. Similarly, nitrate and sulfate concentrations increased between sampling events in all upper zone wells. The highest concentrations of these parameters were in well 5A, having nitrate levels at 4.8 mg/L and sulfate at 110 mg/L. The overall trend in the water quality parameters was one of increasing values between sampling rounds in all upper zone wells, except 5D and 5G. Water quality indicators in the Paluxy well (P1) remained stable between samplings.

Heavy Metals--Concentrations of heavy metals in ground water were determined to exceed MCLs in the first round of sampling for: arsenic in wells 5D, 5E, and 5G; lead in 5A, 5D, 5E, and 5F; and chromium in 5A, 5B, 5D, 5E, 5F, 5G, and 5H. Second round values of heavy metals that exceeded the MCLs are arsenic at well 5F; lead in 5C and 5F; chromium in 5C and 5F; and barium in 5F. Except for wells 5B, 5C, and 5F, the trend in heavy metal concentrations at Site 5 was an overall decrease from the first to second sampling rounds. MCLGs for iron and manganese were exceeded in all samples from the upper zone at Site 5. Iron in the Paluxy well (P1) was above the MCLG in the first round, but not in the second. Concentrations of iron and manganese were generally in excess of MCLGs in ground water sampled from the upper zone.

Purgeable Halocarbons--Trichloroethene (TCE) was detected in every sample from the upper zone wells, except well 5B. The highest TCE concentration (3,800 µg/L) occurred at well 5F and the lowest concentration (52 µg/L) occurred at 5D. The upgradient wells, 5A and 5E, both experienced increased concentrations between sampling rounds. 1,1,1-trichloroethane was detected (67 µg/L) in the first round sample at 5D. Other purgeable halocarbons detected above MCL values included vinyl chloride and trans-1,2-dichloroethene. Vinyl chloride was not detected in well 5B in March, but was detected at 110 µg/L in the April 1988 sample. In well 5F,

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trans-1,2,-dichloroethene was detected (and verified by duplicate) with a concentration averaging 900 µg/L in first round, but was not detected in the second round.

No purgeable halocarbons were detected in well P1.

Purgeable Aromatics--The only detected purgeable aromatic in the upper zone was benzene (220 µg/L), which was detected in the first round sample from well 5G. Benzene was not detected in the second sampling at 5G.

Samples from the Paluxy well (P1) contained toluene ranging from 0.60 µg/L (round 1) to 5.7 µg/L (round 2). These concentrations are below the MCLG for toluene, and were probably due to sample-container contaminants, based on trip- and field-blank results (see Section 4.5).

Extractable Priority Pollutants--Water samples from wells 5A and P1 were analyzed for extractable priority pollutants. Bis(2-ethylhexyl)phthalate was detected in low levels at both well 5A (5.2 µg/L) and P1 (3.0 µg/L). This compound was also detected in the reagent blank, without background subtraction performed. Di-n-butylphthalate (9.4 µg/L) was also detected in P1 and the reagent blank.

#### 4.2.3.3 Significance of Findings

The principal effort for the Stage 2 field program at Site 5 was to define the extent of contamination in ground water in the upper zone. The following paragraphs contain a discussion of the significance of the findings for soil and ground-water contamination at Landfill 5.

Soil--Since most of the Stage 2 monitor wells were installed either on the base golf course or west of Landfill 5, areas not affected by waste disposal activities, soil analyses did not yield any evidence of contaminants in the upper zone above the water table. Only at well 5D, which was drilled at the northwestern boundary of Landfill 5, were minor amounts of near-surface

wastes (e.g., trash, construction debris) encountered during drilling. Below the water table, soil samples did yield evidence of contaminants associated with the plume of halogenated organic compounds in the ground water. Therefore, the main concern regarding possible contaminated soils in the vadose zone would be focused directly on Landfill 5 itself, not at golf course locations outside the landfill boundary.

Ground Water--The Stage 1 findings regarding the nature and occurrence of ground-water contaminants are supported and amplified by the Stage 2 results. The principal conclusions of the Stage 2 program are:

1. The principal ground-water contaminant in the upper zone is trichloroethene (TCE).
2. TCE occurs in upper zone wells downgradient (generally east) of the landfill and in upper zone wells upgradient to the southwest, but not (or in concentrations much less than MCL values) in wells north and northeast of the landfill (e.g., 5B, 11A, and 11B).
3. Ground water in the Paluxy aquifer contains no halogenated or aromatic organic compounds. Levels of toluene in P1 samples may be attributed to trace amounts of toluene in sample containers, based on trip blank and field blank results.

Zones of Contamination--The ground-water contamination at Landfill 5, and other Flightline Area sites, is best described in terms of TCE, which has consistently been detected in the upper zone. Figure 4.2.2-1 is a contour map of TCE concentrations in the upper zone for Flightline Area sites, including Landfill 5. The contour map illustrates a plume of TCE outlined by, but not limited to, the 1,000  $\mu\text{g/L}$  TCE contour line that encompasses much of Landfill 4, all of Site 10, the southern portion of Landfill 5, areas west of Landfill 5 and Site 10, and the golf course area east of the Flightline sites. The size and shape of the TCE plume was consistent between sampling rounds,

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and also with the Stage 1 data. The center (i.e., highest concentrations of TCE) of the plume is at well 10B, southeast of Landfill 5. The western limit of the plume is not completely defined, since ground water from wells 5A and 5E is upgradient of all IRP sites and is within the plume. The eastern limit of the plume is also not completely defined; wells 5H, 5C, 4G, and 4H are within the plume such that the contour lines can not be "closed" to define the limit of the TCE.

While TCE serves as an appropriate indicator of contamination, the absence of TCE in some areas does not preclude the inclusion of the areas in a contamination plume because of the variable chemistry of the plume. For example, vinyl chloride has been consistently detected at well 5B (both in Stage 1 and 2), although TCE has been absent. Because of the presence of vinyl chloride, ground water at 5B is considered to be in the contaminant plume. Similarly, metals concentrations above MCLs, while not exhibiting a consistent trend or correlated to TCE concentrations, are also considered to be evidence of a contaminant plume in the upper zone.

Contaminant Migration--The Stage 2 results indicate the following regarding the source and migration of contaminants at Landfill 5.

1. The plume of TCE in ground water detected in Site 5 wells is due to multiple sources, probably including Landfill 5. Of particular interest in discussing the source of the TCE plume near Landfill 5 is the occurrence of TCE in upgradient wells 5A and 5E. Upon completion and review of ground-water analyses, a field survey was conducted of the area outside of the IRP site boundaries west of Landfill 5 to determine possible explanations for the occurrence of upgradient TCE concentrations. Building 4126, southwest of the landfill and north of White Settlement Road, was inspected and determined to have been the site of previous fire department training exercises. The building is a two-story structure, obviously used for fire training because of scorched block walls and

sprinkler facilities in the interior. The area in the vicinity of Building 4126 is also labeled "Fire Training Area" on the Carswell AFB "Comprehensive Plan - Base Layout" map, dated May, 1986. Based on the evidence of fire department training at this building, it is reasonable to assume that the presence of TCE in the upper zone is due to infiltration of flammable solvents associated with the training.

Levels of TCE in wells 5C, 5G, and 5H are probably due primarily to Landfill 5, with possible contributions from other sites. The disposal methods and types of waste materials believed to be at Landfill 5 are consistent with the types and amounts of contaminants observed in downgradient wells. TCE in well 5F is probably due to a source other than Landfill 5, since ground-water flow lines from Landfill 5 would not intersect the area near well 5F.

2. The interpretation of chemistry data from well 5B and the position of well 5B peripheral to ground-water flow pathways from the landfill also suggest contaminant sources other than Landfill 5. Although well 5B is screened in the same alluvial materials as other flightline wells, the proximity of 5B to the small tributary to Farmers Branch suggests that surface water infiltration in this area would affect the composition of the contaminant plume. Since the tributary originates at Site 12, the active fire department training area, contaminated runoff (documented in the Stage 1 investigation) likely affects ground-water chemistry at 5B. The existence of a clay berm around the landfill, documented in the Phase I report (CH2M-Hill, 1984) and discovered in the Stage 1 geophysical survey (Radian, 1986), may also influence or deflect ground-water flow lines in the vicinity of the small tributary.

3. Although the downgradient limit of the TCE plume has not been completely defined by the current well configuration, the occurrence of TCE at Site 5 wells nearly 700 feet east of the east boundary of the landfill (5G and 5H) is reasonable considering the prevailing direction of ground-water flow and the estimated ground-water flow rate in the upper zone. Since the ground-water flow rate in the upper zone is estimated to be approximately 0.2 feet per day, contaminants may be expected east of the current well system, assuming that the direction and rate of ground-water flow has remained constant over the last 25 years.
  
4. Contaminants in the upper zone ground water would not be expected to move off-base, since ground-water in the upper zone flows toward Farmers Branch or its tributaries, which are completely on base property. To determine if ground-water discharge was visible at the surface near Farmers Branch, a field survey of upper zone and bedrock outcrop at Farmers Branch was conducted in August 1988. The survey indicated that the creek flows over limestone, with the south cut bank of the creek exposed in limestone. No seeps or springs in the limestone were observed, although a zone (approximately 40 feet long, several feet wide) of moist soil and green grass (in a field of otherwise dead grass) was observed at the contact between alluvial (upper zone) and bedrock material at the south side of Farmers Branch. Thus, upper zone ground water (and contaminants, if present) probably is discharged to the land surface within the base directly by evaporation or evapotranspiration in a diffuse seepage zone where the alluvial materials pinch out and disappear at Farmers Branch.

4.2.3.4 Baseline Risk Assessment

Summary of Indicator Chemicals

Results of the Stage 2 investigation indicate the presence of these indicator chemicals in at least one soil and/or ground water sample at the site:

<u>Metals</u>	<u>PNAs</u>	<u>VOCs</u>
Antimony	Bis(2-ethylhexyl)-	Benzene
Arsenic	phthalate	Methylene chloride
Barium		Toluene
Beryllium		Trichloroethene
Cadmium		Vinyl chloride
Chromium		
Lead		
Nickel		
Selenium		
Silver		

Tables 3.8-2, 3.8-3, and 3.8-4 in Section 3.8 present important physical, chemical, and biological characteristics for these and all other indicator chemicals.

Some of the above indicator chemicals, particularly those at very low concentrations, may be due in part to matrix interferences or sample vial contamination. Nevertheless, these chemicals were included in the risk assessment process in order to ensure a conservative (stringent-case) evaluation of possible health risks.

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Source and Release Characterization

Possible sources of contaminant release from Landfill 5, as for Landfills 3 and 4, include: 1) volatilization to the air, 2) fugitive dust generation, 3) recharge to ground water, 4) surface runoff, and 5) direct release to surface water.

Volatilization to the Air--VOCs present in the soil are subject to volatilization to the air by virtue of high vapor pressures. PNAs generally have very low vapor pressures and are not subject to volatilization. Most metals are nonvolatile as well. Indicator chemicals detected at the site which can volatilize include benzene, methylene chloride, toluene, trichloroethene, and vinyl chloride.

Estimated emission rates based conservatively on maximum concentrations detected in the soil or ground water at the site are:

<u>Indicator Chemical</u>	<u>Emission Rate</u> <u>(grams/second)</u>
Benzene	$5.40 \times 10^{-6}$
Methylene chloride	$1.70 \times 10^{-7}$
Toluene	$2.38 \times 10^{-7}$
Trichloroethene	$6.32 \times 10^{-5}$
Vinyl chloride	$7.51 \times 10^{-5}$

The methodology used to estimate emission rates is described in Section 3.8.

Fugitive Dust Generation--Contaminants must be present in surface soil uncovered by impervious materials or vegetation to be subject to fugitive dust generation. Because wastes are buried at Landfill 5 and the surface is revegetated, contaminants present in the subsoil at this site are not subject to significant fugitive dust generation.

Recharge to Ground Water--Indicator chemicals detected in the ground water near Landfill 5 include: antimony, arsenic, barium, beryllium, cadmium, chromium, lead, nickel, selenium, silver, bis(2-ethylhexyl)phthalate, benzene, toluene, trichloroethene, and vinyl chloride. Section 4.1 summarizes and discusses the significance of the concentrations detected in the ground water at the site.

Surface Runoff--Contaminants must be present in surface soil uncovered by impervious materials to be subject to significant surface runoff during precipitation. Landfill 5 was covered and vegetated after waste burial operations ceased, as were Landfills 3 and 4. However, because the landfill was constructed above ground level and adjacent to a small tributary to Farmers Branch, there is a greater potential for surface runoff of contaminants than there is for Landfills 3 and 4.

Discharge to Surface Water--There is no known direct discharge of contaminants from this site to surface water. The potential exists for contaminants to leach through the clay berm to the adjacent small tributary to Farmers Branch. Therefore, this release mechanism cannot be entirely dismissed. However, there is no evidence to date of any aqueous discharge from the berm after precipitation.

Transport and Fate of Contaminants

Landfill 5 potentially releases VOCs to the air via volatilization and VOCs, bis(2-ethylhexyl)phthalate, and metals to the ground and surface water via site leaching, surface runoff, and discharge to an adjacent Farmers Branch tributary. Potentially significant contaminant transport and fate mechanisms in the air and ground and surface water media include: 1) air dispersion, 2) ground water migration, 3) transport in surface water, and 4) subsequent uptake by plants and animals. Except for transport in surface water, the transport and fate of contaminants from Landfill 5 will follow the same pathways as described for Landfill 4 in Section 4.2.1.2. Refer to this section for details on transport and fate.

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As is true for Landfill 4, contaminants originating from Landfill 5 can potentially reach Farmers Branch via ground-water migration. Landfill 5 also can theoretically contribute contaminants to Farmers Branch via surface runoff and direct discharge to an adjacent Farmers Branch tributary. Any contaminants reaching Farmers Branch will follow the same surface flow described above for Landfill 4 to the West Fork of the Trinity River, downstream of Lake Worth.

#### Exposure Pathways

Figure 4.2.3-1 depicts potential pathways for contaminants to move from Landfill 5 to human exposure points. Pathways which are not complete have been crossed out. Remaining pathways include:

1. Volatilization to the air/air dispersion/inhalation of ambient air;
2. Volatilization to the air/air dispersion/inhalation by animals/ingestion of meat and dairy products;
3. Leaching to ground water/ground-water migration to surface water (fishable source)/uptake by fish and other aquatic organisms/ingestion of aquatic organisms;
4. Leaching to ground water/ground-water migration to surface water (agricultural use source)/ingestion by animals/ingestion of meat and dairy products;
5. Leaching to ground water/ground-water migration to surface water (source used for contact sports)/skin contact with water;  
and



6. Leaching to ground water/ground-water migration to surface water/volatilization of volatiles/inhalation of vapors close to source.

Contaminant contributions to surface water used for fishing, for agriculture, for water contact sports, or from which VOCs can volatilize, can also potentially derive from surface runoff and direct discharge to a Farmers Branch tributary.

#### Identification of Receptors

Based on available exposure pathways, potential human receptors for exposure to contaminants originating from Landfill 5, as for Landfills 3 and 4, include: 1) persons residing and/or working in nearby areas, particularly downwind of the site; 2) persons ingesting meat and dairy products from animals exposed to contaminants in the ambient air or contaminated surface water; 3) persons ingesting fish or other aquatic organisms exposed to contaminated surface water; and 4) persons swimming or participating in other contact sports in contaminated water. Landfill 5 is located closer to residential areas of the base than is Landfill 3, but farther from these areas than Landfill 4.

Potential wildlife receptors include: 1) terrestrial organisms with habitats close to Landfill 5 that inhale ambient air and ingest surface water, particularly from Farmers Branch and its tributary adjacent to the site, and 2) aquatic organisms in Farmers Branch/West Fork of the Trinity River.

#### Threat to Human Health

Inhalation Exposure--Inhalation of ambient air is the most direct exposure pathway for contaminants to move from Landfill 5 to human receptors. Table 4.2.3-6 presents the on-site maximum and off-site maximum predicted annual ambient air concentrations resulting from estimated Landfill 5 emissions, and predicted concentrations at several discrete locations: site

TABLE 4.2.3-6. PREDICTED ANNUAL AVERAGE AMBIENT AIR CONCENTRATIONS RESULTING FROM ESTIMATED LANDFILL 5 EMISSIONS

Contaminant	Predicted Annual Average Ambient Air Concentration (ug/m <sup>3</sup> )							IACB Annual Effects Screening Level (ug/m <sup>3</sup> )
	On-Site Maximum	Off-Site Maximum	Dog Care	Fish Hatchery	Dairy Operation	Beef Operation		
Benzene	1.1x10 <sup>-4</sup>	1.9x10 <sup>-6</sup>	3.7x10 <sup>-6</sup>	1.9x10 <sup>-7</sup>	3.6x10 <sup>-8</sup>	1.4x10 <sup>-6</sup>		3
Methylene chloride	3.6x10 <sup>-6</sup>	5.9x10 <sup>-8</sup>	1.1x10 <sup>-7</sup>	6.0x10 <sup>-9</sup>	1.0x10 <sup>-9</sup>	< 10 <sup>-9</sup>		26
Toluene	5.0x10 <sup>-6</sup>	9.3x10 <sup>-8</sup>	1.7x10 <sup>-7</sup>	6.0x10 <sup>-9</sup>	2.0x10 <sup>-9</sup>	1.0x10 <sup>-8</sup>		375
Trichloroethene	1.3x10 <sup>-3</sup>	2.2x10 <sup>-5</sup>	4.4x10 <sup>-5</sup>	2.2x10 <sup>-6</sup>	4.6x10 <sup>-7</sup>	1.6x10 <sup>-7</sup>		135
Vinyl chloride	1.6x10 <sup>-3</sup>	2.6x10 <sup>-5</sup>	5.2x10 <sup>-5</sup>	2.7x10 <sup>-6</sup>	5.4x10 <sup>-7</sup>	1.9x10 <sup>-7</sup>		10

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PROJECT: [Illegible]

of the proposed base day care center, which is central to the largest on-base residential area, the Fort Worth National Fish Hatchery, and the closest dairy and beef operations. The table also lists Texas Air Control Board (TACB) health Effects Screening Levels (ESLs) which the agency uses to evaluate the impacts of air contaminants. TACB screening levels are based on occupational exposure limits (American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs), Occupational Health and Safety Administration (OSHA) standards, or National Institute for Occupational Safety and Health (NIOSH) recommendations), odor nuisance potential, vegetation effects, or corrosion effects. Generally, the annual ESL corresponds to 0.1% of the lowest occupational exposure limit.

The maximum predicted annual average concentrations resulting from estimated Landfill 5 emissions for benzene, methylene chloride, toluene, trichloroethene, and vinyl chloride are lower than the conservative TACB Effects Screening Levels by orders of magnitude ranging from 4 to 8.

Table 4.2.3-7 shows estimates of average daily inhalation exposure (in mg/kg body weight/day) at the location of the on-site and off-site maximum predicted annual average concentration, and at the proposed on-site day care facility, and compares these values with inhalation Acceptable Daily Intakes (ADIs) for chronic (long-term) exposure. An inhalation ADI is an estimate of the dose of a chemical that can be inhaled daily for a lifetime without producing adverse noncarcinogenic health effects. Section 3.8 discusses the derivation of ADIs used in this assessment.

Average daily inhalation exposures for benzene, methylene chloride, toluene, trichloroethene, and vinyl chloride are lower than pollutant-specific ADIs in all cases by more than 3 orders of magnitude.

TABLE 4.2.3-7. ESTIMATED ANNUAL AVERAGE DAILY INHALATION EXPOSURES FOR CONTAMINANTS ORIGINATING FROM LANDFILL 5

Contaminant	On-Site Maximum			Off-Site Maximum			Day Care		
	Inhalation Acceptable Daily Intake <sup>a</sup> (mg/kg/day)	Inhalation <sup>b</sup> Exposure (mg/kg/day)	Safety Factor <sup>c</sup>	Inhalation <sup>b</sup> Exposure (mg/kg/day)	Safety Factor <sup>c</sup>	Inhalation <sup>b</sup> Exposure (mg/kg/day)	Safety Factor <sup>c</sup>	Inhalation <sup>b</sup> Exposure (mg/kg/day)	Safety Factor <sup>c</sup>
Benzene	$1.9 \times 10^{-2}$	$3.24 \times 10^{-8}$	$5.86 \times 10^5$	$5.40 \times 10^{-10}$	$3.52 \times 10^7$	$1.06 \times 10^{-9}$	$3.52 \times 10^7$	$1.06 \times 10^{-9}$	$1.76 \times 10^7$
Methylene chloride	$6.0 \times 10^{-2}$	$1.02 \times 10^{-9}$	$5.88 \times 10^7$	$1.70 \times 10^{-11}$	$3.53 \times 10^9$	$3.35 \times 10^{-11}$	$3.53 \times 10^9$	$3.35 \times 10^{-11}$	$1.79 \times 10^9$
Toluene	1.5	$1.43 \times 10^{-9}$	$1.05 \times 10^9$	$2.36 \times 10^{-11}$	$6.30 \times 10^{10}$	$4.69 \times 10^{-11}$	$6.30 \times 10^{10}$	$4.69 \times 10^{-11}$	$3.2 \times 10^{10}$
Trichloroethene	$2.46 \times 10^{-2}$	$3.79 \times 10^{-7}$	$6.49 \times 10^4$	$6.32 \times 10^{-9}$	$3.89 \times 10^6$	$1.23 \times 10^{-8}$	$3.89 \times 10^6$	$1.23 \times 10^{-8}$	$1.97 \times 10^6$
Vinyl chloride	$1.3 \times 10^{-3}$	$4.51 \times 10^{-7}$	$2.89 \times 10^3$	$7.51 \times 10^{-9}$	$1.73 \times 10^5$	$1.48 \times 10^{-8}$	$1.73 \times 10^5$	$1.48 \times 10^{-8}$	$6.78 \times 10^4$

<sup>a</sup> Estimate of the dose of a chemical that can be inhaled daily for a lifetime without producing adverse noncarcinogenic health effects.

<sup>b</sup> Inhalation exposure assumes inhalation for 24 hours/day of predicted annual average ambient concentrations by an individual with an average body weight of 70 kg and with an average inhalation rate of 20 m<sup>3</sup>/day.

<sup>c</sup> Inhalation Acceptable Daily Intake/Inhalation Exposure

Ingestion Exposure--Potential ingestion exposures include ingestion of meat and dairy products from animals exposed to contaminants in the ambient air or contaminated surface water and fish exposed to contaminated surface water. For the same reasons discussed in Section 4.2.1.4 for Landfill 3, exposure by these pathways is likely to be minimal and was not quantified.

Dermal Exposure--The potential for skin contact with contaminants originating from Landfill 5 is limited to exposures while swimming in (or otherwise in contact with) contaminated surface water. Again, for reasons discussed in Section 4.2.1.4 for Landfill 3, exposure by this pathway is also likely to be minimal and was not quantified.

#### Carcinogenic Risks

Inhalation Risk--Of the five indicator chemicals which might be emitted to the air from Landfill 5, four are potential carcinogens. These are benzene, methylene chloride, trichloroethene, and vinyl chloride. Cancer potency estimates developed by EPA were used in conjunction with total daily contaminant doses to develop estimates of individual cancer risk:

$$\text{individual cancer risk} = \frac{\text{total daily dose} \times \text{cancer potency}}{(\text{mg/kg/day}) \quad (\text{mg/kg/day})^{-1}}$$

Individual cancer risk is the increased probability of getting cancer in one's lifetime.

Table 4.2.3-8 shows estimates of individual cancer risk for the maximum on-site and maximum off-site exposed individual and for an individual inhaling ambient concentrations in the immediate vicinity of the proposed day care facility continuously for a lifetime. These risks, the highest of which is 1.4 in 100 million, can be dismissed as inconsequential.

TABLE 4.2.3-8. ESTIMATED INDIVIDUAL CANCER RISK ASSOCIATED WITH INHALATION OF POTENTIAL CARCINOGENS ORIGINATING FROM LANDFILL 5

Contaminant	Potency Slope <sup>a</sup> (mg/kg/day)	Individual Cancer Risk <sup>b</sup>	
		On-Site Maximum Exposed Individual	Off-Site Maximum Exposed Individual at Day Care Facility
Benzene	$2.6 \times 10^{-2}$	$8.4 \times 10^{-10}$	$1.4 \times 10^{-11}$
Methylene chloride	$1.65 \times 10^{-3}$	$1.7 \times 10^{-12}$	$2.8 \times 10^{-14}$
Trichloroethene	$4.6 \times 10^{-3}$	$1.7 \times 10^{-9}$	$2.9 \times 10^{-11}$
Vinyl chloride	$2.5 \times 10^{-2}$	$1.1 \times 10^{-6}$	$1.9 \times 10^{-10}$
TOTAL 70 year risk		$1.4 \times 10^{-8}$	$2.3 \times 10^{-10}$

<sup>a</sup> See Section 3.8 for discussion and documentation.

<sup>b</sup> Risk calculation assumes inhalation for 24 hours/day for a 70 year lifetime of predicted annual average ambient concentrations by an individual with an average body weight of 70 kg and with an average inhaled rate of 20 m<sup>3</sup>/day.

City of Houston

Ingestion Risk--The potential for ingestion exposure to contaminants originating from Landfill 5 is remote and likely to be minimal. The risk of ingestion exposure was therefore not quantified.

Dermal Risk--The potential for dermal exposure to contaminants originating from Landfill 5 is also remote. Unless an individual immersed himself frequently in the waters of Farmers Branch for a long period of time, skin contact exposure can be considered insignificant. The risk of dermal exposure was therefore not quantified.

Threat to Wildlife

Contaminants originating from Landfill 5, as discussed previously for Landfills 3 and 4, pose some risk to terrestrial wildlife that use Farmers Branch as a source of drinking water as well as aquatic organisms in Farmers Branch and its tributary adjacent to the landfill. In the past, there have been some instances of fish kills in Farmers Branch and in the ponds adjacent to Bldg. 233. The potential contribution of Landfill 5 to contaminant concentrations in Farmers Branch was not estimated because neither the ground-water inflow to Farmers Branch nor existing contaminant concentrations in Farmers Branch is known. The threat of failure of the clay berm to contain contaminants during heavy precipitation probably poses the greatest risk to aquatic organisms in Farmers Branch and the tributary.



surficial clay and silt deposits are 7 to 14 feet thick and the sand and gravel deposits are 19 to greater than 27 feet thick. It was observed that in most borings in the vicinity of the flightline, the grain size of the sand and gravel increases with depth. Coarse gravel and cobbles were encountered in borings that reached bedrock at the base of the upper zone.

Shale and limestone of the Goodland Formation underlie the upper zone materials at all locations. The top of the Goodland occurs at a maximum depth of greater than 39 feet west of the site (at 10A) and at its shallowest depth of 31 feet northeast of the site (at 10C). The contact between the bedrock and the upper zone is generally flat, in contrast to the pronounced slope to the northeast under Landfill 4. A slight bedrock high exists in the vicinity of boring 10B (Figure 4.2-2).

#### Hydrogeology

The upper zone materials underlying the Waste Burial Area contain ground water occurring at depths ranging from 20 feet at 10C to 30 feet at 10A. Soil borings 10D, 10E, and 10F all encountered ground water at 27 feet. As at the other Flightline sites, ground water exists under unconfined (water table) conditions in the upper zone materials.

Figure 4.2-3 illustrates the potentiometric surface of the water table as determined in March, 1988. Comparison of the potentiometric surface map for the upper zone ground water and the contour map of the base of the upper zone strongly suggests that the occurrence and direction of movement of ground water in the upper zone is closely related to the configuration of the bedrock surface. Ground water flows to the east under a hydraulic gradient of approximately 0.005, apparently not affected by the slight bedrock high in the vicinity of 10B. Ground-water flow rates in the upper zone would be essentially the same as the flow rates calculated for Landfills 4 and 5.

#### 4.2.4.2 Chemical Analytical Results

##### Soil Chemistry

Soil samples from three soil borings (10D, 10E, 10F) were analyzed for heavy metals, oil and grease, petroleum hydrocarbons, volatile organic compounds, semivolatile organic compounds, pesticides, and PCBs. Results of soil analyses are provided in Table 4.2.4-1 (inorganic parameters) and Table 4.2.4-2 (organic parameters). These data are discussed in the following paragraphs.

Heavy Metals--Results of chemical analyses of soil samples from borings 10D, 10E, and 10F indicate that no metals concentrations are above the normal ranges found in soils (Table 4.1-3). Evaluation of metals results from borings 10E and 10F at different depth intervals (two from each borehole) showed no apparent trends in metals concentrations with depth.

Oil and Grease, Petroleum Hydrocarbons--Chemical analysis of soils from the three soil borings indicated no detection of oil and grease or petroleum hydrocarbons.

Volatile Organic Compounds--Trichloroethene (TCE) was detected once, at 10F (0.0032 mg/kg), in a sand zone 14-18 feet deep. However, this finding was not confirmed with a duplicate sample. Toluene was estimated in low levels in two soil samples from 10E (0.0053 mg/kg) and 10F (0.002 mg/kg). Acetone and methylene chloride were detected and estimated at very low levels in several soil samples, probably attributable to laboratory contaminants.

Semivolatile Organic Compounds--Several phthalate compounds were detected in all soil samples ranging up to 0.39 mg/kg. These values were either estimated or the compounds were detected in the reagent blank and subtraction was not performed.

TABLE 4.2.4-1 RESULTS OF INORGANIC ANALYSES FOR SOIL SAMPLES, SITE 10 (WASTE BURIAL AREA), CARSWELL AFB, TEXAS.

Primary Results		Monitor Well
PARAMETER	10D (24 - 29)	10E (12 - 19)
<b>Metals MG/KG</b>		
Arsenic, graphite AA	0.5 <sup>^</sup>	0.5R
Mercury	ND	0.080 (0.050)
Lead, graphite AA	1.4 <sup>^</sup>	2.4
Selenium, graphite AA	ND	NDR (0.30)
<b>Metal Screen (ICP) MG/KG</b>		
Ag Silver	ND	ND (0.82)
Al Aluminum	430.0	400.0 (18.0)
As Arsenic	NDR	ND (27.0)
B Boron	NDR	ND (55.0)
Ba Barium	2.3	2.5 (0.82)
Be Beryllium	ND	ND (0.091)
Ca Calcium	13000.0B	15000.0 <sup>^</sup> (5.5)
Cd Cadmium	ND	ND (0.27)
Co Cobalt	ND	ND (0.91)
Cr Chromium	ND	2.2 (0.82)
Cu Copper	ND	ND (0.91)
Fe Iron	1800.0	4900.0 (2.7)
K Potassium	60.0	75.0 (27.0)
Mg Magnesium	130.0	170.0 (9.1)
Mn Manganese	22.0	64.0 (0.27)
Mo Molybdenum	ND	ND (4.5)
Na Sodium	70.0	46.0 (7.3)
Ni Nickel	ND	ND (1.8)

B: Detected in Reagent Blank; background subtraction not performed  
 R: Indicates that the matrix spike recovery for this analysis was not within acceptance limits indicating an interferent present.  
 ^: Indicates duplicate analysis is not within control limits.  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

TABLE 4.2.4-1 RESULTS OF INORGANIC ANALYSES FOR SOIL SAMPLES, SITE 10 (WASTE BURIAL AREA), CARSWELL AFB, TEXAS.

Primary Results			
PARAMETER	Monitor Well		Date Sampled
	Sample ID	Sample ID	
	Beg. Depth - End Depth	Beg. Depth - End Depth	
	10D	10E	10E
	10D-7	10E-5	10E-7
	28-Jan-88	29-Jan-88	29-Jan-88
	(24 - 29)	(12 - 19)	(24 - 29)
Pb	ND (4.6)	ND (4.5)	ND (4.5)
Sb	8.0 (5.5)	ND (5.5)	ND (5.5)
Se	NDR (28.0)	ND (27.0)	ND (27.0)
Si	330.0R (28.0)	260.0 (27.0)	300.0 (27.0)
Tl	15.0 (8.3)	ND (8.2)	ND (8.2)
V	ND (1.8)	5.3 (1.8)	ND (1.8)
Zn	1.0 (0.55)	4.4^ (0.55)	2.0 (0.55)

B: Detected in Reagent Blank; background subtraction not performed  
 R: Indicates that the matrix spike recovery for this analysis was not within acceptance limits indicating an interferent present.  
 ^: Indicates duplicate analysis is not within control limits.  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

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TABLE 4.2.4-1 RESULTS OF INORGANIC ANALYSES FOR SOIL SAMPLES, SITE 10 (WASTE BURIAL AREA), CARSWELL AFB, TEXAS.

PARAMETER	Primary Results		Monitor Well Sample ID	Date Sampled	Beg. Depth - End Depth
	10F	10F			
Se	ND	(27.0)	ND	29-Jan-88	(14 - 19)
Si	240.0	(27.0)	270.0	10F-5	(14 - 19)
Tl	ND	(8.2)	ND	10F-5	(14 - 19)
V	2.0	(1.8)	4.0	29-Jan-88	(14 - 19)
Zn	3.0	(0.55)	3.8	29-Jan-88	(14 - 19)

②: Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

APPROVED FOR RELEASE BY NSA ON 05-08-2014 pursuant to E.O. 13526



TABLE 4.2.4-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 10 (WASTE BURIAL AREA), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well	
	Sample ID	Date Sampled
	Beg. Depth - End Depth	
	100	10E
	10D-7	10E-7
	28-Jan-88	29-Jan-88
	24 - 29	24 - 29
carbon tetrachloride	ND (0.0031)	ND (0.0028)
chlorobenzene	ND (0.0067)	ND (0.0061)
chloroethane	ND (0.0056)	ND (0.0051)
chloroform	ND (0.0018)	ND (0.0016)
chloromethane	ND (0.0056)	ND (0.0051)
cis-1,3-Dichloropropene	ND (0.0056)	ND (0.0051)
dibromochloromethane	ND (0.0034)	ND (0.0031)
methylene chloride	0.0018J	ND (0.0028)
styrene	ND (0.0033)	ND (0.0030)
tetrachloroethene	ND (0.0046)	ND (0.0041)
total xylenes	ND (0.0051)	ND (0.0046)
trans-1,2-Dichloroethene	ND (0.0018)	ND (0.0016)
trans-1,3-Dichloropropene	ND (0.0056)	ND (0.0051)
trichlorofluoromethane	ND (0.0056)	ND (0.0051)
vinyl acetate	ND (0.0077)	ND (0.0070)
vinyl chloride	ND (0.0056)	ND (0.0051)
Semivolatile Organic Compounds MC/KC		
1,2,4-trichlorobenzene	ND (0.14)	ND (0.13)
1,2-dichlorobenzene	ND (0.14)	ND (0.13)
1,3-dichlorobenzene	ND (0.14)	ND (0.13)
1,4-dichlorobenzene	ND (0.32)	ND (0.29)
2,4,5-trichlorophenol	ND (0.73)	ND (0.67)
2,4,6-trichlorophenol	ND (0.20)	ND (0.18)
2,4-dichlorophenol	ND (0.20)	ND (0.18)

B: Detected in Reagent Blank; background subtraction not performed  
 BJ: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

Copy of Report

TABLE 4.2.4-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 10 (WASTE BURIAL AREA), CARSWELL AFB, TEXAS.

- D R A F T -

PARAMETER	Monitor Well	
	Sample ID	Date Sampled
	10D	10E
	10D-7	10E-7
	28-Jan-88	29-Jan-88
	24 - 29	24 - 29
2,4-dimethylphenol	ND (0.20)	ND (0.18)
2,4-dinitrophenol	ND (3.1)	ND (2.8)
2,4-dinitrotoluene	ND (0.42)	ND (0.38)
2,6-dinitrotoluene	ND (0.14)	ND (0.13)
2-chloronaphthalene	ND (0.14)	ND (0.13)
2-chlorophenol	ND (0.24)	ND (0.22)
2-methylnaphthalene	ND (0.73)	ND (0.67)
2-methylphenol	ND (0.73)	ND (0.67)
2-nitroaniline	ND (3.7)	ND (3.3)
2-nitrophenol	ND (0.26)	ND (0.24)
3,3'-dichlorobenzidine	ND (1.2)	ND (1.1)
3-nitroaniline	ND (3.7)	ND (3.3)
4,6-dinitro-2-methylphenol	ND (1.8)	ND (1.6)
4-bromophenyl-phenylether	ND (0.14)	ND (0.13)
4-chloro-3-methylphenol	ND (0.22)	ND (0.20)
4-chloroaniline	ND (0.73)	ND (0.67)
4-chlorophenyl-phenylether	ND (0.31)	ND (0.28)
4-methylphenol	ND (0.73)	ND (0.67)
4-nitroaniline	ND (3.7)	ND (3.3)
4-nitrophenol	ND (0.18)	ND (0.16)
acensaphthene	ND (0.14)	ND (0.13)
acensaphthylene	ND (0.26)	ND (0.23)
aniline	ND (0.73)	ND (0.67)
anthracene	ND (0.14)	ND (0.13)
benzidine	ND (3.2)	ND (2.9)

B: Detected in Reagent Blank; background subtraction not performed  
 BJ: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit



TABLE 4.2.4-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 10 (WASTE BURIAL AREA), CARSWELL AFB, TEXAS.

PARAMETER	10D		10E	
	28-Jan-88		29-Jan-88	
	24 - 29	12 - 19	24 - 29	10E
	10D-7	10E-5	10E-7	10E-7
	Beg. Depth - End Depth			
	Date Sampled			
	Sample ID			
	Monitor Well			
isophorone	ND (0.16)	ND (0.15)	ND (0.17)	ND (0.17)
n-nitroso-di-n-propylamine	ND (0.88)	ND (0.80)	ND (0.95)	ND (0.95)
n-nitrosodimethylamine	ND (0.73)	ND (0.67)	ND (0.79)	ND (0.79)
n-nitrosodiphenylamine	ND (0.14)	ND (0.13)	ND (0.15)	ND (0.15)
naphthalene	ND (0.12)	ND (0.11)	ND (0.13)	ND (0.13)
nitrobenzene	ND (0.14)	ND (0.13)	ND (0.15)	ND (0.15)
pentachlorophenol	ND (0.26)	ND (0.24)	ND (0.29)	ND (0.29)
phenanthrene	ND (0.39)	ND (0.36)	ND (0.43)	ND (0.43)
phenol	ND (0.11)	ND (0.10)	ND (0.12)	ND (0.12)
pyrene	ND (0.14)	ND (0.13)	ND (0.15)	ND (0.15)
<b>Organochlorine Pesticides and PCBs MC/KG</b>				
4,4'-DDO	ND (0.0011)	ND (0.0010)	ND (0.0012)	ND (0.0012)
4,4'-DDE	ND (0.0011)	ND (0.0010)	ND (0.0012)	ND (0.0012)
4,4'-DDT	ND (0.0022)	ND (0.0020)	ND (0.0024)	ND (0.0024)
PCB-1016	ND (0.057)	ND (0.051)	ND (0.058)	ND (0.058)
PCB-1221	ND (0.11)	ND (0.10)	ND (0.12)	ND (0.12)
PCB-1232	ND (0.11)	ND (0.10)	ND (0.12)	ND (0.12)
PCB-1242	ND (0.057)	ND (0.051)	ND (0.058)	ND (0.058)
PCB-1248	ND (0.057)	ND (0.051)	ND (0.058)	ND (0.058)
PCB-1254	ND (0.022)	ND (0.020)	ND (0.024)	ND (0.024)
PCB-1260	ND (0.022)	ND (0.020)	ND (0.024)	ND (0.024)
aldrin	ND (0.0011)	ND (0.0010)	ND (0.0012)	ND (0.0012)
alpha-BHC	ND (0.0057)	ND (0.0051)	ND (0.0058)	ND (0.0058)
beta-BHC	ND (0.0057)	ND (0.0051)	ND (0.0058)	ND (0.0058)

B: Detected in Reagent Blank; background subtraction not performed  
 BJ: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

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TABLE 4.2.4-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 10 (WASTE BURIAL AREA), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well	
	Sample ID	Date Sampled
	10D	10E
	10D-7	10E-5
	28-Jan-88	29-Jan-88
	24 - 29	12 - 19
chlordanes	ND (0.0055)	ND (0.0050)
delta-BHC	ND (0.0011)	ND (0.0010)
dieldrin	ND (0.0011)	ND (0.0010)
endosulfan I	ND (0.0011)	ND (0.0010)
endosulfan II	ND (0.0033)	ND (0.0030)
endosulfan sulphate	ND (0.0055)	ND (0.0050)
endrin	ND (0.0011)	ND (0.0010)
endrin aldehyde	ND (0.0022)	ND (0.0020)
endrin ketone	ND (0.0055)	ND (0.0050)
gamma-BHC (lindane)	ND (0.0057)	ND (0.0051)
heptachlor	ND (0.0011)	ND (0.0058)
heptachlor epoxide	ND (0.0011)	ND (0.0058)
methoxychlor	ND (0.0055)	ND (0.0050)
toxaphene	ND (0.055)	ND (0.050)

B: Detected in Reagent Blank; background subtraction not performed  
 BJ: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

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TABLE 4.2.4-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 10 (WASTE BURIAL AREA), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well	
	Sample ID	Date Sampled
	Beg. Depth -	End Depth
Oil & Grease MG/KC	10F (5.0)	10F (5.0)
Oil and grease, infrared	10F-5 (5.0)	10F-5 (5.0)
Petroleum Hydrocarbons MG/KC	29-Jan-88	29-Jan-88
Petroleum Hydrocarbons	14 - 19	14 - 19
Volatiles Organic Compounds MG/KG		
1,1,1-trichloroethane	ND (0.0042)	ND (0.0042)
1,1,2,2-tetrachloroethane	ND (0.0077)	ND (0.0076)
1,1,2-trichloroethane	ND (0.0056)	ND (0.0055)
1,2-dichloroethane	ND (0.0031)	ND (0.0031)
1,2-dichloropropane	ND (0.0067)	ND (0.0066)
2-butanone	ND (0.028)	ND (0.028)
2-chloroethylvinyl ether	ND (0.0056)	ND (0.0055)
2-hexanone	ND (0.040)	ND (0.040)
4-methyl-2-pentanone	ND (0.051)	ND (0.051)
Benzene	ND (0.0049)	ND (0.0048)
Ethylbenzene	ND (0.0080)	ND (0.0079)
Toluene	0.0020J (0.0067)	ND (0.0066)
Trichloroethene	ND (0.0021)	0.0032 (0.0021)
acetone	0.00508J (0.0083)	0.00378J (0.0083)
bromodichloromethane	ND (0.0024)	ND (0.0024)
bromoform	ND (0.0052)	ND (0.0052)
bromomethane	ND (0.0056)	ND (0.0055)
carbon disulfide	ND (0.0019)	ND (0.0019)

B: Detected in Reagent Blank; background subtraction not performed

BJ: Analyte detected in blank. Estimated value below detection limit.

J: Estimated value (GC test codes)

ND: Not detected at specified detection limit

( ): Detection limit

TABLE 4.2.4-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 10 (WASTE BURIAL AREA), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well	
	Sample ID	
	Date Sampled	
	Reg. Depth -	End Depth
	10F	10F
	10F-5	10F-5
	29-Jan-88	29-Jan-88
	14 - 19	14 - 19
carbon tetrachloride	ND (0.0031)	ND (0.0031)
chlorobenzene	ND (0.0067)	ND (0.0066)
chloroethane	ND (0.0056)	ND (0.0055)
chloroform	ND (0.0018)	ND (0.0018)
chloromethane	ND (0.0056)	ND (0.0055)
cis-1,3-Dichloropropene	ND (0.0056)	ND (0.0055)
dibromochloromethane	ND (0.0034)	ND (0.0034)
methylene chloride	0.0021J (0.0031)	0.0022J (0.0031)
styrene	ND (0.0033)	ND (0.0033)
tetrachloroethene	ND (0.0046)	ND (0.0045)
total xylenes	ND (0.0051)	ND (0.0051)
trans-1,2-Dichloroethene	ND (0.0018)	ND (0.0018)
trans-1,3-Dichloropropene	ND (0.0056)	ND (0.0055)
trichlorofluoromethane	ND (0.0056)	ND (0.0055)
vinyl acetate	ND (0.0077)	ND (0.0076)
vinyl chloride	ND (0.0056)	ND (0.0055)
Semi-volatile Organic Compounds MC/KG		
1,2,4-trichlorobenzene	ND (0.14)	ND (0.14)
1,2-dichlorobenzene	ND (0.14)	ND (0.14)
1,3-dichlorobenzene	ND (0.14)	ND (0.14)
1,4-dichlorobenzene	ND (0.32)	ND (0.32)
2,4,5-trichlorophenol	ND (0.73)	ND (0.73)
2,4,6-trichlorophenol	ND (0.20)	ND (0.20)
2,4-dichlorophenol	ND (0.20)	ND (0.20)

B: Detected in Reagent Blank; background subtraction not performed  
 BJ: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

Environmental Sciences

TABLE 4.2.4-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 10 (WASTE BURIAL AREA), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well	
	Sample ID	Date Sampled
	Req. Depth - End Depth	
	10F	10F
	10F-5	10F-5
	29-Jan-88	29-Jan-88
	14 - 19	14 - 19
2,4-dimethylphenol	ND (0.20)	ND (0.20)
2,4-dinitrophenol	ND (3.0)	ND (3.1)
2,4-dinitrotoluene	ND (0.41)	ND (0.42)
2,6-dinitrotoluene	ND (0.14)	ND (0.14)
2-chloronaphthalene	ND (0.14)	ND (0.14)
2-chlorophenol	ND (0.24)	ND (0.24)
2-methylnaphthalene	ND (0.73)	ND (0.73)
2-methylphenol	ND (0.73)	ND (0.73)
2-nitroaniline	ND (3.6)	ND (3.7)
2-nitrophenol	ND (0.26)	ND (0.26)
3,3'-dichlorobenzidine	ND (1.2)	ND (1.2)
3-nitroaniline	ND (3.6)	ND (3.7)
4,6-dinitro-2-methylphenol	ND (1.7)	ND (1.8)
4-bromophenyl-phenylether	ND (0.14)	ND (0.14)
4-chloro-3-methylphenol	ND (0.22)	ND (0.22)
4-chloroaniline	ND (0.73)	ND (0.73)
4-chlorophenyl-phenylether	ND (0.30)	ND (0.31)
4-methylphenol	ND (0.73)	ND (0.73)
4-nitroaniline	ND (3.6)	ND (3.7)
4-nitrophenol	ND (0.17)	ND (0.18)
acenaphthene	ND (0.14)	ND (0.14)
acenaphthylene	ND (0.25)	ND (0.26)
aniline	ND (0.73)	ND (0.73)
anthracene	ND (0.14)	ND (0.14)
benzidine	ND (3.2)	ND (3.2)

B: Detected in Reagent Blank; background subtraction not performed  
 BJ: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
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TABLE 4.2.4-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 10 (WASTE BURIAL AREA), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well		Date Sampled	Beg. Depth - End Depth
	Sample ID	Sample ID		
	10P	10P-5		
			14 - 19	14 - 19
	29-Jan-88	29-Jan-88		
benzo(a)anthracene	ND (0.57)	ND (0.57)		
benzo(a)pyrene	ND (0.18)	ND (0.18)		
benzo(b)fluoranthene	ND (0.35)	ND (0.35)		
benzo(k)fluoranthene	ND (0.18)	ND (0.18)		
benzoic acid	ND (3.6)	ND (3.7)		
benzyl alcohol	ND (3.6)	ND (3.7)		
bis(2-chloroethoxy)methane	ND (0.38)	ND (0.39)		
bis(2-chloroethyl) ether	ND (0.41)	ND (0.42)		
bis(2-chloroisopropyl) ether	ND (0.41)	ND (0.42)		
bis(2-ethylhexyl) phthalate	0.20 (0.18)	0.23 (0.18)		
butylbenzylphthalate	ND (0.18)	ND (0.18)		
chrysene	ND (0.18)	ND (0.18)		
di-n-butylphthalate	0.278 (0.18)	0.758 (0.18)		
di-n-octyl phthalate	0.089J (0.18)	0.085J (0.18)		
dibenzo(a,h)anthracene	ND (0.18)	ND (0.18)		
dibenzofuran	ND (0.73)	ND (0.73)		
diethyl phthalate	ND (0.14)	ND (0.14)		
dimethyl phthalate	ND (0.12)	ND (0.12)		
fluoranthene	ND (0.16)	ND (0.16)		
fluorene	ND (0.14)	ND (0.14)		
hexachlorobenzene	ND (0.14)	ND (0.14)		
hexachlorobutadiene	ND (0.065)	ND (0.066)		
hexachlorocyclopentadiene	ND (0.44)	ND (0.44)		
hexachloroethane	ND (0.12)	ND (0.12)		
indeno(1,2,3-cd)pyrene	ND (0.27)	ND (0.27)		

8: Detected in Reagent Blank; background subtraction not performed  
 8J: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ) : Detection limit



TABLE 4.2.4-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 10 (WASTE BURIAL AREA), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	Monitor Well	
	Sample ID	Date Sampled
	10F	10F-5
	14 - 19	14 - 19
	10F	10F-5
	29-Jan-88	29-Jan-88
	14 - 19	14 - 19
chlordane	ND (0.0050)	ND (0.0050)
dieldrin	ND (0.0010)	ND (0.0010)
endosulfan I	ND (0.0010)	ND (0.0010)
endosulfan II	ND (0.0010)	ND (0.0010)
endosulfan sulphate	ND (0.0030)	ND (0.0030)
endrin	ND (0.0050)	ND (0.0050)
endrin aldehyde	ND (0.0010)	ND (0.0010)
endrin ketone	ND (0.0020)	ND (0.0020)
gamma-BHC (Lindane)	ND (0.0050)	ND (0.0050)
heptachlor	ND (0.0051)	ND (0.0051)
heptachlor epoxide	ND (0.0051)	ND (0.0051)
methoxychlor	ND (0.0050)	ND (0.0050)
toxaphene	ND (0.050)	ND (0.050)

B: Detected in Reagent Blank; background subtraction not performed  
 BJ: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

Approved for Release by NSA on 05-08-2014 pursuant to E.O. 13526

Organochlorine Pesticides and PCBs--Pesticides or PCBs were not detected in soil samples at this site.

Water Quality

The three Stage 1 upper zone monitor wells 10A, 10B, and 10C were sampled for chemical analysis in two rounds of sampling. Samples were analyzed for water quality indicators, heavy metals, oil and grease, petroleum hydrocarbons, phenols, purgeable halocarbons, purgeable aromatics, pesticides, and herbicides. Results of water quality analyses are in Table 4.2.4-3 (inorganic parameters) and Table 4.2.4-4 (organic parameters). Table 4.2.4-5 provides the results of field chemistry analyses.

Water Quality Indicators--Total dissolved solids (TDS) concentrations were fairly uniform through the two sampling rounds, ranging from 510 to 670 mg/L. Common anions tended to remain stable or show a slight increase between sampling rounds.

Heavy Metals--Chromium exceeded the MCL at well 10A in both the first (0.089 mg/L) and second (0.098 mg/L) sampling rounds. Chromium also exceeded MCLs at well 10B (0.066 mg/L) in the first round and well 10C (0.052 mg/L) in the second round of sampling. In general, metals concentrations increased in concentration from the first to second rounds at 10A and 10C and decreased in concentration at 10B. Iron and manganese exceed MCLGs at the three wells during both rounds of sampling. Barium (1.1 mg/L) exceeded the MCL during the second sampling event at 10A.

Oil and Grease--Ground-water analyses detected oil and grease in all three monitor wells in Round 1. Values ranged from 1 mg/L at well 10C to 0.3 mg/L at well 10B. However in Round 2, oil and grease was not detected at any of the wells.

TABLE 4.2.4-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 10 (WASTE BURIAL AREA), CARSWELL AFB, TEXAS.

Primary Results	Monitor Well		Monitor Well	
	Sample ID	Date Sampled	Sample ID	Date Sampled
	10A	10B	10B	10B
	03-22	03-28	03-28	04-60
	02-Mar-88	03-Mar-88	03-Mar-88	14-Apr-88
PARAMETER	10K	10A	10B	10B
Total Dissolved Solids MG/L	540.0	620.0	510.0	540.0
Total Dissolved Solids	(2.0)	(1.0)	(1.0)	(1.0)
Fluoride MG/L	0.27	0.27	0.24	0.28
Fluoride	4.0(M)	2.0(G)		
Chloride MG/L	18.0	30.0	15.0	26.0
Chloride	250.0(G)			
Nitrate MG/L	1.5	2.2	3.6	3.6
Nitrate + Nitrite	10.0(M)			
Orthophosphate MG/L	0.050	0.37	0.11	0.070
Orthophosphate	(0.020)	(0.020)	(0.020)	(0.020)
Sulfate MG/L	30.0	72.0	25.0	42.0
Sulfate, nephelometry	250.0(G)			
Metals MG/L	0.027	0.040	0.022	0.019
Arsenic, graphite AA	ND	ND#	0.00030	ND
Mercury	0.0020(M)	(0.00012)	(0.00012)	(0.00012)
Lead, graphite AA	0.034	0.037	0.029	0.015
Selenium, graphite AA	ND	ND	ND	ND
	(0.010(M))	(0.0050)	(0.0050)	(0.0030)
Metal Screen (ICP) MG/L				

D R A F T

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

# : Matrix spike outside control limits.  
 @ : Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.  
 ^ : Indicates duplicate analysis is not within control limits.  
 ND : Not detected at specified detection limit  
 ( ) : Detection limit

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TABLE 4.2.4-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 10 (WASTE BURIAL AREA), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well			
	Sample ID			
	Date Sampled			
	10A	10B	108	10B
	03-22	04-50	03-28	04-60
EPA Standards, Criteria	13-Apr-88			
	02-Mar-88	03-Mar-88	14-Apr-88	
Ag Silver	ND (0.0090)	0.027 (0.0090)	ND (0.0090)	ND (0.0090)
Al Aluminum	38.0 (0.20)	40.0 (0.20)	43.0 (0.20)	11.0 (0.20)
As Arsenic	ND (0.30)	ND# (0.30)	ND (0.30)	ND# (0.30)
B Boron	ND (0.60)	ND (0.60)	ND (0.60)	ND (0.60)
Ba Barium	0.93 (0.0090)	1.1 (0.0090)	0.24 (0.0090)	0.14^ (0.0090)
Be Beryllium	0.0040 (0.0010)	0.0010 (0.0010)	ND (0.0010)	ND (0.0010)
Ca Calcium	478.8 (0.060)	530.0 (0.060)	390.0 (0.060)	230.0^ (0.060)
Cd Cadmium	ND (0.0030)	ND (0.0030)	ND (0.0030)	ND (0.0030)
Co Cobalt	0.036 (0.010)	0.030 (0.010)	ND (0.010)	0.020 (0.010)
Cr Chromium	0.009 (0.0090)	0.098 (0.0090)	0.066 (0.0090)	0.018 (0.0090)
Cu Copper	0.040 (0.010)	0.060 (0.010)	0.020 (0.010)	0.010 (0.010)
Fe Iron	79.0 (0.030)	83.0 (0.030)	52.0 (0.030)	19.0 (0.030)
K Potassium	6.3 (0.30)	7.1 (0.30)	8.6 (0.30)	2.1^ (0.30)
Mg Magnesium	14.0 (0.10)	16.0 (0.10)	13.0 (0.10)	7.3^ (0.10)
Mn Manganese	6.3 (0.0030)	7.3 (0.0030)	0.65 (0.0030)	0.26^ (0.0030)
Mo Molybdenum	ND (0.050)	ND (0.050)	ND (0.050)	ND (0.050)
Na Sodium	22.0 (0.080)	22.0 (0.080)	22.0 (0.080)	19.0^ (0.080)
Ni Nickel	0.030 (0.020)	0.11 (0.020)	0.060 (0.020)	0.030 (0.020)
Pb Lead	ND (0.050)	0.10 (0.050)	ND (0.050)	ND (0.050)
Sb Antimony	ND (0.060)	ND (0.060)	0.15 (0.060)	ND (0.060)
Se Selenium	ND (0.30)	0.40 (0.30)	ND (0.30)	ND (0.30)
Si Silicon	80.0 (0.30)	78.0 (0.30)	81.0 (0.30)	30.0 (0.30)
Tl Thallium	0.11 (0.090)	0.10 (0.090)	ND (0.090)	ND (0.090)
V Vanadium	0.16 (0.020)	0.20 (0.020)	0.12 (0.020)	0.030 (0.020)
Zn Zinc	0.13 (0.0060)	0.14 (0.0060)	0.10 (0.0060)	0.044 (0.0060)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

# : Matrix spike outside control limits.

@ : Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.

^ : Indicates duplicate analysis is not within control limits.

ND: Not detected at specified detection limit

( ) : Detection limit

TABLE 4.2.4-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 10 (WASTE BURIAL AREA), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards, Criteria		Monitor Well	
	10C 03-29 03-Mar-88	10C 04-62 14-Apr-88	Sample ID 10C	Date Sampled 04-63 14-Apr-88
Total Dissolved Solids MG/L	670.0 (1.0)	590.0 (1.0)		580.0 (1.0)
Total Dissolved Solids				
Fluoride MG/L	4.0(M)	2.0(G)	0.27	0.29
Fluoride				0.30
Chloride MG/L	250.0(G)		27.0	32.0
Chloride				30.0
Nitrate MG/L	10.0(M)		0.22	0.15
Nitrate + Nitrite				0.16
Orthophosphate MG/L	0.030	(0.020)	0.080	(0.020)
Orthophosphate				0.030 (0.020)
Sulfate MG/L	250.0(G)		17.0	42.0
Sulfate, nephelometry				42.0
Metals MG/L				
Arsenic, graphite AA	0.050(M)		0.027	0.033
Mercury	0.0020(M)	(0.00012)	ND	ND (0.00012)
Lead, graphite AA	0.050(M)		0.024	0.033
Selenium, graphite AA	0.010(M)	(0.0050)	ND	ND (0.0030)
Metal Screen (ICP) MG/L				
Ag Silver	ND	(0.0090)	ND	ND (0.0090)
Al Aluminum	8.2	(0.20)	21.0	34.0 (0.20)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

#: Matrix spike outside control limits.

ND: Not detected at specified detection limit

( ): Detection limit

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TABLE 4.2.4-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 10 (WASTE BURIAL AREA), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards,		Criteria		Monitor Well		
	03-29		03-Mar-88		14-Apr-88		
	10C	04-62	10C	04-62	10C	04-63	
As	0.050(M)	ND	(0.30)	ND#	(0.30)	ND#	(0.30)
B		ND	(0.60)	ND	(0.60)	ND	(0.60)
Ba	1.0(M)	0.19	(0.0090)	0.27	(0.0090)	0.30	(0.0090)
Be		ND	(0.0010)	0.0020	(0.0010)	ND	(0.0010)
Ca		180.0	(0.060)	260.0	(0.060)	300.0	(0.060)
Cd	0.010(M)	ND	(0.0030)	ND	(0.0030)	0.0060	(0.0030)
Co		ND	(0.010)	0.020	(0.010)	0.030	(0.010)
Cr	0.050(M)	0.011	(0.0090)	0.037	(0.0090)	0.052	(0.0090)
Cu	1.0(G)	ND	(0.010)	0.040	(0.010)	0.030	(0.010)
Fe	0.30(G)	9.9	(0.030)	33.0	(0.030)	49.0	(0.030)
K		2.5	(0.30)	3.9	(0.30)	5.4	(0.30)
Mg		9.7	(0.10)	12.0	(0.10)	14.0	(0.10)
Mn		0.21	(0.0030)	0.48	(0.0030)	0.67	(0.0030)
Mo		ND	(0.050)	ND	(0.050)	ND	(0.050)
Na		27.0	(0.080)	24.0	(0.080)	24.0	(0.080)
Ni		ND	(0.020)	0.040	(0.020)	0.060	(0.020)
Pb	0.050(M)	ND	(0.050)	ND	(0.050)	ND	(0.050)
Sb		0.080	(0.060)	ND	(0.060)	ND	(0.060)
Se		ND	(0.30)	ND	(0.30)	0.30	(0.30)
Si		24.0	(0.30)	50.0	(0.30)	74.0	(0.30)
Tl		ND	(0.090)	ND	(0.090)	ND	(0.090)
V		ND	(0.020)	0.070	(0.020)	0.090	(0.020)
Zn	5.0(G)	0.016	(0.0060)	0.076	(0.0060)	0.097	(0.0060)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

# : Matrix spike outside control limits.

ND: Not detected at specified detection limit

( ) : Detection limit

Approved for Release by NSA on 09-08-2013 pursuant to E.O. 13526

TABLE 4.2.4-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 10 (WASTE BURIAL AREA), CARSWELL AFB, TEXAS.

Primary Results		Monitor Well	
PARAMETER	Criteria	Sample ID	Date Sampled
Oil & Grease MG/L		10A	10B
		03-22	03-28
		02-Mar-88	03-Mar-88
		13-Apr-88	14-Apr-88
Oil and grease, Infrared	0.60	ND (0.20)	ND (0.20)
Petroleum Hydrocarbons UG/L			
Petroleum Hydrocarbons	600.0	ND (200.0)	ND (200.0)
Phenols UG/L			
2,4,6-trichlorophenol	ND (0.60)	ND (1.2)	ND (1.2)
2,4-dichlorophenol	3090.0(G)	ND (1.0)	ND (1.0)
2,4-dimethylphenol	400.0(G)	ND (0.60)	ND (0.60)
2,4-dinitrophenol	14.0C	ND (26.0)	ND (26.0)
2-chlorophenol	13.0C	ND (0.40)	ND (0.40)
2-methyl-4,6-dinitrophenol	19.0C	ND (32.0)	ND (32.0)
2-nitrophenol	ND (2.0)	ND (4.0)	ND (4.0)
4-chloro-3-methylphenol	ND (0.40)	ND (0.80)	ND (0.80)
4-nitrophenol	ND (2.5)	ND (5.0)	ND (5.0)
pentachlorophenol	200.0(G)	ND (15.0)	ND (15.0)
phenol	3500.0(G)	ND (0.40)	ND (0.40)
Purgeable Halocarbons UG/L			
1,1,1-Trichloroethane	200.0(H)	ND (90.0)	ND (90.0)
1,1,2,2-Tetrachloroethane		ND (120.0)	ND (120.0)
1,1,2-Trichloroethane		ND (70.0)	ND (70.0)
1,1-Dichloroethane		ND (90.0)	ND (90.0)
1,1-Dichloroethene	7.0(H)	ND (100.0)	ND (100.0)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

Q: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

C: Second Column Confirmed

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ): Detection limit

APR 14 1988



TABLE 4.2.4-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 10 (WASTE BURIAL AREA), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	EPA Standards, Criteria	Monitor Well Sample ID Date Sampled			
		10A	10A	10B	10B
		03-22 02-Mar-88	04-50 13-Apr-88	03-28 03-Mar-88	04-60 14-Apr-88
1,2-Dichlorobenzene	620.0(G)	ND (40.0)	ND (40.0)	ND (40.0)	ND (40.0)
1,3-Dichlorobenzene	400.0(G)	ND (40.0)	ND (40.0)	ND (40.0)	ND (40.0)
1,4-Dichlorobenzene	750.0(M)	750.0(G)	ND (30.0)	ND (30.0)	ND (30.0)
Benzene	5.0(M)	0.0(G)	ND (20.0)	ND (20.0)	ND (20.0)
Chlorobenzene	60.0(G)	ND (30.0)	ND (30.0)	ND (30.0)	ND (30.0)
Ethylbenzene	680.0(G)	ND (30.0)	ND (30.0)	ND (30.0)	ND (30.0)
Toluene	2000.0(G)	ND (20.0)	ND (20.0)	ND (20.0)	ND (20.0)
m-Xylene		ND (20.0)	ND (20.0)	ND (20.0)	ND (20.0)
o-Xylene		ND (10.0)	ND (10.0)	ND (10.0)	ND (10.0)
p-Xylene		ND (20.0)	ND (20.0)	ND (20.0)	ND (20.0)
Organochlorine Pesticides	UG/L				
4,4'-DDD		ND (0.25)	ND (0.050)	ND (0.040)	ND (0.040)
4,4'-DDE		ND (0.25)	ND (0.050)	ND (0.25)	ND (0.25)
4,4'-DDT		ND (0.040)	ND (0.10)	ND (0.080)	ND (0.080)
PCB-1016		ND (0.20)	ND (0.50)	ND (0.40)	ND (0.40)
PCB-1221		ND (0.40)	ND (1.0)	ND (5.0)	ND (5.0)
PCB-1232		ND (0.40)	ND (1.0)	ND (0.80)	ND (0.80)
PCB-1242		ND (0.20)	ND (0.50)	ND (0.40)	ND (0.40)
PCB-1248		ND (0.20)	ND (0.50)	ND (0.40)	ND (0.40)
PCB-1254		ND (5.0)	ND (1.0)	ND (0.80)	ND (0.80)
PCB-1260		ND (5.0)	ND (1.0)	ND (0.80)	ND (0.80)
aldrin		ND (0.020)	ND (0.050)	ND (0.040)	ND (0.040)
alpha-BHC		ND (0.020)	ND (0.050)	ND (0.040)	ND (0.040)
beta-BHC		ND (0.020)	ND (0.050)	ND (0.040)	ND (0.040)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

4: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

C: Second Column Confirmed

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ): Detection limit

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TABLE 4.2.4-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 10 (WASTE BURIAL AREA), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards,		Monitor Well	
	Criteria	03-Mar-88	Sample ID	Date Sampled
Oil & Grease ME/L			10C	10C
Oil and grease, Infrared		1.0	04-62	04-63
			14-Apr-88	14-Apr-88
Petroleum Hydrocarbons UG/L				
Petroleum Hydrocarbons		400.0	ND (0.20)	ND (0.20)
Phenols UG/L				
2,4,6-trichlorophenol		ND (0.60)	ND (1.2)	ND (3.0)
2,4-dichlorophenol	3090.0(G)	1.4C (0.50)	ND (1.0)	ND (2.5)
2,4-dimethylphenol	400.0(G)	ND (0.30)	ND (0.60)	ND (1.5)
2,4-dinitrophenol		ND (13.0)	ND (26.0)	ND (65.0)
2-chlorophenol		ND (0.20)	ND (0.40)	ND (1.0)
2-methyl-4,6-dinitrophenol		ND (16.0)	ND (32.0)	ND (80.0)
2-nitrophenol		ND (2.0)	ND (4.0)	ND (10.0)
4-chloro-3-methylphenol		ND (0.40)	ND (0.80)	ND (2.0)
4-nitrophenol		ND (2.5)	ND (5.0)	ND (13.0)
pentachlorophenol	200.0(G)	ND (7.5)	ND (15.0)	ND (38.0)
phenol	3500.0(G)	ND (0.20)	ND (0.40)	ND (1.0)
Purgeable Halocarbons UG/L				
1,1,1-Trichloroethane	200.0(M)	200.0(G)	ND (90.0)	ND (90.0)
1,1,2,2-Tetrachloroethane		ND (30.0)	ND (120.0)	ND (120.0)
1,1,2-Trichloroethane		ND (18.0)	ND (70.0)	ND (70.0)
1,1-Dichloroethane		ND (23.0)	ND (90.0)	ND (90.0)
1,1-Dichloroethene	7.0(M)	7.0(G)	ND (100.0)	ND (100.0)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

6: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

C: Second Column Confirmed

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ): Detection limit

APR 14 1988

TABLE 4.2.4-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 10 (WASTE BURIAL AREA), CARSWELL AFB, TEXAS.

Primary Results	EPA Standards,		Criteria		Monitor Well	
					Sample-ID	Date Sampled
	10C	03-29	03-Mar-88	14-Apr-88	10C	04-63
PARAMETER						14-Apr-88
1,2-Dichlorobenzene	620.0(G)	ND	(130.0)	ND	(500.0)	ND (500.0)
1,2-Dichloroethane	5.0(M)	0.0(G)	(7.5)	ND	(30.0)	ND (30.0)
1,2-Dichloropropane			(25.0)	ND	(100.0)	ND (100.0)
1,3-Dichlorobenzene	400.0(G)		(75.0)	ND	(300.0)	ND (300.0)
1,4-Dichlorobenzene	750.0(M)	750.0(G)	(100.0)	ND	(400.0)	ND (400.0)
2-Chloroethylvinyl ether			(50.0)	ND	(200.0)	ND (200.0)
Bromodichloromethane			(25.0)	ND	(100.0)	ND (100.0)
Bromoform			(75.0)	ND	(300.0)	ND (300.0)
Bromomethane			(300.0)	ND	(1200.0)	ND (1200.0)
Carbon tetrachloride	5.0(M)	0.0(G)	(25.0)	ND	(100.0)	ND (100.0)
Chlorobenzene	60.0(G)		(75.0)	ND	(300.0)	ND (300.0)
Chloroethane			(130.0)	850.0	(500.0)	ND (500.0)
Chloroform			(13.0)	ND	(50.0)	ND (50.0)
Chloromethane			(75.0)	ND	(300.0)	ND (300.0)
Dibromochloromethane			(50.0)	ND	(200.0)	ND (200.0)
Methylene chloride			(75.0)	ND	(300.0)	ND (300.0)
Tetrachloroethene	8.0(G)		(7.5)	ND	(30.0)	ND (30.0)
Trichloroethene	5.0(M)	0.0(G)	(50.0)	1900.0	(200.0)	1900.0 (200.0)
Trichlorofluoromethane			(25.0)	ND	(100.0)	ND (100.0)
Vinyl chloride	2.0(M)	0.0(G)	(50.0)	ND	(200.0)	ND (200.0)
cis-1,3-Dichloropropene				ND		ND
trans-1,2-Dichloroethene	70.0(G)		(50.0)	ND	(200.0)	ND (200.0)
trans-1,3-Dichloropropene			(75.0)	ND	(300.0)	ND (300.0)
Purgeable Aromatics						

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

Δ: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

C: Second Column Confirmed

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ): Detection limit

TABLE 4.2.4-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 10 (WASTE BURIAL AREA), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards, Criteria		Monitor Well	
	Criteria		Sample ID	Date Sampled
	03-Mar-88	14-Apr-88	10C	10C
1,2-Dichlorobenzene	620.0(G)	ND (40.0)	ND	ND (40.0)
1,3-Dichlorobenzene	400.0(G)	ND (40.0)	ND	ND (40.0)
1,4-Dichlorobenzene	750.0(M)	750.0(G)	ND	ND (30.0)
Benzene	5.0(M)	0.0(G)	ND	ND (20.0)
Chlorobenzene	60.0(G)	ND (30.0)	ND	ND (30.0)
Ethylbenzene	680.0(G)	ND (30.0)	ND	ND (30.0)
Toluene	2000.0(G)	ND (20.0)	ND	ND (20.0)
m-Xylene		ND (20.0)	ND	ND (20.0)
o-Xylene		ND (10.0)	ND	ND (10.0)
p-Xylene		ND (20.0)	NDQ	NDQ (20.0)
<b>Organochlorine Pesticides UG/L</b>				
4,4'-DDD		ND (0.040)	ND	ND (0.041)
4,4'-DDE		ND (0.25)	ND	ND (0.041)
4,4'-DDT		ND (0.080)	ND	ND (0.082)
PCB-1016		ND (2.5)	ND	ND (2.6)
PCB-1221		ND (5.0)	ND	ND (0.82)
PCB-1232		ND (5.0)	ND	ND (0.82)
PCB-1242		ND (2.5)	ND	ND (0.41)
PCB-1248		ND (0.40)	ND	ND (0.41)
PCB-1254		ND (0.80)	ND	ND (0.82)
PCB-1260		ND (0.80)	ND	ND (0.82)
aldrin		ND (0.040)	ND	ND (0.041)
alpha-BHC		ND (0.25)	ND	ND (0.26)
beta-BHC		ND (0.25)	ND	ND (0.041)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

t: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

C: Second Column Confirmed

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ): Detection limit

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TABLE 4.2.4-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 10 (WASTE BURIAL AREA), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards,		Monitor Well	
	Criteria		Sample ID	Date Sampled
	03-Mar-88	14-Apr-88	10C	10C
Chlordane	ND	(0.20)	ND	(0.21)
delta-BHC	ND	(0.040)	ND	(0.042)
dieldrin	ND	(0.25)	ND	(0.042)
endosulfan I	ND	(0.25)	ND	(0.042)
endosulfan II	ND	(0.12)	ND	(0.13)
endosulfan sulphate	ND	(0.20)	ND	(0.21)
endrin	0.20(M)	(0.040)	ND	(0.042)
endrin aldehyde	ND	(0.080)	ND	(0.082)
endrin ketone	ND	(0.20)	ND	(0.21)
gamma-BHC (lindane)	ND	(0.25)	ND	(0.26)
heptachlor	ND	(0.25)	ND	(0.042)
heptachlor epoxide	ND	(0.25)	ND	(0.042)
methoxychlor	100.0(M)	(0.20)	ND	(0.21)
toxaphene	5.0(M)	(2.0)	ND	(2.1)
Chlorinated Phenoxy Acid Herbicides				
2,4,5-T	ND	(0.50)	ND	(0.10)
2,4,5-TP (Silvex)	10.0(M)	(0.50)	ND	(0.10)
2,4-D	100.0(M)	(2.5)	ND	(0.50)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

A: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

C: Second Column Confirmed

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ): Detection limit



TABLE 4.2.4-5. RESULTS OF FIELD ANALYSES FOR WATER SAMPLES, SITE 10 (WASTE BURIAL AREA), CARSWELL AFB, TEXAS

Analyte	Unit of Measure	Monitor Well	
		Sample ID	Date Sampled
		10C	10C
		03-29	04-62
		03-Mar-88	14-Apr-88
Alkalinity	mg/L	625.0	(5.0)
Specific Conductance	µMOS/CM	930.0	(10.0)
Temperature	C	18.0	(1.0)
pH	S. U.	6.7	(0.010)

( ) : Detect Limit

Petroleum Hydrocarbons--Water analysis revealed a petroleum hydrocarbon detection of 0.60 mg/L at 10A and 0.40 mg/L at 10C in Round 1. No hydrocarbons were detected at Site 10 in Round 2.

Phenols--Phenols were detected (and confirmed by second-column analysis) in wells 10A and 10C in Round 1. Concentrations of 2,4-dinitrophenol, 2-chlorophenol, and 2-methyl-4,6-dinitrophenol were detected in the first, but not the second sampling round at 10A.

Purgeable Halocarbons--Trichloroethene (TCE) was detected in concentrations greater than the MCL in all ground water sampled at Site 10. Values ranged from 11,000 µg/L at 10B (Round 1) to 1,900 µg/L at 10C (Rounds 1 and 2). TCE values increased slightly between sampling rounds at 10A, decreased at 10B, and remained stable at 10C. In well 10C, chloroethane was detected at 850 µg/L in the first sampling round. Chloroethane was not detected in the second sampling round at 10C.

Purgeable Aromatics--Purgeable aromatics were not detected in ground water at Site 10.

Organochlorine Pesticides and PCBs--Pesticides and PCBs were not detected in ground water at Site 10.

Chlorinated Phenoxy Acid Herbicides--Herbicides were not detected in ground water at Site 10.

#### 4.2.4.3 Significance of Findings

The principal effort for the RI/FS Stage 2 field program at Site 10 was to determine if contaminants occurred in the soil underlying the Waste Burial Area. The following paragraphs contain a discussion of the significance of the findings for soil and ground-water contamination at Site 10.

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Soil--Three soil borings were advanced to 29 feet below the land surface at Site 10. Based on a review of the soil chemistry data, the samples collected and analyzed from these boreholes did not indicate the presence of contaminants or waste materials. Although the site is marked as a burial area for tetraethyllead, it is probable that the actual burial area is not extensive and simply was not encountered during the drilling.

Ground Water--Analysis of ground-water samples collected at Site 10 showed:

1. The principal ground-water contaminant in the upper zone is trichloroethene (TCE).
2. TCE occurs in the three Site 10 upper zone wells both up-gradient and downgradient of the Waste Burial Area.

Zones of Contamination--The ground-water contamination at the Waste Burial Area, and other Flightline Area sites, is best described in terms of TCE, which has consistently been detected in the upper zone. Figure 4.2.2-1 is a contour map of TCE concentrations in the upper zone for Flightline Area sites, including the Waste Burial Area. The contour map illustrates a plume of TCE outlined by, but not limited to, the 1,000  $\mu\text{g/L}$  TCE contour line that encompasses much of Landfill 4, all of Site 10, the southern portion of Landfill 5, areas west of Landfill 5 and Site 10, and the golf course area east of the Flightline sites. The size and shape of the TCE plume was consistent between sampling rounds, and also with the Stage 1 data. The center (i.e., highest concentrations of TCE) of the plume is at well 10B, southeast of the Waste Burial Area. The western limit of the plume is not completely defined, since ground water from wells 5A and 5E is upgradient of all IRP sites and is within the plume. The eastern limit of the plume is also not completely defined; wells 5H, 5C, 4G, and 4H are within the plume such that the contour lines can not be "closed" to define the limit of the TCE plume.

Contaminant Migration--The Stage 2 results indicate the following regarding the source and migration of contaminants at the Waste Burial Area.

1. The plume of TCE in ground water detected in Site 10 wells is due to multiple sources, probably including the Waste Burial Area. The ground-water flow lines intersecting wells 10A and 10C indicate that TCE in these wells could not have originated at the Waste Burial Area. However, the reported types of materials (e.g., drums of cleaning solvents) deposited at the Waste Burial Area suggest that this site is a source of TCE in upper zone ground water at other Site 10 wells. Particularly strong evidence is the high concentration of TCE in well 10B, at the downgradient (east) margin of the site. The high TCE concentrations (up to 11,000  $\mu\text{g}/\text{L}$ ), combined with the adjacent downgradient location, indicate a TCE source at the Waste Burial Area.
2. Although the downgradient limit of the TCE plume has not been completely defined by the current well configuration, the occurrence of TCE at Flightline Area wells as far as 600 feet east of the east boundary of the site (4G and 5F) is reasonable considering the prevailing direction of ground-water flow and the estimated ground-water flow rate in the upper zone. Since the ground-water flow rate in the upper zone is estimated to be approximately 0.2 feet per day, contaminants entrained in ground-water flow in the center of Waste Burial Area would be able to reach the downgradient wells in several years. With disposal operations at Waste Burial Area taking place during the 1960s, ground-water contaminants may be expected east of the current well system, assuming that the direction and rate of ground-water flow has remained constant over the last 20 years.

3. Contaminants in the upper zone ground water would not be expected to move off-base, since ground-water in the upper zone flows toward Farmers Branch or its tributaries, which are completely on base property. To determine if ground-water discharge was visible at the surface near Farmers Branch, a field survey of upper zone and bedrock outcrop at Farmers Branch was conducted in August 1988. The survey indicated that the creek flows over limestone, with the south cut bank of the creek exposed in limestone. No seeps or springs in the limestone were observed, although a zone (approximately 40 feet long, several feet wide) of moist soil and green grass (in a field of otherwise dead grass) was observed at the contact between alluvial (upper zone) and bedrock material at the south side of Farmers Branch. Thus, upper zone ground water (and contaminants, if present) probably is discharged to the land surface within the base directly by evaporation or evapotranspiration in a diffuse seepage zone where the alluvial materials pinch out and disappear at Farmers Branch.

#### 4.2.4.4 Baseline Risk Assessment

##### Summary of Indicator Chemicals

Results of the Stage 2 investigation indicate the presence of these indicator chemicals in at least one soil and/or ground water sample at the site:

<u>Metals</u>	<u>PNAs</u>	<u>VOCs</u>
Antimony	Bis(2-ethylhexyl)	Methylene chloride
Arsenic	phthalate	Toluene
Barium		Trichloroethene
Beryllium		
Cadmium		
Chromium		
Lead		
Nickel		
Selenium		
Silver		

Tables 3.8-2, 3.8-3, and 3.8-4 in Section 3.8 present important physical, chemical, and biological characteristics for these and all other indicator chemicals.

Some of the above indicator chemicals, particularly those at very low concentrations, may be due in part to matrix interferences or sample vial contamination. Nevertheless, these chemicals were included in the risk assessment process in order to ensure a conservative (stringent-case) evaluation of possible health risks.

#### Source and Release Characterization

Possible sources of contaminant release from the Waste Burial Area, as for Landfills 3, 4, and 5, include: 1) volatilization to the air, 2) fugitive dust generation, 3) recharge to ground water, 4) surface runoff, and 5) direct release to surface water.

Volatilization to the Air--VOCs present in the soil are subject to volatilization to the air by virtue of high vapor pressures. PNAs generally have very low vapor pressures and are not subject to volatilization. Most

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metals are nonvolatile as well. Indicator chemicals detected at the site which can volatilize include methylene chloride, toluene, and trichloroethene.

Estimated emission rates based conservatively on maximum concentrations detected in the soil or ground water at the site are:

<u>Indicator Chemical</u>	<u>Emission Rate</u> <u>(grams/second)</u>
Methylene chloride	$4.23 \times 10^{-8}$
Toluene	$3.69 \times 10^{-8}$
Trichloroethene	$4.94 \times 10^{-5}$

The methodology used to estimate emission rates is described in Section 3.8.

Fugitive Dust Generation--Contaminants must be present in surface soil uncovered by impervious materials or vegetation to be subject to fugitive dust generation. Because wastes are buried at the Waste Burial Area and the surface is vegetated, contaminants present in the subsoil at this site are not subject to fugitive dust generation.

Recharge to Ground Water--Indicator chemicals detected in the ground water near the Waste Burial Area include: antimony, arsenic, barium, beryllium, cadmium, chromium, lead, nickel, selenium, silver, toluene, and trichloroethene. Section 4.2.4.3 summarizes and discusses the significance of the concentrations detected in the ground water at the site.

Surface Runoff--Contaminants must be present in surface soil uncovered by impervious materials to be subject to significant surface runoff during precipitation. Because the Waste Burial Area was covered and vegetated after waste burial operations ceased and the site is flat, contaminants present in the subsoil at this site are not subject to significant surface runoff.

Discharge to Surface Water--There is no direct discharge of contaminants from this site to surface water.

#### Transport and Fate of Contaminants

The Waste Burial Area potentially releases VOCs to the air via volatilization and VOCs, bis(2-ethylhexyl)phthalate, and metals to the ground water via site leaching. Potentially significant contaminant transport and fate mechanisms in the air and ground water media include: 1) air dispersion, 2) ground water migration, 3) transport in surface water, and 4) subsequent uptake by plants and animals. The transport and fate of contaminants from the Waste Burial Area will follow the same pathways as described for Landfill 4 in Section 4.2.2.4. Refer to this section for details on transport and fate.

#### Exposure Pathways

Figure 4.2.1-2 in Section 4.2.1.4 depicts potential pathways for contaminants to move from Landfill 3 to human exposure points. These same pathways apply to the Waste Burial Area. Pathways which are not complete have been crossed out. Remaining pathways include:

1. Volatilization to the air/air dispersion/inhalation of ambient air;
2. Volatilization to the air/air dispersion/inhalation by animals/ingestion of meat and dairy products;
3. Leaching to ground water/ground-water migration to surface water (fishable source)/uptake by fish and other aquatic organisms/ingestion of aquatic organisms;
4. Leaching to ground water/ground-water migration to surface water (agricultural use source)/ingestion by animals/ingestion of meat and dairy products;

5. Leaching to ground water/ground-water migration to surface water (source used for contact sports)/skin contact with water; and
6. Leaching to ground water/ground-water migration to surface water/volatilization of volatiles/inhalation of vapors close to source.

#### Identification of Receptors

Based on available exposure pathways, potential human receptors for exposure to contaminants originating from the Waste Burial Area, as for Landfills 3, 4, and 5, include: 1) persons residing and/or working in nearby areas, particularly downwind of the site; 2) persons ingesting meat and dairy products from animals exposed to contaminants in the ambient air or contaminated surface water; 3) persons ingesting fish or other aquatic organisms exposed to contaminated surface water; and 4) persons swimming or participating in other contact sports in contaminated water. As are Landfills 4 and 5, the Waste Burial Area is located closer to residential areas of the base than is Landfill 3.

Potential wildlife receptors include: 1) terrestrial organisms with habitats close to the Waste Burial Area that inhale ambient air and ingest surface water, particularly from Farmers Branch, and 2) aquatic organisms in Farmers Branch and the West Fork of the Trinity River.

#### Threat to Human Health

Inhalation Exposure--Inhalation of ambient air is the most direct exposure pathway for contaminants to move from the Waste Burial Area to human receptors. Table 4.2.4-6 presents the on-site maximum and off-site maximum predicted annual ambient air concentrations resulting from estimated Waste Burial Area emissions, and predicted concentrations at several discrete locations: site of the proposed base day care center, which is central to the



largest on-base residential area, the Fort Worth National Fish Hatchery, and the closest dairy and beef operations. The table also lists Texas Air Control Board (TACB) health Effects Screening Levels (ESLs) which the agency uses to evaluate the impacts of air contaminants. TACB screening levels are based on occupational exposure limits (American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs), Occupational Health and Safety Administration (OSHA) standards, or National Institute for Occupational Safety and Health (NIOSH) recommendations), odor nuisance potential, vegetation effects, or corrosion effects. Generally, the annual ESL corresponds to 0.1% of the lowest occupational exposure limit.

The maximum predicted annual average concentrations resulting from estimated Waste Burial Area emissions for methylene chloride, toluene, and trichloroethene are lower than the conservative TACB Effects Screening Levels by 7, 8, and 6 orders of magnitude, respectively.

Table 4.2.4-7 shows estimates of average daily inhalation exposure (in mg/kg body weight/day) at the location of the on-site and off-site maximum predicted annual average concentration, and at the proposed on-site day care facility, and compares these values with inhalation Acceptable Daily Intakes (ADIs) for chronic (long-term) exposure. An inhalation ADI is an estimate of the dose of a chemical that can be inhaled daily for a lifetime without producing adverse noncarcinogenic health effects. Section 3.8 discusses the derivation of ADIs used in this assessment.

Average daily inhalation exposures for methylene chloride, toluene, and trichloroethene are lower than pollutant-specific ADIs in all cases by more than 5 orders of magnitude.

Ingestion Exposure--Potential ingestion exposures include ingestion of meat and dairy products from animals exposed to contaminants in the ambient air or contaminated surface water and fish exposed to contaminated surface water. For the same reasons discussed in Section 4.2.1.4 for Landfill 3, exposure by these pathways is likely to be minimal and was not quantified.

TABLE 4.2.4-7. ESTIMATED ANNUAL AVERAGE DAILY INHALATION EXPOSURES FOR CONTAMINANTS ORIGINATING FROM THE WASTE BURIAL AREA

Contaminant	On-Site Maximum			Off-Site Maximum			Day Care		
	Inhalation Acceptable Daily Intake <sup>a</sup> (mg/kg/day)	Inhalation Exposure (mg/kg/day)	Safety Factor <sup>c</sup>						
Methylene chloride	$6.0 \times 10^{-2}$	$1.17 \times 10^{-10}$	$5.12 \times 10^6$	$5.56 \times 10^{-12}$	$1.06 \times 10^{10}$	$1.15 \times 10^{-11}$	$5.23 \times 10^9$		
Toluene	1.5	$1.02 \times 10^{-10}$	$1.47 \times 10^{10}$	$4.85 \times 10^{-12}$	$3.09 \times 10^{11}$	$1.0 \times 10^{-11}$	$1.5 \times 10^{11}$		
Trichloroethene	$2.46 \times 10^{-2}$	$1.37 \times 10^{-7}$	$1.80 \times 10^5$	$6.49 \times 10^{-9}$	$3.79 \times 10^6$	$1.34 \times 10^{-6}$	$1.84 \times 10^6$		

<sup>a</sup> Estimate of the dose of a chemical that can be inhaled daily for a lifetime without producing adverse noncarcinogenic health effects.

<sup>b</sup> Inhalation exposure assumes inhalation for 24 hours/day of predicted annual average ambient concentrations by an individual with an average body weight of 70 kg and with an average inhalation rate of 20 m<sup>3</sup>/day.

<sup>c</sup> Inhalation Acceptable Daily Intake/Inhalation Exposure

Dermal Exposure--The potential for skin contact with contaminants originating from the Waste Burial Area is limited to exposures while swimming in (or otherwise in contact with) contaminated surface water. Again, for reasons discussed in Section 4.2.1.4 for Landfill 3, exposure by this pathway is also likely to be minimal and was not quantified.

#### Carcinogenic Risks

Inhalation Risk--Of the three indicator chemicals which might be emitted to the air from the Waste Burial Area, methylene chloride and trichloroethene are potential carcinogens. Cancer potency estimates developed by EPA were used in conjunction with total daily contaminant doses to develop estimates of individual cancer risk:

$$\text{individual cancer risk} = \text{total daily dose} \times \text{cancer potency} \\ (\text{mg/kg/day}) \quad (\text{mg/kg/day})^{-1}$$

Individual cancer risk is the increased probability of getting cancer in one's lifetime.

Table 4.2.4-8 shows estimates of individual cancer risk for the maximum on-site and maximum off-site exposed individual and for an individual inhaling ambient concentrations in the immediate vicinity of the proposed day care facility continuously for a lifetime. These risks, the highest of which is 6.3 in 10 billion, can be dismissed as inconsequential.

Ingestion Risk--The potential for ingestion exposure to contaminants originating from the Waste Burial Area is remote and likely to be minimal. The risk of ingestion exposure was therefore not quantified.

Dermal Risk--The potential for dermal exposure to contaminants originating from the Waste Burial Area is also remote. Unless an individual immersed frequently in the waters of Farmers Branch for a long period of time, skin contact exposure can be considered insignificant. The risk of dermal exposure was therefore not quantified.

TABLE 4.2.4-8. ESTIMATED INDIVIDUAL CANCER RISK ASSOCIATED WITH INHALATION OF POTENTIAL CARCINOGENS ORIGINATING FROM THE WASTE BURIAL AREA

Contaminant	Potency Slope <sup>a</sup> (mg/kg/day) <sup>-1</sup>	Individual Cancer Risk <sup>b</sup>		
		On-Site Maximum Exposed Individual	Off-Site Maximum Exposed Individual	Individual Exposed at Day Care Facility
Methylene chloride	$1.6 \times 10^{-3}$	$1.9 \times 10^{-13}$	$9.2 \times 10^{-15}$	$1.9 \times 10^{-14}$
Trichloroethene	$4.6 \times 10^{-3}$	$6.3 \times 10^{-10}$	$3.0 \times 10^{-11}$	$9.2 \times 10^{-11}$
TOTAL 70 year risk		$6.3 \times 10^{-10}$	$3.0 \times 10^{-11}$	$6.2 \times 10^{-11}$

<sup>a</sup> See Section 3.8 for discussion and documentation.

<sup>b</sup> Risk calculation assumes inhalation for 24 hours/day for a 70 year lifetime of predicted annual average ambient concentrations by an individual with an average body weight of 70 kg and with an average inhalation rate of 20 m<sup>3</sup>/day.

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Threat to Wildlife

Contaminants originating from the Waste Burial Area, as discussed previously for Landfill 3, pose some risk to terrestrial wildlife that use Farmers Branch as a source of drinking water as well as aquatic organisms in Farmers Branch. In the past, there have been some instances of fish kills in Farmers Branch. The potential contribution of the Waste Burial Area to contaminant concentrations in Farmers Branch was not estimated because neither the ground-water inflow to Farmers Branch nor existing contaminant concentrations in Farmers Branch is known.

4.2.5 Fire Department Training Area 1 (Site 11)

RI/FS Stage 2 activities at Fire Department Training Area 1 (FDTA 1) consisted of the collection and analysis of ground water from wells 11A and 11B. These upper zone monitor wells were installed during the Stage 1 program, which also included a geophysical survey at the site.

4.2.5.1 Site Description

Topography

Site 11 is located in the southern part of Carswell AFB just west of Cody Drive and north of Landfill 5. The land surface elevation is approximately 605 feet MSL. The site now consists of a level, gravel-surfaced area on a drainage divide between an unnamed tributary of Farmers Branch and Farmers Branch.

Geology

Geologic data developed for Site 11 resulted from three Stage 1 activities: geophysical surveys (EMP and VES), geologic sampling during drilling operations, and observations of water levels during and after monitor well installation. Water levels were also observed during the RI/FS Stage 2 program.

The geologic picture at Site 11 is based on an evaluation of drilling logs developed during the installation of two upper zone monitor wells. Upper zone materials consist of surficial deposits of clayey silt with variable amounts of fine sand and gravel, underlain by sand and gravel deposits. The thickness of the upper zone is approximately 14 feet at both of the monitor wells. Generally, the surficial clay and silt deposits are 5 feet in thickness and the sand and gravel deposits are 8 to 10 feet thick. Shale and limestone of the Goodland Formation underlie the upper zone materials at

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all locations. Figure 4.2-2 illustrates the relationship between the upper zone materials and the underlying limestone and shale.

### Hydrogeology

Ground water occurs in the upper zone materials underlying Site 11 at depths ranging from 6 feet at 11B to 9 feet at 11A. The ground water exists under unconfined (water table) conditions in the upper zone materials. Figure 4.2-3 illustrates the potentiometric surface of the water table as determined in March 1988. As at the other Flightline sites, the occurrence and direction of movement of ground water in the upper zone appears to be directly related to the configuration of the bedrock surface.

#### 4.2.5.2 Chemical Analytical Results

##### Water Quality

Samples of ground water were collected and analyzed from monitor wells 11A and 11B in two sampling rounds. Parameters analyzed were water-quality indicators, heavy metals, petroleum hydrocarbons, purgeable halocarbons, purgeable aromatics, and extractable priority pollutants (11A only). The results of these tests are presented in Tables 4.2.5-1 (inorganic parameters) and Table 4.2.5-2 (organic parameters) and are summarized in the following paragraphs. Table 4.2.5-3 provides the results of field chemistry analyses.

Water Quality Indicators--Total dissolved solids (TDS) ranged from 570 mg/L to 820 mg/L during the two sampling rounds. Other indicators were within recommended standards and did not display any discernable trend between sampling rounds.

Petroleum Hydrocarbons--Petroleum hydrocarbons were not detected at 11A or 11B.



TABLE 4.2.5-1 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 11 (FDTA 1), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well			
	Sample ID			
	Date Sampled			
	11A	11A	11B	11B
	02-151	04-02	02-152	04-03
	24-Feb-88	05-Apr-88	24-Feb-88	05-Apr-88
EPA Standards, Criteria	11A	11A	11B	11B
Aluminum	4.7 (0.20)	13.0 (0.20)	32.0 (0.20)	20.0 (0.20)
Arsenic	ND (0.30)	ND (0.30)	ND (0.30)	ND (0.30)
Boron	ND (0.60)	ND (0.60)	ND (0.60)	ND (0.60)
Barium	0.18 (0.0090)	0.19 (0.0090)	0.25 (0.0090)	0.20 (0.0090)
Beryllium	0.0010 (0.0010)	0.0020 (0.0010)	0.0020 (0.0010)	0.0060 (0.0010)
Calcium	170.0 (0.060)	220.0 (0.060)	350.0 (0.060)	320.0 (0.060)
Cadmium	ND (0.0030)	ND (0.0030)	ND (0.0030)	ND (0.0030)
Cobalt	ND (0.010)	ND (0.010)	ND (0.010)	ND (0.010)
Chromium	0.012 (0.0090)	0.024 (0.0090)	0.053 (0.0090)	0.044 (0.0090)
Copper	ND (0.010)	ND (0.010)	0.040 (0.010)	0.030 (0.010)
Iron	5.4 (0.030)	13.0 (0.030)	68.0 (0.030)	46.0 (0.030)
Potassium	5.4 (0.30)	7.4 (0.30)	5.3 (0.30)	3.8 (0.30)
Magnesium	10.0 (0.10)	13.0 (0.10)	13.0 (0.10)	11.0 (0.10)
Manganese	0.22 (0.0030)	0.29 (0.0030)	1.5 (0.0030)	1.3 (0.0030)
Molybdenum	ND (0.050)	ND (0.050)	ND (0.050)	ND (0.050)
Sodium	14.0 (0.080)	14.0 (0.080)	35.0 (0.080)	36.0 (0.080)
Nickel	ND (0.020)	ND (0.020)	0.050 (0.020)	0.030 (0.020)
Lead	ND (0.050)	ND (0.050)	0.10 (0.050)	0.060 (0.050)
Antimony	ND (0.060)	ND (0.060)	0.070 (0.060)	ND (0.060)
Selenium	ND (0.30)	ND (0.30)	ND (0.30)	ND (0.30)
Silicon	19.0 (0.30)	30.0 (0.30)	80.0 (0.30)	41.0 (0.30)
Thallium	ND (0.090)	ND (0.090)	ND (0.090)	ND (0.090)
Vanadium	ND (0.020)	0.030 (0.020)	0.11 (0.020)	0.080 (0.020)
Zinc	0.023 (0.0060)	0.055 (0.0060)	0.098 (0.0060)	0.070 (0.0060)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), C-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

R+: Matrix spike recovery and X difference (MS and MS dup) outside control limits.

^: Indicates duplicate analysis is not within control limits.

ND: Not detected at specified detection limit

( ) : Detection limit

TABLE 4.2.5-2 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 11 (FDIA 1), CARSWELL AFB, TEXAS.

Primary Results	EPA Standards,		Criteria		Monitor Well	
	11A	11B	11A	11B	Sample ID	Date Sampled
PARAMETER	02-151	02-152	04-02	02-152	11B	11B
Petroleum Hydrocarbons UG/L	24-Feb-88	24-Feb-88	05-Apr-88	24-Feb-88	04-03	05-Apr-88
Petroleum Hydrocarbons	ND (200.0)	ND (200.0)	ND (200.0)	ND (200.0)	ND	ND (200.0)
Purgeable Halocarbons UG/L						
1,1,1-Trichloroethane	200.0(M)	200.0(G)	ND (0.090)	ND (0.090)	ND	ND (0.090)
1,1,2,2-Tetrachloroethane			ND (0.12)	ND (0.12)	ND	ND (0.12)
1,1,2-Trichloroethane			ND (0.070)	ND (0.070)	ND	ND (0.070)
1,1-Dichloroethane			ND (0.090)	ND (0.090)	ND	ND (0.090)
1,1-Dichloroethane	7.0(M)	7.0(G)	ND (0.10)	ND (0.10)	ND	ND (0.10)
1,2-Dichlorobenzene	620.0(G)		ND (0.50)	ND (0.50)	ND	ND (0.50)
1,2-Dichloroethane	5.0(M)	0.0(G)	ND (0.030)	ND (0.030)	ND	ND (0.030)
1,2-Dichloropropane			ND (0.10)	ND (0.10)	ND	ND (0.10)
1,3-Dichlorobenzene	400.0(G)		ND (0.30)	ND (0.30)	ND	ND (0.30)
1,4-Dichlorobenzene	750.0(M)	750.0(G)	ND (0.40)	ND (0.40)	ND	ND (0.40)
2-Chloroethylvinyl ether			ND (0.20)	ND (0.20)	ND	ND (0.20)
Bromodichloromethane			ND (0.10)	ND (0.10)	ND	ND (0.10)
Bromoform			ND (0.30)	ND (0.30)	ND	ND (0.30)
Bromomethane			ND (1.2)	ND (1.2)	ND	ND (1.2)
Carbon tetrachloride	5.0(M)	0.0(G)	ND (0.10)	ND (0.10)	ND	ND (0.10)
Chlorobenzene	60.0(G)		ND (0.30)	ND (0.30)	ND	ND (0.30)
Chloroethane			ND (0.50)	ND (0.50)	ND	ND (0.50)
Chloroform			ND (0.050)	ND (0.050)	ND	ND (0.050)
Chloromethane			ND (0.30)	ND (0.30)	ND	ND (0.30)
Dibromochloromethane			ND (0.20)	ND (0.20)	ND	ND (0.20)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

- A: cis-1,3-Dichloropropene cannot be quantitated due to coelution.
- B: Detected in Reagent Blank; background subtraction not performed
- J: Estimated value (GC test codes)
- Q: Daily EPA QC recovery outside 95% confidence limit.
- ND: Not detected at specified detection limit
- ( ): Detection limit



TABLE 4.2.5-2 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 11 (FDIA 1), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards,		11A		11B		11B	
	Criteria		02-151	04-02	02-152	04-03		
	24-Feb-88	05-Apr-88	05-Apr-88	24-Feb-88	05-Apr-88			
Methylene chloride		MD (0.30)						
Tetrachloroethene	8.0(G)	MD (0.030)						
Trichloroethene	5.0(M)	0.0(G)	MD (0.20)					
Trichlorofluoromethane		MD (0.10)						
Vinyl chloride	2.0(M)	0.0(G)	MD (0.20)					
cis-1,3-Dichloropropene		MDL						
trans-1,2-Dichloroethene	70.0(G)	MD (0.20)						
trans-1,3-Dichloropropene		MD (0.30)						
Purgeable Aromatics UG/L								
1,2-Dichlorobenzene	620.0(G)	MD (0.40)	MD (0.40)	MD (0.40)	MD (4.0)	MD (4.0)	MD (0.40)	MD (0.40)
1,3-Dichlorobenzene	400.0(G)	MD (0.40)	MD (0.40)	MD (0.40)	MD (4.0)	MD (4.0)	MD (0.40)	MD (0.40)
1,4-Dichlorobenzene	750.0(M)	750.0(G)	MD (0.30)	MD (0.30)	MD (3.0)	MD (3.0)	MD (0.30)	MD (0.30)
Benzene	5.0(M)	0.0(G)	MD (0.20)	MD (0.20)	MD (2.0)	MD (2.0)	MD (0.20)	MD (0.20)
Chlorobenzene	60.0(G)	MD (0.30)	MD (0.30)	MD (0.30)	MD (3.0)	MD (3.0)	MD (0.30)	MD (0.30)
Ethylbenzene	680.0(G)	MD (0.30)	MD (0.30)	MD (0.30)	MD (3.0)	MD (3.0)	MD (0.30)	MD (0.30)
Toluene	2000.0(G)	0.60	MD (0.20)	13.0	MD (2.0)	3.2	MD (2.0)	19.0
m-Xylene		MDQ	MD (0.20)	MD (0.20)	MDQ	MDQ	MD (2.0)	MD (0.20)
o-Xylene		MD (0.10)	MD (0.10)	MD (0.10)	MD (1.0)	MD (1.0)	MD (0.10)	MD (0.10)
p-Xylene		MD (0.20)	MD (0.20)	MD (0.20)	MD (2.0)	MD (2.0)	MD (0.20)	MD (0.20)
Extractable Priority Pollutants UG/L								
1,2,4-trichlorobenzene		MD (1.9)	MD (1.9)	MD (2.1)	MD (2.1)	MD (2.1)	MD (1.9)	MD (2.1)
1,2-dichlorobenzene		MD (1.9)	MD (1.9)	MD (2.1)	MD (2.1)	MD (2.1)	MD (1.9)	MD (2.1)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

L: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

B: Detected in Reagent Blank; background subtraction not performed

J: Estimated value (GC test codes)

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ) : Detection limit



TABLE 4.2.5-2 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 11 (PDTA 1), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards.		Monitor Well	
	Criteria		Sample ID	Date Sampled
	11A	11B	11A	11B
	02-151	04-02	05-APR-88	04-03
	24-FEB-88	24-FEB-88	05-APR-88	05-APR-88
1,3-dichlorobenzene	ND (1.9)	ND (2.1)	ND (2.1)	ND (2.1)
1,4-dichlorobenzene	ND (4.4)	ND (4.8)	ND (4.8)	ND (4.8)
2,4,5-trichlorophenol	ND (10.0)	ND (11.0)	ND (11.0)	ND (11.0)
2,4,6-trichlorophenol	ND (2.7)	ND (2.9)	ND (2.9)	ND (2.9)
2,4-dichlorophenol	ND (2.7)	ND (2.9)	ND (2.9)	ND (2.9)
2,4-dimethylphenol	ND (2.7)	ND (2.9)	ND (2.9)	ND (2.9)
2,4-dinitrophenol	ND (42.0)	ND (46.0)	ND (46.0)	ND (46.0)
2,4-dinitrotoluene	ND (5.7)	ND (6.2)	ND (6.2)	ND (6.2)
2,6-dinitrotoluene	ND (1.9)	ND (2.1)	ND (2.1)	ND (2.1)
2-chloronaphthalene	ND (1.9)	ND (2.1)	ND (2.1)	ND (2.1)
2-chlorophenol	ND (3.3)	ND (3.6)	ND (3.6)	ND (3.6)
2-methylnaphthalene	ND (10.0)	ND (11.0)	ND (11.0)	ND (11.0)
2-methylphenol	ND (10.0)	ND (11.0)	ND (11.0)	ND (11.0)
2-nitroaniline	ND (50.0)	ND (55.0)	ND (55.0)	ND (55.0)
2-nitrophenol	ND (3.6)	ND (3.9)	ND (3.9)	ND (3.9)
3,3'-dichlorobenzidine	ND (17.0)	ND (18.0)	ND (18.0)	ND (18.0)
4,6-dinitro-2-methylphenol	ND (24.0)	ND (26.0)	ND (26.0)	ND (26.0)
4-bromophenyl-phenylether	ND (1.9)	ND (2.1)	ND (2.1)	ND (2.1)
4-chloro-3-methylphenol	ND (3.0)	ND (3.3)	ND (3.3)	ND (3.3)
4-chloroaniline	ND (10.0)	ND (11.0)	ND (11.0)	ND (11.0)
4-chlorophenyl-phenylether	ND (4.2)	ND (4.6)	ND (4.6)	ND (4.6)
4-methylphenol	ND (10.0)	ND (11.0)	ND (11.0)	ND (11.0)
4-nitroaniline	ND (50.0)	ND (55.0)	ND (55.0)	ND (55.0)
4-nitrophenol	ND (2.4)	ND (2.6)	ND (2.6)	ND (2.6)

Primary Results

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

A: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

B: Detected in Reagent Blank; background subtraction not performed

J: Estimated value (GC test codes)

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ): Detection limit

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TABLE 4.2.5-2 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 11 (FDIA 1), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	EPA Standards,		Criteria		Monitor Well	
	11A	11B	11A	11B	Sample ID	Date Sampled
acenaphthene	ND	(1.9)	ND	(2.1)	11B	02-152
acenaphthylene	ND	(3.5)	ND	(3.8)	11B	04-03
aniline	ND	(10.0)	ND	(10.0)	05-Apr-88	24-Feb-88
anthracene	ND	(1.9)	ND	(2.1)	05-Apr-88	05-Apr-88
benzidine	ND	(44.0)	ND	(44.0)		
benzo(a)anthracene	ND	(7.8)	ND	(8.5)		
benzo(a)pyrene	ND	(2.5)	ND	(2.7)		
benzo(b)fluoranthene	ND	(4.8)	ND	(5.2)		
benzo(g,h,i)perylene	ND	(4.1)	ND	(4.5)		
benzo(k)fluoranthene	ND	(2.5)	ND	(2.7)		
benzoic acid	ND	(50.0)	ND	(55.0)		
benzyl alcohol	ND	(50.0)	ND	(55.0)		
bis(2-chloroethoxy)methane	ND	(5.3)	ND	(5.8)		
bis(2-chloroethyl) ether	ND	(5.7)	ND	(6.2)		
bis(2-chloroisopropyl)ether	ND	(5.7)	ND	(6.2)		
bis(2-ethylhexyl)phthalate	11.0B	(2.5)	ND	(2.7)		
butylbenzylphthalate	ND	(2.5)	1.8J	(2.7)		
chrysene	ND	(2.5)	ND	(2.7)		
di-n-butylphthalate	6.1B	(2.5)	ND	(2.7)		
di-n-octyl phthalate	3.8B	(2.5)	2.0J	(2.7)		
dibenzo(a,h)anthracene	ND	(2.5)	ND	(2.7)		
dibenzofuran	ND	(10.0)	ND	(11.0)		
diethylphthalate	ND	(1.9)	ND	(2.1)		
dimethyl phthalate	ND	(1.6)	ND	(1.7)		

- D R A F T -

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

6: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

B: Detected in Reagent Blank; background subtraction not performed

J: Estimated value (GC test codes)

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ): Detection limit

10/11/88

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TABLE 4.2.5-2 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 11 (FDYA 1), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards,		11A		11A		11B	
	Criteria		02-151	04-02	02-152	04-03		
			24-Feb-88	05-Apr-88	24-Feb-88	05-Apr-88		
fluoranthene	0.030(G)	ND (2.2)	ND (2.4)					
fluorene	0.030(G)	ND (1.9)	ND (2.1)					
hexachlorobenzene		ND (1.9)	ND (2.1)					
hexachlorobutadiene		ND (0.90)	ND (0.98)					
hexachlorocyclopentadiene		ND (6.0)	ND (6.5)					
hexachloroethane		ND (1.6)	ND (1.7)					
indeno(1,2,3-cd)pyrene		ND (3.7)	ND (4.0)					
isophorone	5200.0(G)	ND (2.2)	ND (2.4)					
n-nitroso-di-n-propylamine		ND (12.0)	ND (13.0)					
n-nitrosodimethylamine		ND (10.0)						
n-nitrosodiphenylamine		ND (1.9)	ND (2.1)					
naphthalene	620.0(G)	ND (1.6)	ND (1.7)					
nitrobenzene		ND (1.9)	ND (2.1)					
pentachlorophenol	200.0(G)	ND (3.6)	ND (3.9)					
phenanthrene	0.030(G)	ND (5.4)	ND (5.9)					
phenol	3500.0(G)	ND (1.5)	ND (1.6)					
pyrene	0.030(G)	ND (1.9)	ND (2.1)					

- D R A F T -

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

t: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

B: Detected in Reagent Blank; background subtraction not performed

J: Estimated value (GC test codes)

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ) : Detection limit

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TABLE 4.2.5-3. RESULTS OF FIELD ANALYSES FOR WATER SAMPLES, SITE 11 (FDA 1), CARSWELL AFB, TEXAS

Analyte	Unit of Measure	Monitor Well	
		Sample ID	Date Sampled
		11A	11B
		04-02	04-03
		05-Apr-88	05-Apr-88
Alkalinity	mg/L		
Specific Conductance	uMOS/CM	830.0 (1.0)	690.0 (5.0)
Temperature	C	17.0 (1.0)	1100.0 (10.0)
pH	S.U.	6.7 (0.010)	16.0 (1.0)
			6.8 (0.010)

( ): Date Limit

Heavy Metals--Maximum contaminant levels were exceeded by arsenic in the first (0.096 mg/L) and second (0.068 mg/L) sampling events at monitor well 11B. Chromium (0.053 mg/L) also surpassed MCLs at 11B in the first sampling round. Iron and manganese were found in levels above the MCLGs in both sampling rounds at both wells. Lead was found in levels above the MCL at 11B using the ICP metal screen, but this was not confirmed with the graphite atomic absorption test.

Well 11B had a higher concentration of heavy metals than 11A, but the trend from the first sampling round to the second was a decrease in metals concentrations at well 11B, whereas there was an increase in metals at 11A.

Purgeable Halocarbons--Purgeable halocarbons were not detected in the ground water at Site 11.

Purgeable Aromatics--Toluene was found in all ground-water samples, ranging from 19 µg/L to 0.6 µg/L. Concentrations increased at both wells from the first to the second rounds, but were under the toluene MCLG of 2.0 mg/L.

Extractable Priority Pollutants--Several priority pollutants (phthalate compounds) were detected in water samples from 11A. However, the substances detected were at low, sometimes estimated, levels, and occasionally were detected in the reagent blank sample.

#### 4.2.5.3 Significance of Findings

The principal effort for the Stage 2 field program at Site 11 was to determine if contaminants occurred in the upper zone ground water.

Ground Water--The principal conclusions of the Stage 2 program are:

1. Volatile organic compounds (with the exception of low levels of toluene and phthalate compounds attributable to laboratory

contamination) were not detected in the upper zone ground water.

2. Water quality parameters and metals concentrations were within expected and typical ranges for shallow alluvial aquifers.
3. Previous activities at Site 11 do not appear to have introduced contaminants into the shallow ground water.

#### 4.2.5.4 Baseline Risk Assessment

##### Summary of Indicator Chemicals

Results of the Stage 2 investigation indicate the presence of these indicator chemicals in at least one soil and/or ground water sample at the site:

<u>Metals</u>	<u>PNAs</u>	<u>VOCs</u>
Antimony	Bis(2-ethylhexyl)	Toluene
Arsenic	phthalate	
Barium		
Beryllium		
Chromium		
Lead		
Nickel		
Silver		

Tables 3.8-2, 3.8-3, and 3.8-4 in Section 3.8 present important physical, chemical, and biological characteristics for these and all other indicator chemicals.

Some of the above indicator chemicals, particularly those at very low concentrations, may be due in part to matrix interferences or sample vial

contamination. Nevertheless, these chemicals were included in the risk assessment process in order to ensure a conservative (stringent-case) evaluation of possible health risks.

Source and Release Characterization

Possible sources of contaminant release from FDTA 1, as discussed previously for Landfill 3, include: 1) volatilization to the air, 2) fugitive dust generation, 3) recharge to ground water, 4) surface runoff, and 5) direct release to surface water.

Volatilization to the Air--VOCs present in the soil are subject to volatilization to the air by virtue of high vapor pressures. PNAs generally have very low vapor pressures and are not subject to volatilization. Most metals are nonvolatile as well. Toluene is the only indicator chemical detected at the site which can volatilize.

Estimated emission rates based conservatively on maximum concentrations detected in the soil or ground water at the site are:

<u>Indicator Chemical</u>	<u>Emission Rate</u> <u>(grams/second)</u>
Toluene	$7.82 \times 10^{-8}$

The methodology used to estimate emission rates is described in Section 3.8.

Fugitive Dust Generation--Contaminants must be present in surface soil uncovered by impervious materials or vegetation to be subject to fugitive dust generation. Because FDTA 1 is covered by vegetation, contaminants present in the soil at this site are not subject to significant fugitive dust generation.

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Leaching to Ground Water--Indicator chemicals detected in the ground water near FDTA 1 include: antimony, arsenic, barium, beryllium, chromium, lead, nickel, silver, and toluene. Section 4.2.5.3 summarizes and discusses the significance of the concentrations detected in the ground water at the site.

Surface Runoff--Contaminants must be present in surface soil uncovered by impervious materials to be subject to significant surface runoff during precipitation. Although FDTA 1 is covered by vegetation, surface runoff can potentially dislodge soil particles at the surface and/or dissolve and transport soluble compounds present at the soil surface.

Discharge to Surface Water--There is no direct discharge of contaminants from this site to surface water.

#### Transport and Fate of Contaminants

FDTA 1 potentially releases toluene to the air via volatilization and toluene, bis(2-ethylhexyl)phthalate, and metals to the ground and surface water via site leaching and surface runoff. Potentially significant contaminant transport and fate mechanisms in the air and ground and surface water media include: 1) air dispersion, 2) ground water migration, 3) transport in surface water, and 4) subsequent uptake by plants and animals. The transport and fate of contaminants from FDTA 1 will follow the same pathways as described for Landfill 4 in Section 4.2.1.2, except that contaminant contributions from this site to Farmers Branch can potentially derive from surface runoff as well as ground water migration. Refer to Section 4.2.1.2 for details on transport and fate.

#### Exposure Pathways

Figure 4.2-2 in Section 4.2.1.3 depicts potential pathways for contaminants to move from Landfill 5 to human exposure points. These same pathways apply to FDTA 1, except direct discharge to surface water, which does

not occur at this site. Pathways which are not complete have been crossed out. Remaining pathways include:

1. Volatilization to the air/air dispersion/inhalation of ambient air;
2. Volatilization to the air/air dispersion/inhalation by animals/ingestion of meat and dairy products;
3. Leaching to ground water/ground-water migration to surface water (fishable source)/uptake by fish and other aquatic organisms/ingestion of aquatic organisms;
4. Leaching to ground water/ground-water migration to surface water (agricultural use source)/ingestion by animals/ingestion of meat and dairy products;
5. Leaching to ground water/ground-water migration to surface water (source used for contact sports)/skin contact with water; and
6. Leaching to ground water/ground-water migration to surface water/volatilization of volatiles/inhalation of vapors close to source.

As is also true for Landfill 5, contaminant contributions to surface water can also derive from surface runoff.

#### Identification of Receptors

Based on available exposure pathways, potential human receptors for exposure to contaminants originating from FDTA 1, as for Landfills 3, 4, 5 and the Waste Burial Area, include: 1) persons residing and/or working in nearby areas, particularly downwind of the site; 2) persons ingesting meat and dairy

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products from animals exposed to contaminants in the ambient air or contaminated surface water; 3) persons ingesting fish or other aquatic organisms exposed to contaminated surface water; and 4) persons swimming or participating in other contact sports in contaminated water.

Potential wildlife receptors include: 1) terrestrial organisms with habitats close to FDTA 1 that inhale ambient air and ingest surface water, particularly from Farmers Branch, and 2) aquatic organisms in Farmers Branch and the West Fork of the Trinity River.

#### Threat to Human Health

Inhalation Exposure--Inhalation of ambient air is the most direct exposure pathway for contaminants to move from FDTA 1 to human receptors. Table 4.2.5-4 presents the on-site maximum and off-site maximum predicted annual ambient air concentrations resulting from estimated FDTA 1 emissions of toluene, and predicted concentrations at several discrete locations: site of the proposed base day care center, which is central to the largest on-base residential area, the Fort Worth National Fish Hatchery, and the closest dairy and beef operations. The table also lists the Texas Air Control Board (TACB) health Effects Screening Level (ESL) for toluene which the agency uses to evaluate the impacts of air contaminants. TACB screening levels are based on occupational exposure limits (American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs), Occupational Health and Safety Administration (OSHA) standards, or National Institute for Occupational Safety and Health (NIOSH) recommendations), odor nuisance potential, vegetation effects, or corrosion effects. Generally, the annual ESL corresponds to 0.1% of the lowest occupational exposure limit.

The maximum predicted annual average concentrations resulting from estimated FDTA 1 emissions of toluene is lower than the conservative TACB Effects Screening Level by 8 orders of magnitude.

TABLE 4.2.5-4. PREDICTED ANNUAL AVERAGE AMBIENT AIR CONCENTRATIONS RESULTING FROM ESTIMATED FIRE DEPARTMENT TRAINING AREA 1 EMISSIONS

Contaminant	Predicted Annual Average Ambient Air Concentration (ug/m <sup>3</sup> )					TACB Annual Effects <sup>3</sup> Screening Level (ug/m <sup>3</sup> )	
	On-Site Maximum	Off-Site Maximum	Dry Care	Fish Hatchery	Dairy Operation		Beef Operation
Toluene	1.3x10 <sup>-6</sup>	2.6x10 <sup>-6</sup>	4.3x10 <sup>-6</sup>	3.0x10 <sup>-9</sup>	1.0x10 <sup>-9</sup>	< 10 <sup>-9</sup>	375

TABLE 4.2.5-5. ESTIMATED ANNUAL AVERAGE DAILY INHALATION EXPOSURES FOR CONTAMINANTS ORIGINATING FROM FIRE DEPARTMENT TRAINING AREA 1

Contaminant	On-Site Maximum		Off-Site Maximum		Day Care			
	Inhalation Acceptable Daily Intake <sup>a</sup> (mg/kg/day)	Inhalation Exposure <sup>b</sup> (mg/kg/day)	Inhalation Exposure <sup>b</sup> (mg/kg/day)	Safety Factor <sup>c</sup>	Inhalation Exposure <sup>b</sup> (mg/kg/day)	Safety Factor <sup>c</sup>		
Toluene	1.5	$3.57 \times 10^{-10}$	$4.20 \times 10^{-9}$	$4.20 \times 10^{-9}$	$7.37 \times 10^{-12}$	$2.09 \times 10^{-11}$	$1.23 \times 10^{-11}$	$1.22 \times 10^{-11}$

<sup>a</sup> Estimate of the dose of a chemical that can be inhaled daily for a lifetime without producing adverse noncarcinogenic health effects.

<sup>b</sup> Inhalation exposure assumes inhalation for 24 hours/day of predicted annual average ambient concentrations by an individual with an average body weight of 70 kg and with an average inhalation rate of 20 m<sup>3</sup>/day.

<sup>c</sup> Inhalation Acceptable Daily Intake/Inhalation Exposure

Table 4.2.5-5 shows estimates of average daily inhalation exposure (in mg/kg body weight/day) at the location of the on-site and off-site maximum predicted annual average concentration, and at the proposed on-site day care facility, and compares these values with inhalation Acceptable Daily Intakes (ADIs) for chronic (long-term) exposure. An inhalation ADI is an estimate of the dose of a chemical that can be inhaled daily for a lifetime without producing adverse noncarcinogenic health effects. Section 3.8 discusses the derivation of ADIs used in this assessment.

Average daily inhalation exposures for toluene are lower than the ADI for toluene in all cases by more than 9 orders of magnitude.

Ingestion Exposure--Potential ingestion exposures include ingestion of meat and dairy products from animals exposed to contaminants in the ambient air or contaminated surface water and fish exposed to contaminated surface water. For the same reasons discussed in Section 4.2.1.1 for Landfill 3, exposure by these pathways is likely to be minimal and was not quantified.

Dermal Exposure--The potential for skin contact with contaminants originating from FDTA 1 is limited to exposures while swimming in (or otherwise in contact with) contaminated surface water. Again, for reasons discussed in Section 4.2.1.1 for Landfill 3, exposure by this pathway is also likely to be minimal and was not quantified.

#### Carcinogenic Risks

Inhalation Risk--Toluene is the only indicator chemical estimated to volatilize to the air from FDTA 1. Since toluene is not carcinogenic, there is no inhalation risk associated with this site.

Ingestion Risk--The potential for ingestion exposure to contaminants originating from FDTA 1 is remote and likely to be minimal. The risk of ingestion exposure was therefore not quantified.

Dermal Risk--The potential for dermal exposure to contaminants originating from FDTA 1 is also remote. Unless an individual immersed frequently in the waters of Farmers Branch for a long period of time, skin contact exposure can be considered insignificant. The risk of dermal exposure was therefore not quantified.

Threat to Wildlife

Contaminants originating from FDTA 1, as discussed previously for other Flightline area sites, pose some risk to terrestrial wildlife that use Farmers Branch as a source of drinking water as well as aquatic organisms in Farmers Branch. In the past, there have been some instances of fish kills in Farmers Branch. The potential contribution of FDTA 1 to contaminant concentrations in Farmers Branch was not estimated because neither the ground-water inflow to Farmers Branch nor existing contaminant concentrations in Farmers Branch is known. Sampling and analysis of Farmers Branch water at several points in its flow across the base to the West Fork of the Trinity River would provide more useful data with which to evaluate the threat to area wildlife.

#### 4.2.6 Fire Department Training Area 2 (Site 12)

Work performed at Fire Department Training Area 2 (FDTA 2) consisted of the drilling of boreholes installation of upper zone monitor wells, and collection and analysis of soil and ground-water samples. The results of the hydrogeologic and chemical data are discussed in the following sections. A baseline risk assessment is discussed in Section 4.2.6.4. Figure 4.2.6-1 illustrates the locations of the monitor wells and boreholes at Site 12.

##### 4.2.6.1 Site Description

###### Topography

Site 12 is located in the southern part of Carswell AFB just west of the radar facility. The site is an oval-shaped gravel surface containing rectangular metal containers. A low berm surrounds the basically flat area. Surface drainage is generally to the north to an unnamed tributary of Farmers Branch.

###### Geology

Geologic data developed for Site 12 resulted from soil sampling during drilling operations and observations of water levels during and after monitor well installation.

The geology of Site 12 is based on an evaluation of drilling logs from five Stage 1 and Stage 2 upper zone monitor wells and five Stage 2 soil borings. Figures 4.2.6-2 and 4.2.6-3 are cross-sections that illustrate the hydrogeologic conditions at Site 12. Upper zone materials consist of surficial deposits of clayey silt with variable amounts of fine sand and gravel, underlain by sand and gravel deposits. The thickness of the upper zone ranges from 18 feet at the southwest portion of the site to 40 feet north and east of the site. Surficial clay and silt deposits are 10 to 17 feet thick and the

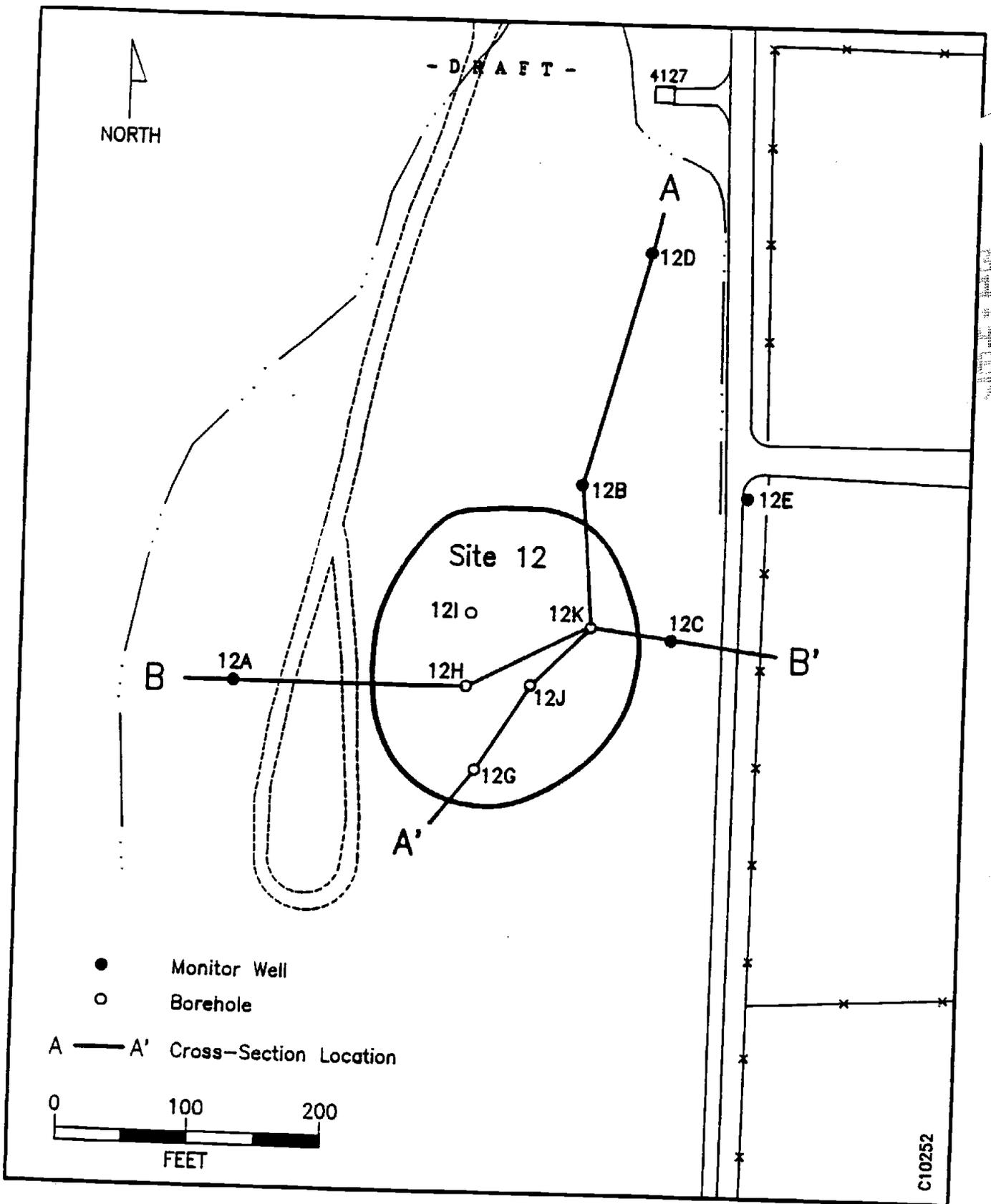


Figure 4.2.6-1. Locations of Monitor Wells and Boreholes at Site 12, Carswell AFB, Texas

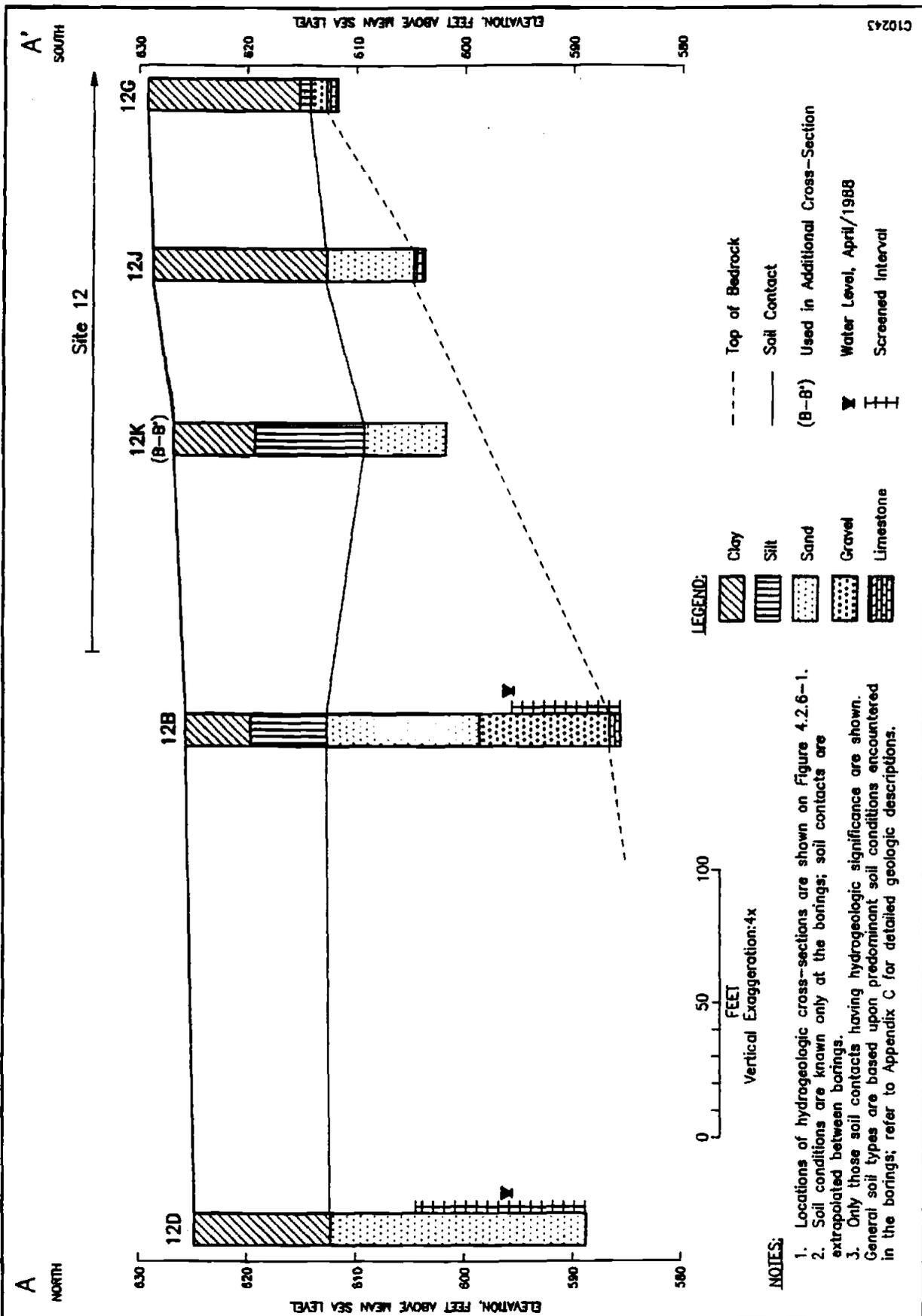


Figure 4.2.6-2. Hydrogeologic Cross-Section A-A' at Site 12, Carswell AFB, Texas

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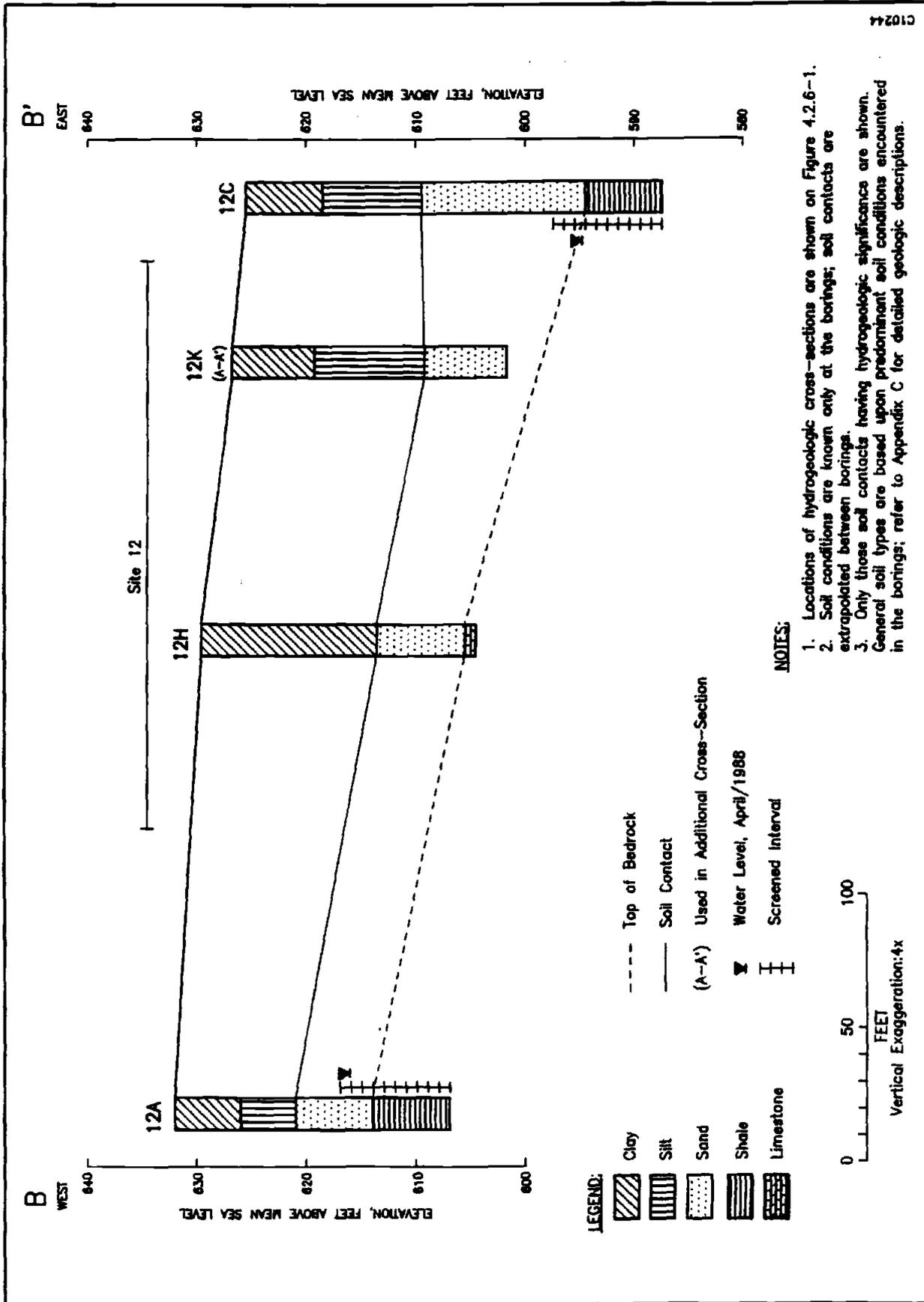


Figure 4.2.6-3. Hydrogeologic Cross-Section B-B' at Site 12, Carswell AFB, TX

sand and gravel deposits are 2 to 27 feet thick. The thickness of sand and gravel deposits decrease abruptly toward the south (e.g. 12G) as the bedrock elevation rises. It was observed that in most borings in the vicinity of the Flightline that the grain size of the sand and gravel increases with depth.

Shale and limestone of the Goodland Formation underlie the upper zone materials at all locations. The top of the Goodland occurs at a maximum depth of 40 feet to the northeast of the site (at 12E) and at its shallowest depth of 18 feet in the southernmost part of the site (at 12G). Limestone of the Goodland Formation crops out just southeast of the site near Landfill 4 in a stream that flows to Farmers Branch. The bedrock/upper zone contact slopes steeply to the northeast under the site. Figure 4.2.6-4 illustrates the relationship between the upper zone materials and the underlying limestone and shale.

#### Hydrogeology

Ground water occurs in the upper zone materials underlying Site 12 at depths ranging from 15 feet at 12A to 30 feet at 12B and 12C. The ground water exists under unconfined (water table) conditions in the upper zone materials. However, observations during drilling of several boreholes (12G, 12H, 12J) indicate that the upper zone is locally dry. In addition, other locations (12A, 12C) reveal that only a very thin zone of saturation exists in the upper zone or uppermost portion of bedrock. The saturated thickness of the upper zone increases to the north and east of the site (e.g., 12D, 12E). Figure 4.2.6-5 illustrates the potentiometric surface of the water table as determined in March 1988. Comparison of the potentiometric surface map for the upper zone ground water and the contour map of the base of the upper zone strongly suggests that the occurrence and direction of movement of ground water in the upper zone is directly related to the configuration of the bedrock surface. The direction of ground-water flow is to the northeast.

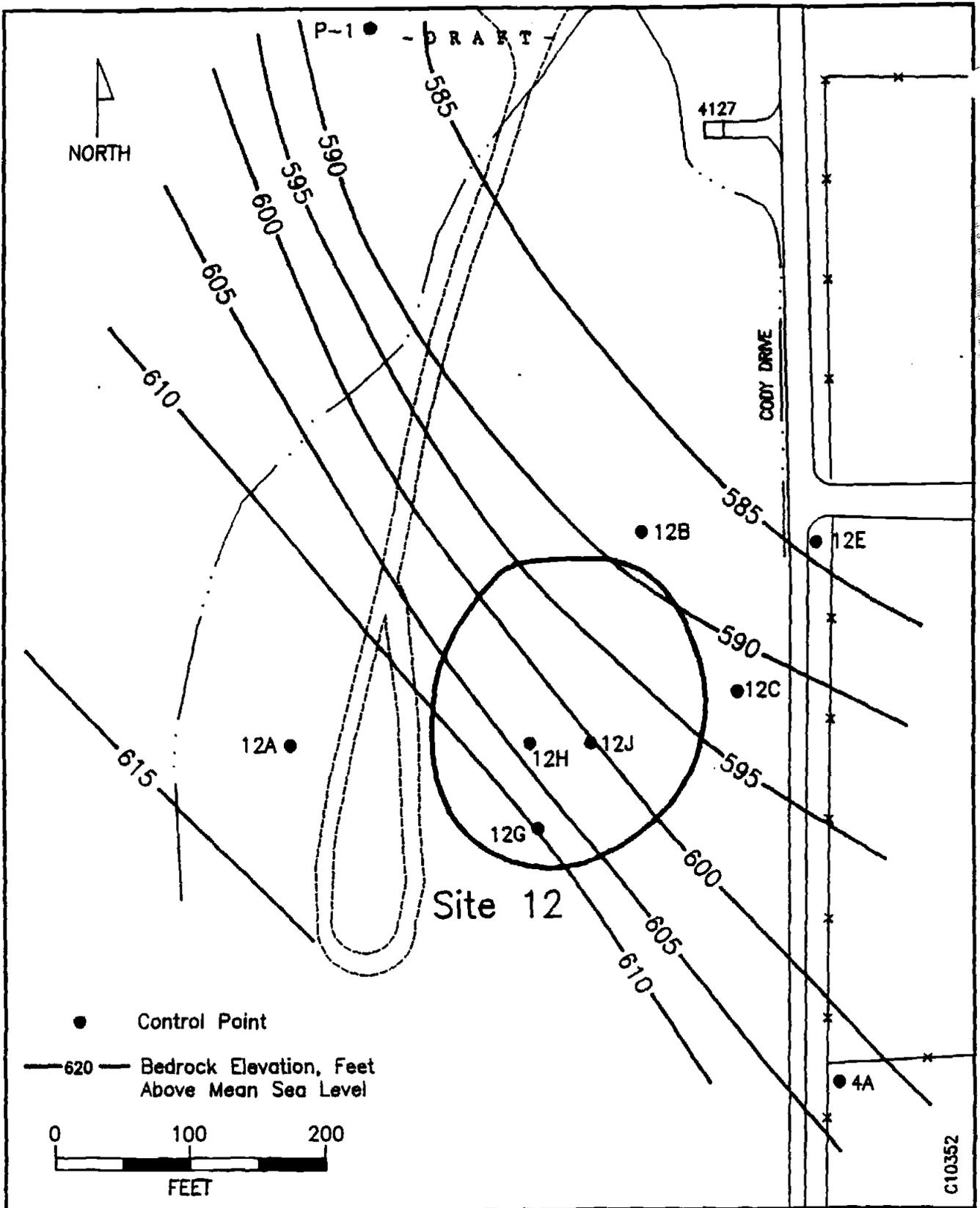


Figure 4.2.6-4. Contour Map of the Top of Bedrock, Site 12 (FDTA 2), Carswell AFB, Texas

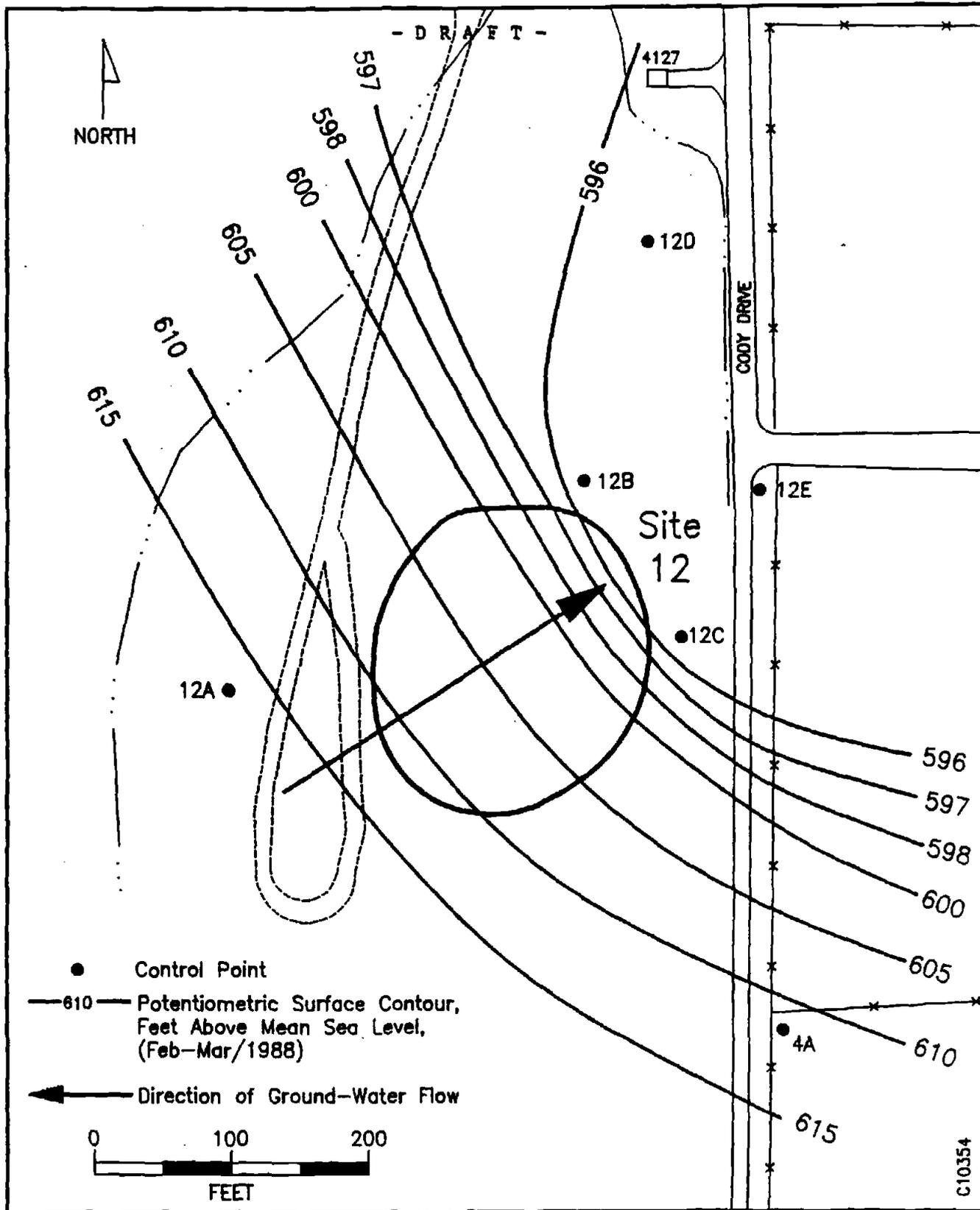


Figure 4.2.6-5. Potentiometric Surface Map of the Upper zone, Site 12 (FDTA 2), Carswell AFB, Texas

#### 4.2.6.2 Chemical Analytical Results

##### Soil Chemistry

At Site 12, two Stage 2 monitor wells were installed downgradient of the site and five soil borings were drilled within the bermed area during February 1988. Split-spoon samples collected during the monitor well installation and the soil borings were retained and visually examined for any evidence of contamination. Based on the depth and location of samples, as well as the presence of water, samples of soil were selected for analysis of moisture content, heavy metals, petroleum hydrocarbons, volatile organic compounds, and semivolatile organic compounds. The samples were selected for analysis such that the vertical and horizontal distribution of contamination could be evaluated. Results of the analyses are provided in Table 4.2.6-1 (inorganic parameters) and Table 4.2.6-2 (organic parameters).

Heavy Metals--Soil samples from boreholes 12D-12K were submitted for heavy metal analysis. As many as six samples were analyzed from each soil boring. Although there are no generally accepted standards or regulations governing heavy metal content in soil, the analytical results were compared to published average metal concentrations in U.S. soils (Table 4.1-3). Selenium was found at elevated levels in 12H, 12I, and 12J, at depths less than 12 feet. Lead was detected above mean values at boring 12J at a depth of 4 to 8 feet. Other metals parameters from Site 12 were at or less than mean U.S. soil concentrations.

Petroleum Hydrocarbons--Petroleum hydrocarbons were encountered at all boreholes except for 12D and 12G. Boring 12H had five samples analyzed from various depths. These samples showed an apparent trend of decreasing petroleum hydrocarbon concentrations with depth until sand was encountered at 19 feet, where the highest values (5,760 mg/kg) were detected. Furthermore, all samples from boring 12H were noted to have petroleum hydrocarbon odors

TABLE 4.2.6-1 RESULTS OF INORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FOIA 2), CARSHILL AFB, TEXAS.

Primary Results

PARAMETER	Soil Moisture X MOISTURE		Dry Weight Determination		Metal Screen (ICP) MC/KG		Monitor Well	
	Sample ID	Date Sampled	Sample ID	Date Sampled	Sample ID	Date Sampled	Sample ID	Date Sampled
	12D	12E	12D-4	12E-2	12D	12E	12E-4	12E
	19-Feb-88	19-Feb-88	19-Feb-88	23-Feb-88	19-Feb-88	23-Feb-88	23-Feb-88	23-Feb-88
	(15 - 20)	(25 - 30)	(4 - 6)	(14 - 19)				
	3.0	14.0	27.0	16.0				
Ag Silver	1.1	(0.88)	ND	(0.89)	ND	(0.88)	ND	(0.88)
Al Aluminum	820.0E	(20.0)	740.0E	(20.0)	8600.0	(20.0)	510.0	(19.0)
As Arsenic	ND	(29.0)	ND	(30.0)	ND	(29.0)	ND	(29.0)
B Boron	ND	(59.0)	ND	(59.0)	ND	(59.0)	ND	(58.0)
Ba Barium	4.9E	(0.88)	5.8E	(0.89)	43.0	(0.88)	2.6	(0.87)
Be Beryllium	0.1	(0.098)	0.1	(0.099)	0.5	(0.098)	0.1	(0.096)
Ca Calcium	650.0	(5.9)	44000.0	(5.9)	51000.0	(5.9)	340.0	(5.8)
Cd Cadmium	ND	(0.29)	0.3	(0.30)	ND	(0.29)	0.5	(0.29)
Co Cobalt	ND	(0.98)	ND	(0.99)	3.8	(0.98)	1.9	(0.96)
Cr Chromium	2.2	(0.88)	3.0	(0.89)	9.6	(0.88)	2.4	(0.87)
Cu Copper	1.9	(0.98)	1.3	(0.99)	3.0	(0.96)	ND	(0.96)
Fe Iron	2700.0	(2.9)	2600.0	(3.0)	8800.0	(2.9)	3200.0	(2.9)
K Potassium	80.0	(29.0)	80.0	(30.0)	1200.0	(29.0)	45.0	(29.0)
Mg Magnesium	120.0E	(9.8)	350.0E	(9.9)	1700.0	(9.8)	74.0	(9.6)
Mn Manganese	21.0E	(0.29)	41.0E	(0.30)	76.0	(0.29)	21.0	(0.29)
Mo Molybdenum	ND	(4.9)	ND	(5.0)	ND	(4.9)	ND	(4.8)
Na Sodium	70.0E	(7.8)	140.0E	(7.9)	40.0	(7.8)	39.0	(7.7)
Ni Nickel	2.0	(2.0)	ND	(2.0)	9.0	(2.0)	4.0	(1.9)
Pb Lead	ND	(4.9)	ND	(5.0)	13.0	(4.9)	6.0	(4.8)
Sb Antimony	ND	(5.9)	ND	(5.9)	7.0	(5.9)	ND	(5.8)
Se Selenium	ND	(29.0)	NDE	(30.0)	ND	(29.0)	ND	(29.0)
Si Silicon	350.0E	(29.0)	440.0	(30.0)	310.0	(29.0)	280.0	(29.0)
Tl Thallium	ND	(8.8)	ND	(8.9)	9.0	(8.8)	ND	(8.7)

E: The reported value is estimated due to the presence of an interferant.

ND: Not detected at specified detection limit

( ): Detection limit

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TABLE 4.2.6-1 RESULTS OF INORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FDA 2), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	Monitor Well		Date Sampled	Beg. Depth - End Depth	Sample ID
	Sample ID	Date Sampled			
V Vanadium	12D	12E	19-Feb-88	23-Feb-88	12E
	(15 - 20)	(25 - 30)	(4 - 6)	(14 - 19)	12E-4
Zn	4.0	7.0	22.0E	6.0E	(1.9)
	(2.0)	(2.0)	(2.0)	3.7	(0.58)
Zinc	3.3E	3.2E	17.0	3.7	(0.58)
	(0.59)	(0.59)	(0.59)		

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E: The reported value is estimated due to the presence of an interferant.  
 ND: Not detected at specified detection limit  
 ( ): Detection Limit

TABLE 4.2.6-1 RESULTS OF INORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FYTA 2), CARSWELL AFB, TEXAS.

PARAMETER		Monitor Well	
		Sample ID	Date Sampled
		Bag. Depth - End Depth	
Soil Moisture & MOISTURE	26.0	12G	12B
Dry Weight Determination	28.0	12G-4	12B-1
		20-Feb-88	23-Feb-88
		(14 - 17)	(0 - 4)
Primary Results			
Metal Screen (ICF) MG/KG			
Ag Silver	1.4	(0.88)	1.3
Al Aluminum	2000.0	(20.0)	7100.0
As Arsenic	ND	(29.0)	ND
B Boron	ND	(59.0)	ND
Ba Barium	8.6	(0.88)	33.0
Be Beryllium	0.2	(0.098)	0.3
Ca Calcium	5600.0	(5.9)	12000.0
Cd Cadmium	ND	(0.29)	0.7
Co Cobalt	2.3	(0.98)	1.6
Cr Chromium	6.4	(0.88)	8.7
Cu Copper	2.0	(0.98)	1.6
Fe Iron	7800.0	(2.9)	7700.0
K Potassium	270.0	(29.0)	690.0
Mg Magnesium	420.0	(9.8)	1400.0
Mn Manganese	60.0	(0.29)	47.0
Mo Molybdenum	ND	(4.9)	ND
Na Sodium	43.0	(7.8)	93.0
Ni Nickel	6.0	(2.0)	6.0
Pb Lead	11.0	(4.9)	9.0
Sb Antimony	ND	(5.9)	19.0
Se Selenium	ND	(29.0)	ND
Si Silicon	330.0	(29.0)	320.0
Tl Thallium	ND	(8.8)	12.0
			29.0
			ND
			13000.0
			30.0
			ND
			86.0
			0.7
			41000.0
			0.6
			4.6
			14.0
			3.4
			12000.0
			1100.0
			1700.0
			250.0
			ND
			74.0
			10.0
			16.0
			ND
			50.0
			350.0
			ND
			(8.8)

E: The reported value is estimated due to the presence of an interferant.

ND: Not detected at specified detection limit

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TABLE 4.2.6-1 RESULTS OF INORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FDIA 2), CARSWELL AFB, TEXAS.

Primary Results		Monitor Well	
PARAMETER		Sample ID	
		Date Sampled	
		Req. Depth - End Depth	
V Vanadium	12E 12E-6 23-Feb-88 (24 - 29)	12G 12G-4 20-Feb-88 (14 - 17)	12H 12H-1 23-Feb-88 (0 - 4)
Zn	15.0E (2.0) 9.8 (0.59)	27.0E (2.0) 12.0 (0.59)	30.0E (2.0) 18.0 (0.59)

E: The reported value is estimated due to the presence of an interferant.

ND: Not detected at specified detection limit

( ): Detection limit



TABLE 4.2.6-1 RESULTS OF INORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FDA 2), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	Monitor Well		Date Sampled	Beg. Depth - End Depth	12H	12H-2	23-Feb-88	(4 - 9)	28.0E (2.0)	15.0 (0.59)	23.0E (1.9)	15.0 (0.58)	29.0E (1.9)	12.0 (0.58)	24.0E (1.9)	16.0 (0.58)
	Sample ID	Sample ID														
V Vanadium	12H	12H	23-Feb-88	12H	12H	23-Feb-88	(4 - 9)	28.0E (2.0)	15.0 (0.59)	23.0E (1.9)	15.0 (0.58)	29.0E (1.9)	12.0 (0.58)	24.0E (1.9)	16.0 (0.58)	
Zn	12H-2	12H-2	23-Feb-88	12H-2	12H-2	23-Feb-88	(4 - 9)	15.0 (0.59)	23.0E (1.9)	15.0 (0.58)	29.0E (1.9)	12.0 (0.58)	24.0E (1.9)	16.0 (0.58)		

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E: The reported value is estimated due to the presence of an interferent.  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

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TABLE 4.2.6-1 RESULTS OF INORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FYTA 2), CARSWELL AFB, TEXAS.

Primary Results		Monitor Well
PARAMETER		Sample ID
		Date Sampled
		Req. Depth - End Depth
V Vanadium	8.0E (2.0)	12I (9 - 14)
Zn Zinc	2.6 (0.59)	12I-2 (4 - 9)
		12I-3 (1.9)
		24-Feb-88 (0.58)
		23-Feb-88 (19 - 25)

E: The reported value is estimated due to the presence of an interferant.  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

TABLE 4.2.6-1 RESULTS OF INORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FDA 2), CARSWELL AFB, TEXAS.

PARAMETER	Primary Results		Monitor Well	
	Sample ID	Date Sampled	Sample ID	Date Sampled
	12I	12J	12J-2	12J
Soil Moisture % MOISTURE	12I-5	12J-2	12J-2	12J-2
Dry Weight Determination	24-Feb-88 (19 - 24)	24-Feb-88 (4 - 9)	24-Feb-88 (4 - 9)	24-Feb-88 (4 - 9)
	4.0	15.0	14.0	
Metal Screen (ICP) MG/KG				
Ag Silver	ND (0.87)	2.0 (0.90)	1.2 (0.86)	
Al Aluminum	590.0 (19.0)	14000.0 (80.0)	21000.0 (76.0)	
As Arsenic	ND (29.0)	ND (30.0)	ND (29.0)	
B Boron	ND (38.0)	ND (60.0)	ND (57.0)	
Ba Barium	15.0E (0.87)	48.0E (0.90)	91.0E (0.86)	
Be Beryllium	0.1 (0.097)	0.7 (0.10)	0.8 (0.095)	
Ca Calcium	5600.0E (5.8)	120000.0E (24.0)	81000.0E (23.0)	
Cd Cadmium	0.5 (0.29)	0.6 (0.30)	0.5 (0.29)	
Co Cobalt	1.2 (0.97)	2.0 (1.0)	4.8 (0.95)	
Cr Chromium	4.2 (0.87)	16.0 (0.90)	19.0 (0.86)	
Cu Copper	1.3 (0.97)	5.0 (1.0)	4.8 (0.95)	
Fe Iron	5500.0 (2.9)	11000.0 (3.0)	13000.0 (2.9)	
K Potassium	ND (29.0)	1400.0 (30.0)	1900.0 (29.0)	
Mg Magnesium	110.0E (9.7)	2300.0E (10.0)	2700.0E (9.5)	
Mn Manganese	170.0 (0.29)	140.0 (0.30)	240.0 (0.29)	
Mo Molybdenum	ND (4.9)	ND (5.0)	ND (4.8)	
Na Sodium	ND (7.8)	ND (8.0)	ND (7.6)	
Ni Nickel	3.0 (1.9)	10.0 (2.0)	12.0 (1.9)	
Pb Lead	7.0 (4.9)	13.0 (5.0)	20.0 (4.8)	
Sb Antimony	ND (5.8)	31.0 (6.0)	20.0 (5.7)	
Se Selenium	ND (29.0)	50.0 (30.0)	70.0 (29.0)	
Si Silicon	260.0 (29.0)	290.0 (30.0)	250.0 (29.0)	
Tl Thallium	9.0 (8.7)	ND (9.0)	ND (8.6)	

E: The reported value is estimated due to the presence of an interferant.

ND: Not detected at specified detection limit

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TABLE 4.2.6-1 RESULTS OF INORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FDA 2), CARSWELL AFB, TEXAS.

Primary Results		Monitor Well
PARAMETER		Sample ID
		Date Sampled
		Req. Depth - End Depth
V	Vanadium	12J
		12J-2
		24-Feb-88
		(4 - 9)
		(4 - 9)
Zn	Zinc	12J
		12J-2
		24-Feb-88
		(4 - 9)
		(4 - 9)
		38.0 (1.9)
		18.0E (0.60)
		24.0E (0.57)

E: The reported value is estimated due to the presence of an interferant.  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

TABLE 4.2.6-1 RESULTS OF INORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FOIA 2), CARSWELL AFB, TEXAS.

PARAMETER		12J		12K	
		12J-3	12J-5	12K-5	12K-5
		24-Feb-88	24-Feb-88	20-Feb-88	20-Feb-88
		(9 - 14)	(19 - 23)	(20 - 25)	(20 - 25)
Soil Moisture X MOISTURE		17.0	4.0	16.0	
Dry Weight Determination					
Metal Screen (ICP) MG/KG					
Ag Silver		1.4 (0.83)	1.7 (0.82)	1.9 (0.89)	
Al Aluminum		10000.0 (74.0)	900.0 (18.0)	5300.0 (20.0)	
As Arsenic		ND (28.0)	ND (27.0)	ND (30.0)	
B Boron		ND (56.0)	ND (55.0)	ND (59.0)	
Ba Barium		38.0E (0.83)	7.0E (0.82)	49.0 (0.89)	
Be Beryllium		0.5 (0.093)	0.090 (0.091)	0.4 (0.099)	
Ca Calcium		110000.0E (22.0)	980.0E (5.5)	27000.0 (5.9)	
Cd Cadmium		0.5 (0.28)	0.3 (0.27)	ND (0.30)	
Co Cobalt		5.2 (0.93)	1.7 (0.91)	4.6 (0.99)	
Cr Chromium		13.0 (0.83)	4.0 (0.82)	9.9 (0.89)	
Cu Copper		4.8 (0.93)	2.0 (0.91)	5.1 (0.99)	
Fe Iron		10000.0 (2.8)	3400.0 (2.7)	11000.0 (3.0)	
K Potassium		1300.0 (28.0)	130.0 (27.0)	670.0 (30.0)	
Mg Magnesium		2000.0E (9.3)	150.0E (9.1)	930.0 (9.9)	
Mn Manganese		150.0 (0.28)	100.0 (0.27)	230.0 (0.30)	
Mo Molybdenum		ND (4.6)	ND (4.5)	ND (5.0)	
Na Sodium		65.0 (7.4)	ND (7.3)	68.0 (7.9)	
Ni Nickel		8.0 (1.9)	4.0 (1.8)	9.0 (2.0)	
Pb Lead		12.0 (4.6)	12.0 (4.5)	11.0 (5.0)	
Sb Antimony		30.0 (5.6)	10.0 (5.5)	6.0 (5.9)	
Se Selenium		30.0 (28.0)	ND (27.0)	ND (30.0)	
Si Silicon		230.0 (28.0)	270.0 (27.0)	330.0 (30.0)	
Tl Thallium		ND (8.3)	ND (8.2)	10.0 (8.9)	

E: The reported value is estimated due to the presence of an interferant.

ND: Not detected at specified detection limit

( ): Detection Limit

4-2201

TABLE 4.2.6-1 RESULTS OF INORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FDA 2), CARSWELL AFB, TEXAS.

Primary Results		Monitor Well	
PARAMETER		Sample ID	
		Date Sampled	
		Req. Depth - End Depth	
V	Vanadium	12J	12K
		12J-3	12K-5
		24-Feb-88	20-Feb-88
		(9 - 14)	(20 - 25)
		26.0 (1.9)	25.0E (2.0)
Zn	Zinc	9.0 (1.8)	17.0 (0.59)
		17.0E (0.56)	4.7E (0.55)

E: The reported value is estimated due to the presence of an interferant.  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

TABLE 4.2.6-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FDA 2), CARSWELL AFB, TEXAS.

Primary Results

Monitor Well

Sample ID

Date Sampled

Req. Depth - End Depth

12E

12D

12E-2

12D-4

12E-4

19-Feb-88

23-Feb-88

25 - 30

4 - 6

14 - 19

PARAMETER

Petroleum Hydrocarbons MG/KG

Petroleum Hydrocarbons

Volatile Organic Compounds MG/KG

1,1,1-trichloroethane

1,1,2,2-tetrachloroethane

1,1,2-trichloroethane

1,2-dichloroethane

1,2-dichloropropane

2-butanone

2-chloroethylvinyl ether

2-hexanone

4-methyl-2-pentanone

Benzene

Ethylbenzene

Toluene

Trichloroethene

acetone

bromodichloromethane

bromoform

bromomethane

carbon disulfide

carbon tetrachloride

chlorobenzene

chloroethane

PARAMETER	12D	12D-4	12E	12E-2	12E-4
Petroleum Hydrocarbons	ND	(5.0)	ND	(2.0)	ND
Petroleum Hydrocarbons	ND	(5.0)	ND	(5.0)	14.0
Volatile Organic Compounds	ND	(0.0040)	ND	(0.0045)	ND
1,1,1-trichloroethane	ND	(0.0073)	ND	(0.0081)	ND
1,1,2,2-tetrachloroethane	ND	(0.0053)	ND	(0.0059)	ND
1,1,2-trichloroethane	ND	(0.0030)	ND	(0.0033)	ND
1,2-dichloroethane	ND	(0.0064)	ND	(0.0071)	ND
1,2-dichloropropane	ND	(0.027)	ND	(0.030)	ND
2-butanone	ND	(0.0053)	ND	(0.0059)	ND
2-chloroethylvinyl ether	ND	(0.038)	ND	(0.042)	ND
2-hexanone	ND	(0.049)	ND	(0.054)	ND
4-methyl-2-pentanone	ND	(0.0047)	ND	(0.0052)	ND
Benzene	ND	(0.0076)	ND	(0.0085)	ND
Ethylbenzene	ND	(0.0064)	0.029	(0.0071)	ND
Toluene	ND	(0.0020)	ND	(0.0022)	ND
Trichloroethene	0.0118	(0.0080)	0.0148	(0.0089)	0.0128
acetone	ND	(0.0023)	ND	(0.0026)	ND
bromodichloromethane	ND	(0.0050)	ND	(0.0055)	ND
bromoform	ND	(0.0053)	ND	(0.0059)	ND
bromomethane	ND	(0.0018)	ND	(0.0020)	ND
carbon disulfide	ND	(0.0030)	ND	(0.0033)	ND
carbon tetrachloride	ND	(0.0064)	ND	(0.0071)	ND
chlorobenzene	ND	(0.0053)	ND	(0.0059)	ND
chloroethane	ND	(0.0053)	ND	(0.0059)	ND

B: Detected in Reagent Blank; background subtraction not performed  
 BJ: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

1000

TABLE 4.2.6-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FOIA 2), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well			
	Sample ID			
	Date Sampled			
	12D	12E	12E	12E
	12D-4	12D-6	12E-2	12E-4
	19-Feb-88	19-Feb-88	23-Feb-88	23-Feb-88
	15 - 20	25 - 30	4 - 6	14 - 19
chloroform	ND (0.0017)	ND (0.0019)	ND (0.0019)	ND (0.0016)
chloromethane	ND (0.0053)	ND (0.0059)	ND (0.0058)	ND (0.0052)
cis-1,3-Dichloropropene	ND (0.0053)	ND (0.0059)	ND (0.0058)	ND (0.0052)
dibromochloromethane	ND (0.0033)	ND (0.0037)	ND (0.0036)	ND (0.0032)
methylene chloride	ND (0.0030)	ND (0.0033)	ND (0.0032)	ND (0.0029)
styrene	ND (0.0032)	ND (0.0035)	ND (0.0035)	ND (0.0031)
tetrachloroethene	ND (0.0043)	ND (0.0048)	ND (0.0048)	ND (0.0042)
total xylenes	ND (0.0049)	ND (0.0054)	ND (0.0053)	ND (0.0047)
trans-1,2-Dichloroethene	ND (0.0017)	ND (0.0019)	ND (0.0019)	ND (0.0016)
trans-1,3-Dichloropropene	ND (0.0053)	ND (0.0059)	ND (0.0058)	ND (0.0052)
trichlorofluoromethane	ND (0.0053)	ND (0.0059)	ND (0.0058)	ND (0.0052)
vinyl acetate	ND (0.0073)	ND (0.0081)	ND (0.0080)	ND (0.0071)
vinyl chloride	ND (0.0053)	ND (0.0059)	ND (0.0058)	ND (0.0052)
Semivolatile Organic Compounds MG/KG				
1,2,4-trichlorobenzene	ND (0.13)	ND (0.15)	ND (0.17)	ND (0.15)
1,2-dichlorobenzene	ND (0.13)	ND (0.15)	ND (0.17)	ND (0.15)
1,3-dichlorobenzene	ND (0.13)	ND (0.15)	ND (0.17)	ND (0.15)
1,4-dichlorobenzene	ND (0.30)	ND (0.34)	ND (0.40)	ND (0.35)
2,4,5-trichlorophenol	ND (0.68)	ND (0.77)	ND (0.91)	ND (0.79)
2,4,6-trichlorophenol	ND (0.18)	ND (0.21)	ND (0.25)	ND (0.21)
2,4-dichlorophenol	ND (0.18)	ND (0.21)	ND (0.25)	ND (0.21)
2,4-dimethylphenol	ND (0.18)	ND (0.21)	ND (0.25)	ND (0.21)
2,4-dinitrophenol	ND (2.9)	ND (3.2)	ND (3.8)	ND (3.3)
2,4-dinitrotoluene	ND (0.39)	ND (0.44)	ND (0.52)	ND (0.45)

B: Detected in Reagent Blank; background subtraction not performed  
 BJ: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

420114



TABLE 4.2.6-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FDA 2), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well					
	Sample ID					
	Date Sampled					
	12D		12E		12E-4	
	12D-4	12D-6	12E-2	12E-2	12E-4	12E-4
	19-Feb-88	19-Feb-88	23-Feb-88	23-Feb-88	23-Feb-88	23-Feb-88
	15 - 20	25 - 30	4 - 6	4 - 6	14 - 19	14 - 19
	Beg. Depth	End Depth	Beg. Depth	End Depth	Beg. Depth	End Depth
benzo(k)fluoranthene	ND (0.17)	ND (0.19)	ND (0.23)	ND (0.23)	ND (0.20)	ND (0.20)
benzoic acid	ND (3.4)	ND (3.9)	ND (4.6)	ND (4.6)	ND (4.0)	ND (4.0)
benzyl alcohol	ND (3.4)	ND (3.9)	ND (4.6)	ND (4.6)	ND (4.0)	ND (4.0)
bis(2-chloroethoxy)methane	ND (0.36)	ND (0.41)	ND (0.48)	ND (0.48)	ND (0.42)	ND (0.42)
bis(2-chloroethyl) ether	ND (0.39)	ND (0.44)	ND (0.52)	ND (0.52)	ND (0.45)	ND (0.45)
bis(2-chloroisopropyl)ether	ND (0.39)	ND (0.44)	ND (0.52)	ND (0.52)	ND (0.45)	ND (0.45)
bis(2-ethylhexyl)phthalate	ND (0.17)	0.15BJ (0.19)	0.11J (0.23)	0.11J (0.23)	0.16J (0.29)	0.16J (0.29)
butylbenzylphthalate	ND (0.17)	ND (0.19)	ND (0.23)	ND (0.23)	ND (0.20)	ND (0.20)
chrysene	ND (0.17)	ND (0.19)	ND (0.23)	ND (0.23)	ND (0.20)	ND (0.20)
di-n-butylphthalate	0.21 (0.17)	0.096J (0.19)	0.15BJ (0.23)	0.15BJ (0.23)	0.25B (0.29)	0.25B (0.29)
di-n-octyl phthalate	ND (0.17)	ND (0.19)	ND (0.23)	ND (0.23)	ND (0.20)	ND (0.20)
dibenzo(a,h)anthracene	ND (0.17)	ND (0.19)	ND (0.23)	ND (0.23)	ND (0.20)	ND (0.20)
dibenzofuran	ND (0.68)	ND (0.77)	ND (0.91)	ND (0.91)	ND (0.79)	ND (0.79)
diethylphthalate	ND (0.13)	ND (0.15)	ND (0.17)	ND (0.17)	ND (0.15)	ND (0.15)
dimethyl phthalate	ND (0.11)	ND (0.12)	ND (0.15)	ND (0.15)	ND (0.13)	ND (0.13)
fluoranthene	ND (0.15)	ND (0.17)	ND (0.20)	ND (0.20)	ND (0.17)	ND (0.17)
fluorene	ND (0.13)	ND (0.15)	ND (0.17)	ND (0.17)	ND (0.15)	ND (0.15)
hexachlorobenzene	ND (0.13)	ND (0.15)	ND (0.17)	ND (0.17)	ND (0.15)	ND (0.15)
hexachlorobutadiene	ND (0.062)	ND (0.069)	ND (0.082)	ND (0.082)	ND (0.071)	ND (0.071)
hexachlorocyclopentadiene	ND (0.41)	ND (0.46)	ND (0.55)	ND (0.55)	ND (0.48)	ND (0.48)
hexachloroethane	ND (0.11)	ND (0.12)	ND (0.15)	ND (0.15)	ND (0.13)	ND (0.13)
indeno(1,2,3-cd)pyrene	ND (0.25)	ND (0.29)	ND (0.34)	ND (0.34)	ND (0.29)	ND (0.29)
isophorone	ND (0.15)	ND (0.17)	ND (0.20)	ND (0.20)	ND (0.17)	ND (0.17)
n-nitroso-di-n-propylamine	ND (0.82)	ND (0.93)	ND (1.1)	ND (1.1)	ND (0.95)	ND (0.95)
n-nitrosodimethylamine	ND (0.68)	ND (0.77)	ND (0.91)	ND (0.91)	ND (0.79)	ND (0.79)

B: Detected in Reagent Blank; background subtraction not performed  
 BJ: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

0.001 - 0.01

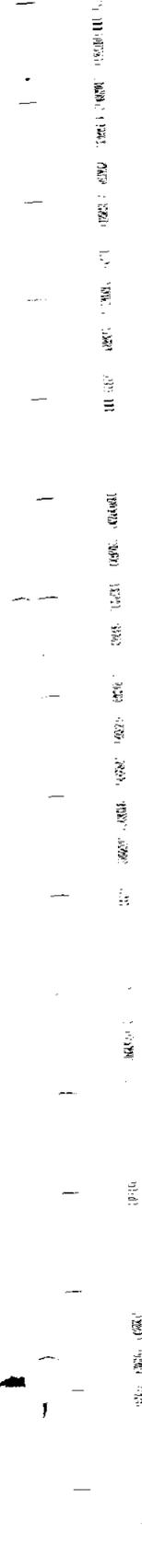






TABLE 4.2.6-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FDTA 2), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well		Date Sampled	Beg. Depth - End Depth	Sample ID
	12E	12G			
chloroform	ND	ND	12G-4	12H-1	ND (0.40)
chloromethane	ND	ND	20-Feb-88	23-Feb-88	ND (1.3)
cis-1,3-Dichloropropene	ND	ND	14 - 17	0 - 4	ND (1.3)
dibromochloromethane	ND	ND			ND (0.78)
methylene chloride	ND	ND			ND (0.70)
styrene	ND	ND			ND (0.75)
tetrachloroethene	ND	ND			ND (1.0)
total xylenes	ND	ND			ND (1.2)
trans-1,2-Dichloroethene	ND	ND			ND (0.40)
trans-1,3-Dichloropropene	ND	ND			ND (1.3)
trichlorofluoromethane	ND	ND			ND (1.3)
vinyl acetate	ND	ND			ND (1.7)
vinyl chloride	ND	ND			ND (1.3)
Semivolatile Organic Compounds MG/KG					
1,2,4-trichlorobenzene	ND	ND			ND (0.22)
1,2-dichlorobenzene	ND	ND			ND (0.22)
1,3-dichlorobenzene	ND	ND			ND (0.22)
1,4-dichlorobenzene	ND	ND			ND (0.51)
2,4,5-trichlorophenol	ND	ND			ND (1.2)
2,4,6-trichlorophenol	ND	ND			ND (0.32)
2,4-dichlorophenol	ND	ND			ND (0.32)
2,4-dimethylphenol	ND	ND			ND (0.32)
2,4-dinitrophenol	ND	ND			ND (4.9)
2,4-dinitrotoluene	ND	ND			ND (0.67)

B: Detected in Reagent Blank; background subtraction not performed  
 BJ: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

[Signature]



TABLE 4.2.6-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FDA 2), CARSWELL AFB, TEXAS.

PARAMETER	12E		12G		12H-1	
	23-Feb-88		20-Feb-88		23-Feb-88	
	24 - 29	14 - 17	0 - 4	0 - 4	0 - 4	0 - 4
benzo(k)fluoranthene	ND (0.22)	ND (0.23)	ND (0.29)	ND (0.29)	ND (0.29)	ND (0.29)
benzoic acid	ND (4.5)	ND (4.6)	ND (5.8)	ND (5.8)	ND (5.8)	ND (5.8)
benzyl alcohol	ND (4.5)	ND (4.6)	ND (5.8)	ND (5.8)	ND (5.8)	ND (5.8)
bis(2-chloroethoxy)methane	ND (0.47)	ND (0.49)	ND (0.62)	ND (0.62)	ND (0.62)	ND (0.62)
bis(2-chloroethyl) ether	ND (0.51)	ND (0.53)	ND (0.67)	ND (0.67)	ND (0.67)	ND (0.67)
bis(2-chloroisopropyl)ether	ND (0.51)	ND (0.53)	ND (0.67)	ND (0.67)	ND (0.67)	ND (0.67)
bis(2-ethylhexyl)phthalate	0.094J (0.22)	0.19J (0.23)	0.53 (0.29)	0.53 (0.29)	0.53 (0.29)	0.53 (0.29)
butylbenzylphthalate	ND (0.22)	ND (0.23)	ND (0.29)	ND (0.29)	ND (0.29)	ND (0.29)
chrysene	ND (0.22)	ND (0.23)	ND (0.29)	ND (0.29)	ND (0.29)	ND (0.29)
di-n-butylphthalate	ND (0.22)	ND (0.23)	ND (0.29)	ND (0.29)	ND (0.29)	ND (0.29)
di-n-octyl phthalate	0.24B (0.22)	0.31B (0.23)	0.62B (0.29)	0.62B (0.29)	0.62B (0.29)	0.62B (0.29)
dibenzo(a,h)anthracene	0.092J (0.22)	0.18J (0.23)	0.15J (0.29)	0.15J (0.29)	0.15J (0.29)	0.15J (0.29)
dibenzofuran	ND (0.22)	ND (0.23)	ND (0.29)	ND (0.29)	ND (0.29)	ND (0.29)
diethylphthalate	ND (0.89)	ND (0.92)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)
dimethyl phthalate	ND (0.17)	ND (0.18)	ND (0.22)	ND (0.22)	ND (0.22)	ND (0.22)
fluoranthene	ND (0.14)	ND (0.15)	ND (0.19)	ND (0.19)	ND (0.19)	ND (0.19)
fluorene	ND (0.20)	ND (0.20)	ND (0.26)	ND (0.26)	ND (0.26)	ND (0.26)
hexachlorobenzene	ND (0.17)	ND (0.18)	ND (0.22)	ND (0.22)	ND (0.22)	ND (0.22)
hexachlorobutadiene	ND (0.17)	ND (0.18)	ND (0.22)	ND (0.22)	ND (0.22)	ND (0.22)
hexachlorocyclopentadiene	ND (0.080)	ND (0.083)	ND (0.11)	ND (0.11)	ND (0.11)	ND (0.11)
hexachloroethane	ND (0.54)	ND (0.55)	ND (0.70)	ND (0.70)	ND (0.70)	ND (0.70)
indeno(1,2,3-cd)pyrene	ND (0.14)	ND (0.15)	ND (0.19)	ND (0.19)	ND (0.19)	ND (0.19)
isophorone	ND (0.33)	ND (0.34)	ND (0.43)	ND (0.43)	ND (0.43)	ND (0.43)
n-nitroso-di-n-propylamine	ND (0.20)	ND (0.20)	ND (0.26)	ND (0.26)	ND (0.26)	ND (0.26)
n-nitrosodimethylamine	ND (1.1)	ND (1.1)	ND (1.4)	ND (1.4)	ND (1.4)	ND (1.4)
	ND (0.89)	ND (0.92)	ND (1.2)	ND (1.2)	ND (1.2)	ND (1.2)

B: Detected in Reagent Blank; background subtraction not performed

BJ: Analyte detected in blank. Estimated value below detection limit.

J: Estimated value (GC test codes)

ND: Not detected at specified detection limit

( ): Detection limit

4-291

TABLE 4.2.6-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FOYA 2), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	Monitor Well	
	Sample ID	Date Sampled
n-nitrosodiphenylamine	12E	12H
naphthalene	12E-6	12H-1
nitrobenzene	23-Feb-88	23-Feb-88
pentachlorophenol	24 - 29	0 - 4
phenanthrene	ND (0.17)	ND (0.18)
phenol	ND (0.14)	ND (0.15)
pyrene	ND (0.17)	3.9 (0.19)
	ND (0.32)	ND (0.22)
	ND (0.68)	ND (0.42)
	ND (0.13)	ND (0.63)
	ND (0.17)	0.50 (0.18)
		ND (0.18)
		ND (0.22)

B: Detected in Reagent Blank; background subtraction not performed  
 BJ: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit



TABLE 4.2.6-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FDA 2), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	Monitor Well					
	Sample ID					
	Date Sampled					
	12H		12H-2		12H-4	
	23-Feb-88		23-Feb-88		23-Feb-88	
	4-9	4-9	4-9	9-14	14-19	14-19
	12H	12H-2	12H	12H-3	12H	12H-4
	23-Feb-88	23-Feb-88	23-Feb-88	23-Feb-88	23-Feb-88	23-Feb-88
	4-9	4-9	4-9	9-14	14-19	14-19
	12H	12H-2	12H	12H-3	12H	12H-4
	23-Feb-88	23-Feb-88	23-Feb-88	23-Feb-88	23-Feb-88	23-Feb-88
	4-9	4-9	4-9	9-14	14-19	14-19
chloroform	ND (0.40)	ND (0.23)	ND (0.24)	ND (0.24)	ND (0.24)	ND (0.24)
chloromethane	ND (1.3)	ND (0.73)	ND (0.74)	ND (0.74)	ND (0.74)	ND (0.74)
cis-1,3-Dichloropropene	ND (1.3)	ND (0.73)	ND (0.74)	ND (0.74)	ND (0.74)	ND (0.74)
dibromochloromethane	ND (0.78)	ND (0.45)	ND (0.46)	ND (0.46)	ND (0.46)	ND (0.46)
methylene chloride	ND (0.70)	ND (0.41)	ND (0.41)	ND (0.41)	ND (0.41)	ND (0.41)
styrene	ND (0.75)	ND (0.44)	ND (0.44)	ND (0.44)	ND (0.44)	ND (0.44)
tetrachloroethene	ND (1.0)	ND (0.59)	ND (0.60)	ND (0.60)	ND (0.60)	ND (0.60)
total xylenes	31.0 (1.2)	23.0 (0.67)	6.4 (0.68)	6.4 (0.68)	4.0 (0.68)	4.0 (0.68)
trans-1,2-Dichloroethene	ND (0.40)	ND (0.23)	ND (0.24)	ND (0.24)	ND (0.24)	ND (0.24)
trans-1,3-Dichloropropene	ND (1.3)	ND (0.73)	ND (0.74)	ND (0.74)	ND (0.74)	ND (0.74)
trichlorofluoromethane	ND (1.3)	ND (0.73)	ND (0.74)	ND (0.74)	ND (0.74)	ND (0.74)
vinyl acetate	ND (1.7)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)	ND (1.0)
vinyl chloride	ND (1.3)	ND (0.73)	ND (0.74)	ND (0.74)	ND (0.74)	ND (0.74)
Semivolatile Organic Compounds MC/KG						
1,2,4-trichlorobenzene	ND (0.17)	ND (0.17)	ND (0.17)	ND (0.17)	ND (0.17)	ND (0.17)
1,2-dichlorobenzene	ND (0.17)	ND (0.17)	ND (0.17)	ND (0.17)	ND (0.17)	ND (0.17)
1,3-dichlorobenzene	ND (0.17)	ND (0.17)	ND (0.17)	ND (0.17)	ND (0.17)	ND (0.17)
1,4-dichlorobenzene	ND (0.40)	ND (0.40)	ND (0.39)	ND (0.39)	ND (0.40)	ND (0.40)
2,4,5-trichlorophenol	ND (0.92)	ND (0.91)	ND (0.89)	ND (0.89)	ND (0.92)	ND (0.92)
2,4,6-trichlorophenol	ND (0.25)	ND (0.25)	ND (0.24)	ND (0.24)	ND (0.25)	ND (0.25)
2,4-dichlorophenol	ND (0.25)	ND (0.25)	ND (0.24)	ND (0.24)	ND (0.25)	ND (0.25)
2,4-dimethylphenol	ND (0.25)	ND (0.25)	ND (0.24)	ND (0.24)	ND (0.25)	ND (0.25)
2,4-dinitrophenol	ND (3.8)	ND (3.8)	ND (3.7)	ND (3.7)	ND (3.9)	ND (3.9)
2,4-dinitrotoluene	ND (0.52)	ND (0.52)	ND (0.51)	ND (0.51)	ND (0.52)	ND (0.52)

B: Detected in Reagent Blank; background subtraction not performed  
 BJ: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ) : Detection limit



TABLE 4.2.6-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FDIA 2), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well			
	Sample ID			
	Date Sampled			
	Beg. Depth - End Depth			
	12H	12H	12H	12H
	12H-2	12H-2	12H-3	12H-4
	23-Feb-88	23-Feb-88	23-Feb-88	23-Feb-88
	4 - 9	4 - 9	9 - 14	14 - 19
benzo(k)fluoranthene	ND (0.23)	ND (0.23)	ND (0.22)	ND (0.23)
benzoic acid	ND (4.6)	ND (4.6)	ND (4.4)	ND (4.6)
benzyl alcohol	ND (4.6)	ND (4.6)	ND (4.4)	ND (4.6)
bis(2-chloroethoxy)methane	ND (0.48)	ND (0.48)	ND (0.47)	ND (0.49)
bis(2-chloroethyl) ether	ND (0.52)	ND (0.52)	ND (0.51)	ND (0.52)
bis(2-chloroisopropyl)ether	ND (0.52)	ND (0.52)	ND (0.51)	ND (0.52)
bis(2-ethylhexyl)phthalate	0.28 (0.23)	0.33 (0.23)	1.18 (0.22)	1.48 (0.23)
butylbenzylphthalate	ND (0.23)	ND (0.23)	ND (0.22)	ND (0.23)
chrysene	ND (0.23)	ND (0.23)	ND (0.22)	ND (0.23)
di-n-butylphthalate	0.288 (0.23)	0.618 (0.23)	ND (0.22)	ND (0.23)
di-n-octyl phthalate	0.10J (0.23)	0.22J (0.23)	0.148J (0.22)	ND (0.23)
dibenzo(a,h)anthracene	ND (0.23)	ND (0.23)	ND (0.22)	ND (0.23)
dibenzofuran	ND (0.92)	ND (0.91)	ND (0.89)	ND (0.92)
diethylphthalate	ND (0.17)	ND (0.17)	ND (0.17)	ND (0.17)
dimethyl phthalate	ND (0.15)	ND (0.15)	ND (0.14)	ND (0.15)
fluoranthene	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
fluorene	ND (0.17)	ND (0.17)	ND (0.17)	ND (0.17)
hexachlorobenzene	ND (0.17)	ND (0.17)	ND (0.17)	ND (0.17)
hexachlorobutadiene	ND (0.082)	ND (0.082)	ND (0.080)	ND (0.083)
hexachlorocyclopentadiene	ND (0.55)	ND (0.55)	ND (0.53)	ND (0.55)
hexachloroethane	ND (0.15)	ND (0.15)	ND (0.14)	ND (0.15)
Indeno(1,2,3-cd)pyrene	ND (0.34)	ND (0.34)	ND (0.33)	ND (0.34)
Isophorone	ND (0.20)	ND (0.20)	ND (0.20)	ND (0.20)
n-nitroso-di-n-propylamine	ND (1.1)	ND (1.1)	ND (1.1)	ND (1.1)
n-nitrosodimethylamine	ND (0.92)	ND (0.91)	ND (0.89)	ND (0.92)

B: Detected in Reagent Blank; background subtraction not performed

BJ: Analyte detected in blank. Estimated value below detection limit.

J: Estimated value (GC test codes)

ND: Not detected at specified detection limit

( ): Detection limit

TABLE 4.2.6-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FOYA 2), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	Monitor Well			
	Sample ID	Date Sampled	Beg. Depth - End Depth	Sample ID
n-nitrosodiphenylamine	12H	12H	12H	12H
naphthalene	12H-2	12H-2	12H-3	12H-4
nitrobenzene	23-Feb-88	23-Feb-88	23-Feb-88	23-Feb-88
pentachlorophenol	4 - 9	4 - 9	9 - 14	14 - 19
phenanthrene	ND (0.17)	ND (0.17)	ND (0.17)	ND (0.17)
phenol	2.1 (0.15)	2.7 (0.15)	0.31 (0.14)	0.37 (0.15)
pyrene	ND (0.17)	ND (0.17)	ND (0.17)	ND (0.17)
	ND (0.33)	ND (0.33)	ND (0.32)	ND (0.33)
	ND (0.49)	ND (0.49)	ND (0.48)	ND (0.50)
	0.33 (0.14)	0.36 (0.14)	ND (0.13)	ND (0.14)
	ND (0.17)	ND (0.17)	ND (0.17)	ND (0.17)

D R A F T -

B: Detected in Reagent Blank; background subtraction not performed  
 BJ: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

02/17/88

TABLE 4.2.6-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FDA 2), CARSWELL APB, TEXAS.

Primary Results		Monitor Well	
		Sample ID	
		Date Sampled	
		Reg. Depth - End Depth	
	12H	12I	12I
	12H-5	12I-2	12I-3
	23-Feb-88	23-Feb-88	24-Feb-88
	19 - 25	4 - 9	9 - 14
PARAMETER			
Petroleum Hydrocarbons	MG/KG		
Petroleum Hydrocarbons	5760.0	670.0	450.0
Volatile Organic Compounds	MG/KG		
1,1,1-trichloroethane	ND (2.4)	ND (0.55)	ND (0.55)
1,1,2,2-tetrachloroethane	1 JJ (4.3)	ND (1.0)	ND (0.99)
1,1,2-trichloroethane	ND (3.1)	ND (0.73)	ND (0.72)
1,2-dichloroethane	ND (1.8)	ND (0.41)	ND (0.40)
1,2-dichloropropane	ND (3.8)	ND (0.87)	ND (0.86)
2-butanone	ND (16.0)	5.0B (3.6)	6.0B (3.6)
2-chloroethylvinyl ether	ND (3.1)	ND (0.73)	ND (0.72)
2-hexanone	ND (23.0)	ND (5.2)	ND (5.2)
4-methyl-2-pentanone	ND (29.0)	ND (6.7)	ND (6.6)
Benzene	ND (2.8)	ND (0.64)	0.54J (0.63)
Ethylbenzene	5.0 (4.5)	1.3 (1.0)	5.6 (1.0)
Toluene	3.7J (3.8)	1.7 (0.87)	2.2 (0.86)
Trichloroethene	ND (1.2)	ND (0.28)	ND (0.27)
acetone	0.87BJ (4.7)	8.2B (1.1)	5.4B (1.1)
bromodichloromethane	ND (1.4)	ND (0.32)	ND (0.32)
bromoform	ND (2.9)	ND (0.68)	ND (0.68)
bromomethane	ND (3.1)	ND (0.73)	ND (0.72)
carbon disulfide	ND (1.1)	ND (0.25)	ND (0.24)
carbon tetrachloride	ND (1.8)	ND (0.41)	ND (0.40)
chlorobenzene	ND (3.8)	ND (0.87)	ND (0.86)

B: Detected in Reagent Blank; background subtraction not performed  
 BJ: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 \*: Indicates duplicate analysis is not within control limits.  
 ND: Not detected at specified detection limit  
 ( ): Detection Limit

D R A F T

APPROVED

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TABLE 4.2.6-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FDA 2), CARSWELL AFB, TEXAS.

PARAMETER	12H		12I	
	12H-5	12H-2	12I-2	12I-3
	23-Feb-88	23-Feb-88	23-Feb-88	24-Feb-88
	19 - 25	4 - 9	9 - 14	
chloroethane	ND (3.1)	ND (0.73)	ND (0.72)	ND (0.72)
chloroform	ND (1.0)	ND (0.23)	ND (0.23)	ND (0.23)
chloromethane	ND (3.1)	ND (0.73)	ND (0.72)	ND (0.72)
cis-1,3-Dichloropropene	ND (3.1)	ND (0.73)	ND (0.72)	ND (0.72)
dibromochloromethane	ND (1.9)	ND (0.45)	ND (0.45)	ND (0.45)
methylene chloride	ND (1.8)	ND (0.41)	ND (0.40)	ND (0.40)
styrene	ND (1.9)	ND (0.44)	ND (0.43)	ND (0.43)
tetrachloroethene	ND (2.6)	ND (0.59)	ND (0.59)	ND (0.59)
total xylenes	32.0 (2.9)	8.6 (0.67)	35.0 (0.66)	35.0 (0.66)
trans-1,2-Dichloroethene	ND (1.0)	ND (0.23)	ND (0.23)	ND (0.23)
trans-1,3-Dichloropropene	ND (3.1)	ND (0.73)	ND (0.72)	ND (0.72)
trichlorofluoromethane	ND (3.1)	ND (0.73)	ND (0.72)	ND (0.72)
vinyl acetate	ND (4.3)	ND (1.0)	ND (0.99)	ND (0.99)
vinyl chloride	ND (3.1)	ND (0.73)	ND (0.72)	ND (0.72)
Semivolatile Organic Compounds MG/KG				
1,2,4-trichlorobenzene	ND (1.4)	ND (0.15)	ND (0.15)	ND (0.15)
1,2-dichlorobenzene	ND (1.4)	ND (0.15)	ND (0.15)	ND (0.15)
1,3-dichlorobenzene	ND (1.4)	ND (0.15)	ND (0.15)	ND (0.15)
1,4-dichlorobenzene	ND (3.3)	ND (0.35)	ND (0.35)	ND (0.35)
2,4,5-trichlorophenol	ND (7.6)	ND (0.80)	ND (0.79)	ND (0.79)
2,4,6-trichlorophenol	ND (2.0)	ND (0.22)	ND (0.21)	ND (0.21)
2,4-dichlorophenol	ND (2.0)	ND (0.22)	ND (0.21)	ND (0.21)
2,4-dimethylphenol	ND (2.0)	ND (0.22)	ND (0.21)	ND (0.21)

B: Detected in Reagent Blank; background subtraction not performed  
 BJ: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 \*: Indicates duplicate analysis is not within control limits.  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

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TABLE 4.2.6-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FDA 2), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well	
	Sample ID	Date Sampled
	Beg. Depth - End Depth	
	12H	12I
	12H-5	12I-3
	23-Feb-88	24-Feb-88
	19 - 25	9 - 14
	4 - 9	
benzo(a)anthracene	ND (5.9)	ND (0.62)
benzo(a)pyrene	ND (1.9)	ND (0.20)
benzo(b)fluoranthene	ND (3.6)	ND (0.38)
benzo(k)fluoranthene	ND (1.9)	ND (0.20)
benzoic acid	ND (38.0)	ND (3.9)
benzyl alcohol	ND (38.0)	ND (3.9)
bis(2-chloroethoxy)methane	ND (4.0)	ND (0.42)
bis(2-chloroethyl) ether	ND (4.3)	ND (0.45)
bis(2-chloroisopropyl) ether	ND (4.3)	ND (0.45)
bis(2-ethylhexyl)phthalate	12.08 (1.9)	0.588 (0.20)
butylbenzylphthalate	ND (1.9)	ND (0.20)
chrysene	ND (1.9)	ND (0.20)
di-n-butylphthalate	ND (1.9)	ND (0.20)
di-n-octyl phthalate	ND (1.9)	ND (0.20)
dibenzo(a,h)anthracene	ND (1.9)	0.47 (0.20)
dibenzofuran	ND (7.6)	ND (0.20)
diallylphthalate	ND (1.4)	ND (0.80)
dimethyl phthalate	ND (1.2)	ND (0.15)
fluoranthene	ND (1.7)	ND (0.13)
fluorene	ND (1.4)	ND (0.17)
hexachlorobenzene	ND (1.4)	ND (0.15)
hexachlorobutadiene	ND (0.68)	ND (0.15)
hexachlorocyclopentadiene	ND (4.5)	ND (0.072)
hexachloroethane	ND (1.2)	ND (0.48)
		ND (0.13)

B: Detected in Reagent Blank; background subtraction not performed

BJ: Analyte detected in blank. Estimated value below detection limit.

J: Estimated value (GC test codes)

?: Indicates duplicate analysis is not within control limits.

ND: Not detected at specified detection limit

( ): Detection limit

ENVIRONMENTAL





TABLE 4.2.6-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FDA 2), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well		Beg. Depth - End Depth	Date Sampled	Sample ID
	Sample ID				
	12I	12J			
chloromethane	ND (0.0051)	ND (0.0059)	ND (0.0058)	12J	12J
cis-1,3-Dichloropropene	ND (0.0051)	ND (0.0059)	ND (0.0058)	12J-2	12J-2
dibromochloromethane	ND (0.0032)	ND (0.0037)	ND (0.0036)	24-Feb-88	24-Feb-88
methylene chloride	0.0050 (0.0029)	0.12 (0.0033)	0.018 (0.0032)	4 - 9	4 - 9
styrene	ND (0.0031)	ND (0.0035)	ND (0.0035)		
tetrachloroethene	ND (0.0042)	ND (0.0048)	ND (0.0048)		
total xylenes	0.0063 (0.0047)	ND (0.0054)	ND (0.0053)		
trans-1,2-Dichloroethene	ND (0.0016)	ND (0.0019)	ND (0.0019)		
trans-1,3-Dichloropropene	ND (0.0051)	ND (0.0059)	ND (0.0058)		
trichlorofluoromethane	ND (0.0051)	ND (0.0059)	ND (0.0058)		
vinyl acetate	ND (0.0070)	ND (0.0081)	ND (0.0080)		
vinyl chloride	ND (0.0051)	ND (0.0059)	ND (0.0058)		
Semivolatile Organic Compounds MG/KG					
1,2,4-trichlorobenzene	ND (0.13)	ND (0.15)	ND (0.15)		
1,2-dichlorobenzene	ND (0.13)	ND (0.15)	ND (0.15)		
1,3-dichlorobenzene	ND (0.13)	ND (0.15)	ND (0.15)		
1,4-dichlorobenzene	ND (0.30)	ND (0.35)	ND (0.34)		
2,4,5-trichlorophenol	ND (0.69)	ND (0.79)	ND (0.77)		
2,4,6-trichlorophenol	ND (0.19)	ND (0.21)	ND (0.21)		
2,4-dichlorophenol	ND (0.19)	ND (0.21)	ND (0.21)		
2,4-dimethylphenol	ND (0.19)	ND (0.21)	ND (0.21)		
2,4-dinitrophenol	ND (2.9)	ND (3.3)	ND (3.2)		
2,4-dinitrotoluene	ND (0.39)	ND (0.45)	ND (0.44)		
2,6-dinitrotoluene	ND (0.13)	ND (0.15)	ND (0.15)		
2-chloronaphthalene	ND (0.13)	ND (0.15)	ND (0.15)		

B: Detected in Reagent Blank; background subtraction not performed

J: Estimated value (GC test codes)

ND: Not detected at specified detection limit

( ) : Detection limit

TABLE 4.2.6-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FDTA 2), CARSWELL AFB, TEXAS.

PARAMETER	12I		12J	
	12I-5	12J-2	12I-5	12J-2
	24-Feb-88	24-Feb-88	24-Feb-88	24-Feb-88
	19 - 24	4 - 9	4 - 9	4 - 9
2-chlorophenol	ND (0.23)	ND (0.26)	ND (0.25)	ND (0.25)
2-methylnaphthalene	0.84 (0.69)	ND (0.79)	ND (0.77)	ND (0.77)
2-methylphenol	ND (0.69)	ND (0.79)	ND (0.77)	ND (0.77)
2-nitroaniline	ND (3.4)	ND (3.9)	ND (3.9)	ND (3.9)
2-nitrophenol	ND (0.25)	ND (0.28)	ND (0.28)	ND (0.28)
3,3'-dichlorobenzidine	ND (1.1)	ND (1.3)	ND (1.3)	ND (1.3)
3-nitroaniline	ND (3.4)	ND (3.9)	ND (3.9)	ND (3.9)
4,6-dinitro-2-methylphenol	ND (1.6)	ND (1.9)	ND (1.8)	ND (1.8)
4-bromophenyl-phenylether	ND (0.13)	ND (0.15)	ND (0.15)	ND (0.15)
4-chloro-3-methylphenol	ND (0.21)	ND (0.24)	ND (0.23)	ND (0.23)
4-chloroaniline	ND (0.69)	ND (0.79)	ND (0.77)	ND (0.77)
4-chlorophenyl-phenylether	ND (0.29)	ND (0.33)	ND (0.32)	ND (0.32)
4-methylphenol	0.16J (0.69)	ND (0.79)	ND (0.77)	ND (0.77)
4-nitroaniline	ND (3.4)	ND (3.9)	ND (3.9)	ND (3.9)
4-nitrophenol	ND (0.16)	ND (0.19)	ND (0.18)	ND (0.18)
acenaphthene	ND (0.13)	ND (0.15)	ND (0.15)	ND (0.15)
acenaphthylene	ND (0.24)	ND (0.27)	ND (0.27)	ND (0.27)
aniline	ND (0.69)	ND (0.79)	ND (0.77)	ND (0.77)
anthracene	ND (0.13)	ND (0.15)	ND (0.15)	ND (0.15)
benzidine	ND (3.0)	ND (3.5)	ND (3.4)	ND (3.4)
benzo(a)anthracene	ND (0.54)	ND (0.61)	ND (0.60)	ND (0.60)
benzo(a)pyrene	ND (0.17)	ND (0.20)	ND (0.19)	ND (0.19)
benzo(b)fluoranthene	ND (0.33)	ND (0.38)	ND (0.37)	ND (0.37)
benzo(k)fluoranthene	ND (0.17)	ND (0.20)	ND (0.19)	ND (0.19)
benzoic acid	ND (3.4)	ND (3.9)	ND (3.9)	ND (3.9)
benzyl alcohol	ND (3.4)	ND (3.9)	ND (3.9)	ND (3.9)

B: Detected in Reagent Blank; background subtraction not performed  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

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TABLE 4.2.6-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FDA 2), CARSMELL AFB, TEXAS.

Primary Results	Monitor Well	
	Sample ID	Date Sampled
	12J	12J
	12J-2	12J-2
	24-Feb-88	24-Feb-88
	19 - 24	4 - 9
PARAMETER	12J	12J-2
	19 - 24	4 - 9
bis(2-chloroethoxy)methane	ND (0.36)	ND (0.42)
bis(2-chloroethyl) ether	ND (0.39)	ND (0.45)
bis(2-chloroisopropyl) ether	ND (0.39)	ND (0.45)
bis(2-ethylhexyl)phthalate	0.868 (0.17)	ND (0.20)
butylbenzylphthalate	ND (0.17)	ND (0.20)
chrysene	ND (0.17)	ND (0.20)
di-n-butylphthalate	ND (0.17)	ND (0.20)
di-n-octyl phthalate	ND (0.17)	ND (0.20)
dibenzo(a,h)anthracene	0.095J (0.17)	ND (0.20)
dibenzofuran	ND (0.17)	ND (0.20)
diethylphthalate	ND (0.69)	ND (0.79)
dimethyl phthalate	ND (0.13)	ND (0.15)
fluoranthene	ND (0.11)	ND (0.13)
fluorene	ND (0.15)	ND (0.17)
hexachlorobenzene	ND (0.13)	ND (0.15)
hexachlorobutadiene	ND (0.062)	ND (0.071)
hexachlorocyclopentadiene	ND (0.41)	ND (0.47)
hexachloroethane	ND (0.11)	ND (0.13)
indeno(1,2,3-cd)pyrene	ND (0.25)	ND (0.29)
isophorone	ND (0.15)	ND (0.17)
n-nitroso-di-n-propylamine	ND (0.82)	ND (0.94)
n-nitrosodimethylamine	ND (0.69)	ND (0.79)
n-nitrosodiphenylamine	ND (0.13)	ND (0.15)
naphthalene	0.28 (0.11)	ND (0.13)
nitrobenzene	ND (0.13)	ND (0.15)
pentachlorophenol	ND (0.25)	ND (0.28)

B: Detected in Reagent Blank; background subtraction not performed

J: Estimated value (GC test codes)

ND: Not detected at specified detection limit

( ) : Detection limit

TABLE 4.2.6-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FOXA 2), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well		
	Sample ID	Date Sampled	Depth
	Sample ID	Date Sampled	Depth
phenanthrene	12I	12J	12J
	12I-5	12J-2	12J-2
	24-Feb-88	24-Feb-88	24-Feb-88
phenol	19 - 24	4 - 9	4 - 9
	ND (0.37)	ND (0.42)	ND (0.42)
	ND (0.10)	ND (0.12)	ND (0.12)
pyrene	ND (0.13)	ND (0.15)	ND (0.15)

B: Detected in Reagent Blank; background subtraction not performed  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

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TABLE 4.2.6-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FDYA 2), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well			
	Sample ID			
	Date Sampled			
	12J	12K	12K-5	20-Feb-88
	9 - 14	19 - 23	20 - 25	
chloroethane	ND (0.0059)	ND (0.0051)	ND (0.0053)	ND (0.0053)
cis-1,3-Dichloropropene	ND (0.0059)	ND (0.0051)	ND (0.0053)	ND (0.0053)
dibromochloromethane	ND (0.0037)	ND (0.0032)	ND (0.0033)	ND (0.0033)
methylene chloride	0.0039	0.0062	ND (0.0029)	ND (0.0029)
styrene	ND (0.0035)	ND (0.0031)	ND (0.0032)	ND (0.0032)
tetrachloroethene	ND (0.0048)	ND (0.0042)	ND (0.0043)	ND (0.0043)
total xylenes	ND (0.0054)	ND (0.0047)	ND (0.0048)	ND (0.0048)
trans-1,2-Dichloroethene	ND (0.0019)	ND (0.0016)	ND (0.0017)	ND (0.0017)
trans-1,3-Dichloropropene	ND (0.0059)	ND (0.0051)	ND (0.0053)	ND (0.0053)
trichlorofluoromethane	ND (0.0059)	ND (0.0051)	ND (0.0053)	ND (0.0053)
vinyl acetate	ND (0.0081)	ND (0.0070)	ND (0.0072)	ND (0.0072)
vinyl chloride	ND (0.0059)	ND (0.0051)	ND (0.0053)	ND (0.0053)
Semivolatile Organic Compounds MG/KG				
1,2,4-trichlorobenzene	ND (0.15)	ND (0.13)	ND (0.15)	ND (0.15)
1,2-dichlorobenzene	ND (0.15)	ND (0.13)	ND (0.15)	ND (0.15)
1,3-dichlorobenzene	ND (0.15)	ND (0.13)	ND (0.15)	ND (0.15)
1,4-dichlorobenzene	ND (0.35)	ND (0.30)	ND (0.35)	ND (0.35)
2,4,5-trichlorophenol	ND (0.80)	ND (0.69)	ND (0.79)	ND (0.79)
2,4,6-trichlorophenol	ND (0.22)	ND (0.19)	ND (0.21)	ND (0.21)
2,4-dichlorophenol	ND (0.22)	ND (0.19)	ND (0.21)	ND (0.21)
2,4-dimethylphenol	ND (0.22)	ND (0.19)	ND (0.21)	ND (0.21)
2,4-dinitrophenol	ND (3.4)	ND (2.9)	ND (3.3)	ND (3.3)
2,4-dinitrotoluene	ND (0.46)	ND (0.39)	ND (0.45)	ND (0.45)
2,6-dinitrotoluene	ND (0.15)	ND (0.13)	ND (0.15)	ND (0.15)
2-chloronaphthalene	ND (0.15)	ND (0.13)	ND (0.15)	ND (0.15)

B: Detected in Reagent Blank; background subtraction not performed  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

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TABLE 4.2.6-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FOUA 2), CARSWELL AFB, TEXAS.

PARAMETER	12J		12K	
	12J-3		12K-5	
	24-Feb-88	19 - 23	20-Feb-88	20 - 25
2-chlorophenol	ND (0.26)	ND (0.23)	ND (0.26)	ND (0.26)
2-methylnaphthalene	ND (0.80)	ND (0.69)	ND (0.69)	ND (0.79)
2-methylphenol	ND (0.80)	ND (0.69)	ND (0.69)	ND (0.79)
2-nitroaniline	ND (4.0)	ND (3.5)	ND (3.5)	ND (3.9)
2-nitrophenol	ND (8.29)	ND (0.25)	ND (0.25)	ND (0.28)
3,3'-dichlorobenzidine	ND (1.3)	ND (1.1)	ND (1.1)	ND (1.3)
3-nitroaniline	ND (4.0)	ND (3.5)	ND (3.5)	ND (3.9)
4,6-dinitro-2-methylphenol	ND (1.9)	ND (1.7)	ND (1.7)	ND (1.9)
4-bromophenyl-phenylether	ND (0.15)	ND (0.13)	ND (0.13)	ND (0.15)
4-chloro-3-methylphenol	ND (0.24)	ND (0.21)	ND (0.21)	ND (0.24)
4-chloroaniline	ND (0.80)	ND (0.69)	ND (0.69)	ND (0.79)
4-chlorophenyl-phenylether	ND (0.34)	ND (0.29)	ND (0.29)	ND (0.33)
4-methylphenol	ND (0.80)	ND (0.69)	ND (0.69)	ND (0.79)
4-nitroaniline	ND (4.0)	ND (3.5)	ND (3.5)	ND (3.9)
4-nitrophenol	ND (0.19)	ND (0.17)	ND (0.17)	ND (0.19)
acenaphthene	ND (0.15)	ND (0.13)	ND (0.13)	ND (0.15)
acenaphthylene	ND (0.28)	ND (0.24)	ND (0.24)	ND (0.28)
aniline	ND (0.80)	ND (0.69)	ND (0.69)	ND (0.79)
anthracene	ND (0.15)	ND (0.13)	ND (0.13)	ND (0.15)
benzidine	ND (3.5)	ND (3.0)	ND (3.0)	ND (3.5)
benzo(a)anthracene	ND (0.62)	ND (0.54)	ND (0.54)	ND (0.61)
benzo(a)pyrene	ND (0.20)	ND (0.17)	ND (0.17)	ND (0.20)
benzo(b)fluoranthene	ND (0.38)	ND (0.33)	ND (0.33)	ND (0.38)
benzo(k)fluoranthene	ND (0.20)	ND (0.17)	ND (0.17)	ND (0.20)
benzoic acid	ND (4.0)	ND (3.5)	ND (3.5)	ND (3.9)
benzyl alcohol	ND (4.0)	ND (3.5)	ND (3.5)	ND (3.9)

B: Detected in Reagent Blank; background subtraction not performed  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

TABLE 4.2-6-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FDTA 2), CARSWELL AFB, TEXAS.

PARAMETER	12J		12K	
	12J-3		12K-5	
	24-Feb-88	9 - 14	24-Feb-88	20-Feb-88
			12J	12K
			12J-5	12K-5
			24-Feb-88	20-Feb-88
			19 - 23	20 - 25
bis(2-chloroethoxy)methane	ND (0.42)	ND (0.37)	ND (0.42)	ND (0.42)
bis(2-chloroethyl) ether	ND (0.46)	ND (0.39)	ND (0.46)	ND (0.45)
bis(2-chloroisopropyl)ether	ND (0.46)	ND (0.39)	ND (0.46)	ND (0.45)
bis(2-ethylhexyl)phthalate	ND (0.20)	0.32B (0.17)	0.12J (0.20)	ND (0.20)
butylbenzylphthalate	ND (0.20)	ND (0.17)	ND (0.20)	ND (0.20)
chrysene	ND (0.20)	ND (0.17)	ND (0.20)	ND (0.20)
di-n-butylphthalate	ND (0.20)	ND (0.17)	ND (0.20)	ND (0.20)
di-n-octyl phthalate	ND (0.20)	ND (0.17)	ND (0.20)	ND (0.20)
dibenzo(a,h)anthracene	ND (0.20)	ND (0.17)	ND (0.20)	ND (0.20)
dibenzofuran	ND (0.80)	ND (0.69)	ND (0.79)	ND (0.79)
diethylphthalate	ND (0.15)	ND (0.13)	ND (0.15)	ND (0.15)
dimethyl phthalate	ND (0.13)	ND (0.11)	ND (0.13)	ND (0.13)
fluoranthene	ND (0.18)	ND (0.15)	ND (0.17)	ND (0.17)
fluorene	ND (0.15)	ND (0.13)	ND (0.15)	ND (0.15)
hexachlorobenzene	ND (0.15)	ND (0.13)	ND (0.15)	ND (0.15)
hexachlorobutadiene	ND (0.072)	ND (0.062)	ND (0.071)	ND (0.071)
hexachlorocyclopentadiene	ND (0.48)	ND (0.41)	ND (0.47)	ND (0.47)
hexachloroethane	ND (0.13)	ND (0.11)	ND (0.13)	ND (0.13)
Indeno(1,2,3-cd)pyrene	ND (0.30)	ND (0.26)	ND (0.29)	ND (0.29)
Isophorone	ND (0.18)	ND (0.15)	ND (0.17)	ND (0.17)
n-nitroso-di-n-propylamine	ND (0.96)	ND (0.83)	ND (0.94)	ND (0.94)
n-nitrosodimethylamine	ND (0.80)	ND (0.69)	ND (0.79)	ND (0.79)
n-nitrosodiphenylamine	ND (0.15)	ND (0.13)	ND (0.15)	ND (0.15)
naphthalene	ND (0.13)	ND (0.11)	ND (0.13)	ND (0.13)
nitrobenzene	ND (0.15)	ND (0.13)	ND (0.15)	ND (0.15)
pentachlorophenol	ND (0.29)	ND (0.25)	ND (0.28)	ND (0.28)

B: Detected in Reagent Blank; background subtraction not performed

J: Estimated value (GC test codes)

ND: Not detected at specified detection limit

( ): Detection limit

Approved: \_\_\_\_\_  
Date: \_\_\_\_\_

TABLE 4.2.6-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 12 (FDYA 2), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	Monitor Well	
	Sample ID	Date Sampled
	Beg. Depth -	End Depth
phenanthrene	12J	12K
	12J-3	12K-5
	24-Feb-88	20-Feb-88
phenol	9 - 14	19 - 23
	ND (0.43)	ND (0.37)
	ND (0.12)	ND (0.10)
pyrene	ND (0.15)	ND (0.12)
		ND (0.15)

B: Detected in Reagent Blank; background subtraction not performed  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

while drilling. Borehole 12I had the next highest readings, again displaying the trend of decreasing hydrocarbon values until the sand zone was encountered at 19 to 22 feet, where the highest value (1,250 mg/kg) was recorded. Borings 12E, 12J, and 12K showed a similar pattern with little or no detection of petroleum hydrocarbons until the sand was encountered.

Volatile Organic Compounds--Soil analysis at Site 12 did not display good correlation with ground-water analyses for purgeable halocarbons. TCE was not detected in any of the soil samples. 1,1,2,2-tetrachloroethane was estimated from GC test codes at 1.3 mg/kg at 12H in the sand layer 19-21 feet below land surface. Maximum concentrations from borehole 12H included 0.37 mg/kg for benzene (in the first two feet of soil), 37 mg/kg for total xylenes (in the first two feet of soil), and 5 mg/kg for ethylbenzene (in the sand layer 19 to 21 feet below land surface). Xylenes concentrations at borehole 12I were 35 mg/kg (9 to 12 feet).

Semivolatile Organic Compounds--Semivolatile organic compounds encountered in soil from 12H were as follows: 2-methylnaphthalene (11 mg/kg), 4-methylphenol (4.2 mg/kg), phenol (0.5 mg/kg), naphthalene (4.7 mg/kg). Samples from borehole 12I had similar compounds, but occurring at lower concentrations. These compounds were not detected in other boreholes. The trend in concentration for naphthalene and 2-methylnaphthalene was high concentrations at the surface, decreasing concentrations with depth, and then maximum concentrations in the sand zone at 19 feet below land surface. Phenol and methylphenol concentrations were highest at the surface, but were not detected at depth.

#### Water Quality

All Stage 1 wells (12A-C) and Stage 2 wells (12D-E) were sampled for chemical analysis during 2 rounds. Results of the two sampling rounds are provided in Table 4.2.6-3 (inorganic parameters) and Table 4.2.6-4 (organic parameters). Field chemistry analyses are reported in Table 4.2.6-5. Samples were analyzed for water quality indicators, heavy metals, petroleum hydro-

carbons, purgeable halocarbons, purgeable aromatics, and extractable priority pollutants (12A and 12C). These data are discussed in the following paragraphs.

Water Quality Indicators--Total dissolved solids (TDS) ranged from 380 to 590 mg/L at Site 12, with the lowest value observed in the upgradient well, 12A. The trend in water quality indicators from the first to second sampling rounds was one of a steady increase in most concentrations of fluoride, chloride, nitrate, and sulfate. Well 12A did not exhibit this increasing trend but, rather, remained fairly stable between samples rounds.

Heavy Metals--Concentrations of several metals were above federal regulatory limits for drinking water (Table 4.1-1). Arsenic (wells 12B, 12C, and 12D), lead (12B, 12C, 12D, and 12E), cadmium (12D), and chromium (12B, 12C, 12D, and 12E) exceeded MCLs in the first sampling round. In the second sampling round, arsenic (12A, 12C, and 12D), lead (12A, 12C, 12D, and 12E), cadmium (12C), and chromium (12A, 12C, 12D, and 12E) concentrations exceeded MCLs. MCLGs were exceeded by iron and manganese in every ground-water sample from Site 12. Cadmium exceeded MCLGs, but not MCLs, in the first sampling round at 12B and 12E. The two southernmost wells, 12A and 12C, showed increased metals concentrations while 12C, 12D, and 12E all declined in ground-water metals concentrations.

Petroleum Hydrocarbons--The only detection of petroleum hydrocarbons was in the ground water monitor well 12C (0.60 mg/L) in Round 1.

Purgeable Halocarbons--Purgeable halocarbons were present in all ground-water samples except the first round sample from the upgradient well, 12A. TCE concentrations were highest at 12B (110  $\mu\text{g/L}$ ) and 12D (55  $\mu\text{g/L}$ ) and tetrachloroethene also occurred at 12B (49  $\mu\text{g/L}$ ). Concentrations in both of



TABLE 4.2.6-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 12 (FDA 2), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well			
	Sample ID			
	12A	12B	12B	12B
EPA Standards, Criteria	02-154	04-04	03-24	03-25
	25-Feb-88	06-Apr-88	03-Mar-88	03-Mar-88
Metal Screen (ICP) MG/L				
Ag Silver	ND (0.0090)	ND (0.0090)	ND (0.0090)	ND (0.0090)
Al Aluminum	16.0 (0.20)	63.0 (0.20)	100.0 (0.20)	130.08 (0.20)
As Arsenic	ND (0.30)	1.0 (0.30)	ND (0.30)	MDR (0.30)
B Boron	ND (0.60)	ND (0.60)	ND (0.60)	MDR (0.60)
Ba Barium	0.14 (0.0090)	0.29 (0.0090)	0.46 (0.0090)	0.53 (0.0090)
Be Beryllium	0.0010 (0.0010)	0.0030 (0.0010)	0.0020 (0.0010)	0.0030 (0.0010)
Ca Calcium	220.0 (0.060)	620.0 (0.060)	1100.0 (0.12)	1200.08 (0.12)
Cd Cadmium	0.0030 (0.0030)	0.0040 (0.0030)	0.0070 (0.0030)	0.0080 (0.0030)
Co Cobalt	ND (0.010)	ND (0.010)	0.060 (0.010)	0.070 (0.010)
Cr Chromium	0.033 (0.0090)	0.10 (0.0090)	0.18 (0.0090)	0.22 (0.0090)
Cu Copper	ND (0.010)	0.010 (0.010)	0.070 (0.010)	0.080 (0.010)
Fe Iron	15.0 (0.030)	58.0 (0.030)	120.0 (0.030)	150.08 (0.030)
K Potassium	3.2 (0.30)	13.0 (0.30)	15.0 (0.60)	19.08 (0.60)
Mg Magnesium	6.4 (0.10)	17.0 (0.10)	24.0 (0.10)	29.0 (0.10)
Mn Manganese	0.17 (0.0030)	0.59 (0.0030)	3.1 (0.0030)	3.5 (0.0030)
Mo Molybdenum	ND (0.050)	ND (0.050)	ND (0.050)	ND (0.050)
Na Sodium	13.0 (0.080)	14.0 (0.080)	23.0 (0.080)	22.0 (0.080)
Ni Nickel	ND (0.020)	0.060 (0.020)	0.16 (0.020)	0.20 (0.020)
Pb Lead	0.041 (0.050)	0.060 (0.050)	0.13 (0.050)	0.11 (0.050)
Sb Antimony	ND (0.060)	0.15 (0.060)	0.30 (0.060)	0.24R (0.060)
Se Selenium	ND (0.30)	ND (0.30)	ND (0.30)	0.50 (0.30)
Si Silicon	42.0 (0.30)	78.0 (0.30)	150.0 (0.30)	160.08 (0.30)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

Q: Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.

B: Detected in Reagent Blank; background subtraction not performed

R: Indicates that the matrix spike recovery for this analysis was not within acceptance limits indicating an interferent present.

^: Indicates duplicate analysis is not within control limits.

ND: Not detected at specified detection limit

( ): Detection limit

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TABLE 4.2.6-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 12 (FOIA 2), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	EPA Standards,		Criteria		Monitor Well	
	12A	12B	12A	12B	Sample ID	Date Sampled
Tl	0.077	(0.090)	ND	(0.090)	ND	ND (0.090)
V	0.053	(0.020)	0.17	(0.020)	0.33	(0.020) 0.39 (0.020)
Zn	0.018	(0.0060)	0.11	(0.0060)	0.23	(0.0060) 0.31 (0.0060)
	25-Feb-88	06-Apr-88	03-Mar-88	03-Mar-88		

D R A F T

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), C-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

⊕: Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.

B: Detected in Reagent Blank; background subtraction not performed

R: Indicates that the matrix spike recovery for this analysis was not within acceptance limits indicating an interferent present.

∧: Indicates duplicate analysis is not within control limits.

ND: Not detected at specified detection limit

( ): Detection limit

0.011

TABLE 4.2.6-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 12 (FUTA 2), CARGWELL AFB, TEXAS.

Primary Results

PARAMETER	EPA Standards, Criteria	12B 04-57 13-Apr-88	12C 03-26 03-Mar-88	12C 04-59 11-Apr-88	12D 03-23 03-Mar-88	Monitor Well Sample ID Date Sampled
Total Dissolved Solids MG/L		490.0 (1.0)	540.0 (1.0)	550.0 (1.0)	590.0 (1.0)	
Total Dissolved Solids						
Fluoride MG/L						
Fluoride	4.0(M)	2.0(G)	0.29	0.34	0.31	
Chloride MG/L						
Chloride	250.0(C)	28.0	18.0	26.0	9.0	
Nitrate MG/L						
Nitrate + Nitrite	10.0(M)	0.43	ND	ND	0.46	
Orthophosphate MG/L						
Orthophosphate		0.040 (0.020)	0.070 (0.020)	ND (0.020)	ND (0.020)	
Sulfate MG/L						
Sulfate, nephelometry	250.0(C)	52.0	15.0	18.0	0.050 (0.020)	
Metals MG/L						
Arsenic, graphite AA	0.050(M)	0.019	0.056	0.074	0.0828	
Mercury	0.0020(M)	ND#	0.00030 (0.00012)	0.00020#	0.00030 (0.00012)	
Lead, graphite AA	0.050(M)	ND	0.050	ND (0.0030)	0.138#	
Selenium, graphite AA	0.010(M)	ND	ND#	ND (0.0030)	ND#	

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), C-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

# : Matrix spike outside control limits.

@ : Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.

B : Detected in Reagent Blank; background subtraction not performed

B+ : Analyte detected in Reagent Blank. % Difference (MS and MS duplicate) outside control limits.

R : Indicates that the matrix spike recovery for this analysis was not within acceptance limits indicating an interferent present.

ND : Not detected at specified detection limit

( ) : Detection limit

I  
D  
R  
A  
M  
I



TABLE 4.2.6-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 12 (FDIA 2), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	EPA Standards, Criteria		12C		12D	
	12B 04-57 13-Apr-88	12C 03-26 03-Mar-88	12C 04-59 11-Apr-88	12D 03-23 03-Mar-88	Monitor Well Sample ID	Date Sampled
Si Silicon	48.0 (0.30)	130.0 (0.30)	110.0 (0.30)	140.0 (0.30)		
Tl Thallium	0.13 (0.090)	ND (0.090)	ND (0.090)	ND (0.090)		
V Vanadium	0.060 (0.020)	0.36 (0.020)	0.40 (0.020)	0.93 (0.020)		
Zn Zinc	5.0(G) (0.0060)	0.19 (0.0060)	0.22 (0.0060)	0.55 (0.0060)		

- D R A F T -

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

#: Matrix spike outside control limits.

@: Indicates that the analytical spike recovery for this analysis was not within acceptance limits indicating an interferent present.

B: Detected in Reagent Blank; background subtraction not performed

B+: Analyte detected in Reagent Blank. X Difference (MS and MS duplicate) outside control limits.

R: Indicates that the matrix spike recovery for this analysis was not within acceptance limits indicating an interferent present.

ND: Not detected at specified detection limit

( ): Detection limit

11-11-88

11-11-88

11-11-88

11-11-88

TABLE 4.2.6-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 12 (FOIA 2), CARSWELL AFB, TEXAS.

Primary Results		Monitor Well	
PARAMETER	EPA Standards, Criteria	Sample ID Date Sampled	12E 12E 03-27 03-Mar-88 13-Apr-88
Total Dissolved Solids	570.0 (1.0)	530.0 (1.0)	590.0 (1.0)
Total Dissolved Solids			
Fluoride MG/L			
Fluoride	4.0(M) 2.0(G)	0.22	0.27
Chloride MG/L			
Chloride	250.0(G)	15.0	16.0
Nitrate MG/L			
Nitrate + Nitrite	10.0(M)	0.13	1.2
Orthophosphate MG/L			
Orthophosphate	0.030 (0.020)	ND (0.020)	ND (0.020)
Sulfate MG/L			
Sulfate, nephelometry	250.0(G)	31.0	88.0
Metals MG/L			
Arsenic, graphite AA	0.050(M)	0.028	0.033
Mercury	0.0020(M)	0.00010 (0.00012)	ND# (0.00012)
Lead, graphite AA	0.050(M)	0.061	
Selenium, graphite AA	0.010(M)	ND (0.0030)	ND (0.0030)
Metal Screen (ICP) MG/L			
Ag Silver	ND (0.0090)	ND (0.0090)	ND (0.0090)
Al Aluminum	76.0 (0.20)	120.0 (0.20)	27.0 (0.20)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

# : Matrix spike outside control limits.

ND: Not detected at specified detection limit

( ) : Detection limit

TABLE 4.2.6-3



TABLE 4.2.6-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 12 (FDA 2), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well			
	Sample ID			
	Date Sampled			
	12A	12A	12B	12B
	02-154	04-04	03-24	03-25
	25-Feb-88	06-Apr-88	05-Mar-88	03-Mar-88
<b>Petroleum Hydrocarbons UC/L</b>				
<b>Petroleum Hydrocarbons</b>	ND	(200.0)	ND	(200.0)
<b>Purgeable Halocarbons UC/L</b>				
1,1,1-Trichloroethane	ND	(0.090)	ND	(2.3)
1,1,2,2-Tetrachloroethane	ND	(0.12)	ND	(3.0)
1,1,2-Trichloroethane	ND	(0.070)	ND	(1.8)
1,1-Dichloroethane	ND	(0.090)	ND	(2.3)
1,1-Dichloroethene	ND	(0.10)	ND	(2.5)
1,2-Dichlorobenzene	ND	(0.50)	ND	(13.0)
1,2-Dichloroethane	ND	(0.030)	ND	(0.75)
1,2-Dichloropropane	ND	(0.10)	ND	(2.5)
1,3-Dichlorobenzene	ND	(0.30)	ND	(7.5)
1,4-Dichlorobenzene	ND	(0.40)	ND	(10.0)
2-Chloroethylvinyl ether	ND	(0.20)	ND	(5.0)
Bromodichloromethane	ND	(0.10)	ND	(2.5)
Bromoform	ND	(0.30)	ND	(7.5)
Bromomethane	ND	(1.2)	ND	(30.0)
Carbon tetrachloride	ND	(0.10)	ND	(2.5)
Chlorobenzene	ND	(0.30)	ND	(7.5)
Chloroethane	ND	(0.50)	ND	(13.0)
Chloroform	ND	(0.050)	0.20	(1.3)
Chloromethane	ND	(0.30)	ND	(7.5)
Dibromochloromethane	ND	(0.20)	ND	(5.0)
Methylene chloride	ND	(0.30)	ND	(7.5)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

†: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

B: Detected in Reagent Blank; background subtraction not performed

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ): Detection limit

0-11-11

TABLE 4.2.6-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 12 (FDTA 2), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well					
	12A		12B		12B	
	EPA Standards, Criteria	02-154 25-Feb-88	04-04 06-Apr-88	03-24 03-Mar-88	03-25 03-Mar-88	
Trichloroethene	8.0(G)	ND (0.030)	0.030 (0.030)	42.0 (0.75)	43.0 (0.75)	
Trichloroethane	5.0(M)	ND (0.20)	0.20 (0.20)	110.0 (5.0)	110.0 (5.0)	
Trichlorofluoromethane	2.0(M)	ND (0.10)	ND (0.10)	ND (2.5)	ND (2.5)	
Vinyl chloride	2.0(M)	ND (0.20)	ND (0.20)	ND (5.0)	ND (5.0)	
cis-1,3-Dichloropropene	70.0(G)	MDA	MDA	MDA	MDA	
trans-1,2-Dichloroethene		ND (0.20)	ND (0.20)	ND (5.0)	ND (5.0)	
trans-1,3-Dichloropropene		ND (0.30)	ND (0.30)	ND (7.5)	ND (7.5)	
<b>Purgeable Aromatics UG/L</b>						
1,2-Dichlorobenzene	620.0(G)	ND (0.40)	ND (0.40)	ND (10.0)	ND (10.0)	
1,3-Dichlorobenzene	400.0(G)	ND (0.40)	ND (0.40)	ND (10.0)	ND (10.0)	
1,4-Dichlorobenzene	750.0(M)	750.0(G)	ND (0.30)	ND (8.0)	ND (8.0)	
Benzene	5.0(M)	0.0(G)	ND (0.20)	ND (5.0)	ND (5.0)	
Chlorobenzene	60.0(G)	ND (0.30)	ND (0.30)	ND (8.0)	ND (8.0)	
Ethylbenzene	680.0(G)	ND (0.30)	ND (0.30)	ND (8.0)	ND (8.0)	
Toluene	2000.0(G)	1.1 (0.20)	1.2 (0.20)	9.0 (5.0)	ND (5.0)	
m-Xylene		ND (0.20)	ND (0.20)	ND (5.0)	ND (5.0)	
o-Xylene		ND (0.10)	ND (0.10)	ND (3.0)	ND (3.0)	
p-Xylene		MDQ (0.20)	ND (0.20)	ND (5.0)	ND (5.0)	
<b>Extractable Priority Pollutants UG/L</b>						
1,2,4-trichlorobenzene		ND (2.0)				
1,2-dichlorobenzene		ND (2.0)				
1,3-dichlorobenzene		ND (2.0)				
1,4-dichlorobenzene		ND (4.5)				

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

k: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

B: Detected in Reagent Blank; background subtraction not performed

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ): Detection limit

This report was prepared by the Environmental Sciences Division, Air Force Research Laboratory, AFRL/ET-10, Dayton, Ohio 45433-7158. The work was performed under the terms of contract number F49620-88-1-0000. The work was performed under the terms of contract number F49620-88-1-0000. The work was performed under the terms of contract number F49620-88-1-0000.

TABLE 4.2.6-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 12 (FDIA 2), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	EPA Standards, Criteria	Monitor Well	
		Sample ID	Date Sampled
2,4,5-trichlorophenol	12A	12A	12B
2,4,6-trichlorophenol	02-154	04-04	03-24
2,4-dichlorophenol	3090.0(G)	06-Apr-88	03-Mar-88
2,4-dimethylphenol	400.0(G)		
2,4-dinitrophenol			
2,4-dinitrotoluene			
2,6-dinitrotoluene			
2-chloronaphthalene			
2-chlorophenol			
2-methylnaphthalene			
2-methylphenol			
2-nitroaniline			
2-nitrophenol			
3,3'-dichlorobenzidine			
4,6-dinitro-2-methylphenol			
4-bromophenyl-phenylether			
4-chloro-3-methylphenol			
4-chloroaniline			
4-chlorophenyl-phenylether			
4-methylphenol			
4-nitroaniline			
4-nitrophenol			
acenaphthene	0.030(G)		
acenaphthylene			
aniline			

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

G: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

B: Detected in Reagent Blank; background subtraction not performed

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ) : Detection limit

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03-MAR-88

TABLE 4.2.6-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 12 (FDA 2), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	EPA Standards,		Criteria		Monitor Well	
	12A	12B	12A	12B	Sample ID	Date Sampled
anthracene	MD	(2.0)	02-154	04-04	12B	12B
benzidine	MD	(45.0)	25-Feb-88	03-24	03-25	03-Mar-88
benzo(a)anthracene	MD	(8.0)				
benzo(a)pyrene	MD	(2.6)				
benzo(b)fluoranthene	MD	(4.9)				
benzo(g,h,i)perylene	MD	(4.2)				
benzo(k)fluoranthene	MD	(2.6)				
benzoic acid	MD	(52.0)				
benzyl alcohol	MD	(32.0)				
bis(2-chloroethoxy)methane	MD	(5.5)				
bis(2-chloroethyl) ether	MD	(5.9)				
bis(2-chloroisopropyl)ether	MD	(5.9)				
bis(2-ethylhexyl)phthalate	17.0	(2.6)				
butylbenzylphthalate	MD	(2.6)				
chrysene	MD	(2.6)				
di-n-butylphthalate	4.23	(2.6)				
di-n-octyl phthalate	MD	(2.6)				
dibenzo(a,h)anthracene	MD	(2.6)				
dibenzofuran	MD	(10.0)				
diethylphthalate	MD	(2.0)				
dimethyl phthalate	MD	(1.6)				
fluoranthene	MD	(2.3)				
fluorene	MD	(2.0)				
hexachlorobenzene	MD	(2.0)				
hexachlorobutadiene	MD	(0.93)				

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EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

A: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

B: Detected in Reagent Blank; background subtraction not performed

Q: Daily EPA QC recovery outside 95% confidence limit.

MD: Not detected at specified detection limit

( ): Detection limit

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TABLE 4.2.6-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 12 (FDA 2), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards,		Monitor Well	
	Criteria	12A 02-154 25-Feb-88	12A 04-04 06-Apr-88	12B 03-24 03-Mar-88
hexachlorocyclopentadiene		ND		12B
hexachloroethane		ND (1.6)		12B
indeno(1,2,3-cd)pyrene		ND (3.8)		03-25
isophorone	5200.0(G)	ND (2.3)		03-Mar-88
n-nitroso-di-n-propylamine		ND (12.0)		
n-nitrosodimethylamine		ND (10.0)		
n-nitrosodiphenylamine		ND (2.0)		
naphthalene	620.0(G)	ND (1.6)		
nitrobenzene		ND (2.0)		
pentachlorophenol	200.0(G)	ND (3.7)		
phenanthrene	0.030(G)	ND (5.6)		
phenol	3500.0(G)	ND (1.5)		
pyrene	0.030(G)	ND (2.0)		

- D R A F T -

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

L: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

B: Detected in Reagent Blank; background subtraction not performed

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ) : Detection limit

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TABLE 4.2.6-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 12 (FDIA 2), CARSWELL AFB, TEXAS.

Primary Results	Monitor Well			
	Sample ID			
	Date Sampled			
	12B	12C	12C	12D
EPA Standards,	04-57	03-26	04-59	03-23
Criteria	13-Apr-88	03-Mar-88	11-Apr-88	03-Mar-88
<b>Petroleum Hydrocarbons</b> UG/L				
<b>Petroleum Hydrocarbons</b>		600.0	ND	(200.0)
<b>Purgeable Halocarbons</b> UG/L				
1,1,1-Trichloroethane	200.0(M)	200.0(G)	0.30	(0.090)
1,1,2,2-Tetrachloroethane			ND	(0.12)
1,1,2-Trichloroethane			ND	(0.070)
1,1-Dichloroethane			3.2	(0.090)
1,1-Dichloroethene	7.0(M)	7.0(G)	ND	(0.10)
1,2-Dichlorobenzene	620.0(G)		ND	(2.5)
1,2-Dichloroethane	5.0(M)	0.0(G)	ND	(0.030)
1,2-Dichloropropane			ND	(0.10)
1,3-Dichlorobenzene	400.0(G)		ND	(1.5)
1,4-Dichlorobenzene	750.0(M)	750.0(G)	ND	(2.0)
2-Chloroethylvinyl ether			ND	(0.20)
Bromodichloroethane			ND	(0.10)
Bromoform			ND	(7.5)
Bromomethane			ND	(30.0)
Carbon tetrachloride	5.0(M)	0.0(G)	ND	(1.2)
Chlorobenzene	60.0(G)		ND	(0.10)
Chloroethane			ND	(1.5)
Chloroform			ND	(0.50)
Chloromethane			ND	(0.050)
Dibromochloroethane			ND	(0.30)
Methylene chloride			ND	(5.0)
			ND	(7.5)

EPA Standards and Criteria are designated: N-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

6: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

J: Estimated value (GC test codes)

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ): Detection limit

ANALYST: [Signature]

DATE: 03-23-88

LABORATORY: [Signature]



TABLE 4.2.6-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 12 (FDYA 2), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards, Criteria		Monitor Well	
	12B	12C	Sample ID	Date Sampled
2,4,5-trichlorophenol			12C	12D
2,4,6-trichlorophenol			04-59	03-23
2,4-dichlorophenol			11-Apr-88	03-Mar-88
2,4-dimethylphenol	3090.0(G)		ND	(13.0)
2,4-dinitrophenol	400.0(G)		ND	(3.6)
2,4-dinitrotoluene			ND	(3.6)
2,4-dinitrotoluene			ND	(55.0)
2,6-dinitrotoluene			ND	(7.5)
2-chloronaphthalene			ND	(2.5)
2-chlorophenol			ND	(2.5)
2-methylnaphthalene			ND	(4.4)
2-methylphenol			ND	(13.0)
2-nitroaniline			ND	(13.0)
2-nitrophenol			ND	(66.0)
3,3'-dichlorobenzidine			ND	(4.8)
4,6-dinitro-2-methylphenol			ND	(22.0)
4-bromophenyl-phenylether			ND	(32.0)
4-chloro-3-methylphenol			ND	(2.5)
4-chloroaniline			ND	(4.0)
4-chlorophenyl-phenylether			ND	(13.0)
4-methylphenol			ND	(5.5)
4-nitroaniline			ND	(13.0)
4-nitrophenol			ND	(66.0)
acenaphthene			ND	(3.2)
acenaphthylene			ND	(2.5)
anthracene			ND	(4.6)
			ND	(2.5)

- D R A F T -

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), C-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

±: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

J: Estimated value (GC test codes)

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ): Detection limit

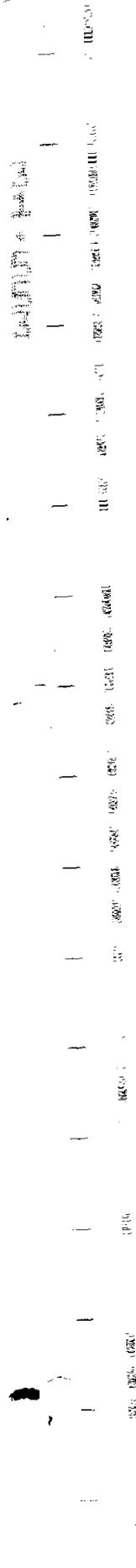


TABLE 4.2.6-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 12 (FDTA 2), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards		Criteria		Monitor Well	
	12B 04-57	12C 03-26	12B 03-Mar-88	12C 04-59	Sample ID	Date Sampled
benzo(a)anthracene					12D	03-Mar-88
benzo(a)pyrene						
benzo(b)fluoranthene						
benzo(g,h,i)perylene						
benzo(k)fluoranthene						
benzoic acid						
benzyl alcohol						
bis(2-chloroethoxy)methane						
bis(2-chloroethyl) ether						
bis(2-chloroisopropyl)ether						
bis(2-ethylhexyl)phthalate	15000.0(C)					
butylbenzylphthalate	940.0(C)					
chrysene						
di-n-butylphthalate	35000.0(C)					
di-n-octyl phthalate						
dibenzo(a,h)anthracene						
dibenzofuran						
diethylphthalate						
dimethyl phthalate						
fluoranthene	0.030(C)					
fluorene	0.030(C)					
hexachlorobenzene						
hexachlorobutadiene						
hexachlorocyclopentadiene						
hexachloroethane						

D R A F T

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

S: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

J: Estimated value (GC test codes)

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ) : Detection limit

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TABLE 4.2.6-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 12 (FDTA 2), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	EPA Standards, Criteria		Monitor Well	
	12B 04-57 13-Apr-88	12C 03-26 03-Mar-88	12C 04-59 11-Apr-88	12D 03-23 03-Mar-88
indeno(1,2,3-cd)pyrene			ND	(4.9)
isophorone	5200.0(G)		ND	(2.9)
n-nitroso-di-n-propylamine			ND	(16.0)
n-nitrosodiphenylamine			ND	(2.5)
naphthalene	620.0(G)		ND	(2.1)
nitrobenzene			ND	(2.5)
pentachlorophenol	200.0(G)		ND	(4.8)
phenanthrene	0.030(G)		ND	(7.1)
phenol	3500.0(G)		ND	(2.0)
pyrene	0.030(G)		ND	(2.5)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

I: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

J: Estimated value (GC test codes)

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ): Detection limit



TABLE 4.2.6-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 12 (EDTA 2), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards,		Criteria		Monitor Well	
	12D	12E	12D	12E	Sample ID	Date Sampled
Petroleum Hydrocarbons UG/L	200.0(M)	200.0(G)	200.0	200.0	12E	03-27
Petroleum Hydrocarbons			200.0	200.0	12E	04-56
Purgeable Halocarbons UG/L						13-Apr-88
1,1,1-Trichloroethane	200.0(M)	200.0(G)	ND	(200.0)	ND	13-Apr-88
1,1,2,2-Tetrachloroethane			ND	(2.3)	ND	(0.090)
1,1,2-Trichloroethane			ND	(3.0)	ND	(0.12)
1,1-Dichloroethane			ND	(1.8)	ND	(0.070)
1,1-Dichloroethane	7.0(M)	7.0(G)	ND	(2.3)	0.80	(0.090)
1,2-Dichlorobenzene	620.0(G)		ND	(2.5)	ND	(0.10)
1,2-Dichloroethane	5.0(M)	0.0(G)	ND	(13.0)	ND	(0.50)
1,2-Dichloropropane	400.0(G)		ND	(0.75)	ND	(0.030)
1,3-Dichlorobenzene	750.0(M)	750.0(G)	ND	(2.5)	ND	(0.10)
1,4-Dichlorobenzene			ND	(7.5)	ND	(0.30)
2-Chloroethylvinyl ether			ND	(10.0)	2.6	(0.40)
Bromodichloromethane			ND	(5.0)	ND	(0.20)
Bromoform			ND	(2.5)	ND	(0.10)
Bromomethane			ND	(7.5)	ND	(0.30)
Carbon tetrachloride	5.0(M)	0.0(G)	ND	(30.0)	ND	(1.2)
Chlorobenzene	60.0(G)		ND	(2.5)	ND	(0.10)
Chloroethane			ND	(7.5)	ND	(0.30)
Chloroform			ND	(13.0)	1.5	(0.50)
Chloromethane			ND	(1.3)	ND	(0.050)
Dibromochloromethane			ND	(7.5)	ND	(0.30)
Methylene chloride			ND	(5.0)	ND	(0.20)
Tetrachloroethene	8.0(G)		ND	(7.5)	ND	(0.30)
			ND	(0.75)	ND	(0.030)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

±: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ): Detection limit

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TABLE 4.2.6-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 12 (FDA 2), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards, Criteria		12D		12E	
	5.0(M)	0.0(G)	04-53	03-27	04-56	04-56
Trichloroethane	55.0	(5.0)	0.80	(0.20)	1.1	(0.20)
Trichlorofluoromethane	ND	(2.5)	ND	(0.10)	ND	(0.10)
Vinyl chloride	ND	(5.0)	3.4	(0.20)	1.8	(0.20)
cis-1,3-Dichloropropene	ND		ND		ND	
trans-1,2-Dichloroethene	ND	(5.0)	ND	(0.20)	ND	(0.20)
trans-1,3-Dichloropropene	ND	(7.5)	ND	(0.30)	ND	(0.30)
Purgeable Aromatics UG/L						
1,2-Dichlorobenzene	620.0(G)		ND	(0.40)	ND	(0.40)
1,3-Dichlorobenzene	400.0(G)		ND	(0.40)	ND	(0.40)
1,4-Dichlorobenzene	750.0(M)	750.0(G)	5.2	(0.30)	5.1	(0.30)
Benzene	5.0(M)	0.0(G)	ND	(0.20)	0.30	(0.20)
Chlorobenzene	60.0(G)		ND	(0.30)	ND	(0.30)
Ethylbenzene	680.0(G)		ND	(0.30)	ND	(0.30)
Toluene	2000.0(G)		47.0	(0.20)	1.0	(0.20)
m-Xylene			ND	(0.20)	ND	(0.20)
o-Xylene			ND	(0.10)	ND	(0.10)
p-Xylene			ND	(0.20)	ND	(0.20)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

Q: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ) : Detection limit

TABLE 4.2.6-5. RESULTS OF FIELD ANALYSES FOR WATER SAMPLES, SITE 12 (FDA 2), CARSWELL AFB, TEXAS

Monitor Well  
Sample ID  
Date Sampled

Analyte	Unit of Measure	12A	12B	12B
		02-154	03-24	04-57
		25-Feb-88	03-Mar-88	13-Apr-88
		04-04		
		06-Apr-88		

Alkalinity	mg/L	845.0	1215.0	(5.0)
Specific Conductance	uMOS/CM	490.0	738.0	(10.0)
Temperature	C	17.0	19.0	(1.0)
pH	S.U.	7.1	6.5	(0.010)

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TABLE 4.2.6-5. RESULTS OF FIELD ANALYSES FOR WATER SAMPLES, SITE 12 (FDA 2), CARSWELL AFB, TEXAS

Analyte	Unit of Measure	Monitor Well			
		Sample ID	Date Sampled	Sample ID	Date Sampled
Alkalinity	mg/L	12C	12C	12D	12D
		03-26	04-59	03-23	04-53
Specific Conductance	µMHOS/CM	03-Mar-88	11-Apr-88	03-Mar-88	13-Apr-88
		820.0	9235.0	838.0	3285.0
Temperature	C	(1.0)	(5.0)	(1.0)	(5.0)
		19.0	820.0	18.0	820.0
pH	S.U.	(1.0)	(1.0)	(1.0)	(1.0)
		6.7	7.0	6.6	20.0
		(0.010)	(0.010)	(0.010)	(0.010)

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( ) : Detec Limit

TABLE 4.2.6-5. RESULTS OF FIELD ANALYSES FOR WATER SAMPLES, SITE 12 (FOFA 2), CARSWELL AFB, TEXAS

Analyte	Unit of Measure	Monitor Well	
		Sample ID	Date Sampled
		12E	12E
		03-27	04-56
		03-Mar-88	19-Apr-88
Alkalinity	mg/L	4180.0	(5.0)
Specific Conductance	µMOS/CM	930.0	(10.0)
Temperature	C	18.0	(1.0)
pH	S.U.	6.5	(0.10) (0.010)

COM-114

( ) : Detection Limit

these wells remained fairly stable between sampling rounds. Vinyl chloride was also detected at 12C during both rounds of sampling (18 and 15  $\mu\text{g/L}$ ). All of these purgeable halocarbons were above their respective MCLs. Other purgeable halocarbons were detected in ground water at Site 12 at lower levels.

Purgeable Aromatics--Several purgeable aromatic compounds were found in low levels in ground water at Site 12. 1,4-dichlorobenzene was detected in monitor wells 12C and 12E, 1,2-dichlorobenzene in 12C, and benzene in 12E. All values were below MCLs for these compounds.

Extractable Priority Pollutants--Analyses for extractable priority pollutants at Site 12 were conducted on the first sample from well 12A and the second sample from 12C. 1,2-dichlorobenzene was found in low levels at monitor well 12C.

#### 4.2.6.3 Significance of Findings

The principal effort for the Stage 2 field program at Site 12 was to determine the extent of contaminants in the soil underlying the bermed area of FDTA 2 and to determine downgradient water-quality conditions. The following paragraphs contain a discussion of the significance of the findings for soil and ground-water contamination.

Soil--Five soil borings were drilled within the bermed area of FDTA 2. Reviewing the Stage 1 hand-augering results and the results of the chemical analyses of Stage 2 borehole soils confirms that the major contaminants of concern are petroleum hydrocarbon compounds. These compounds include both the volatile and semivolatile organic compounds, with the semivolatile compounds apparently more prevalent in the subsurface probably because burning and evaporation of the volatile compounds impeded their infiltration of the soil.

As would be expected from the use of flammable liquids on the surface within the bermed area, the highest concentrations of petroleum hydrocarbons occurred near the surface, with concentrations decreasing with increasing depth. However, this trend was consistently interrupted by an abrupt increase in contaminant concentrations in the sand strata approximately 10 to 15 feet below the land surface. The levels of organic contaminants in the sand strata equaled or exceeded the levels of contaminants observed in the surface samples. This trend is best illustrated in data from boreholes 12H and 12I. The trend was not observed in samples from boreholes located away from the active training area.

Ground Water--The Stage 1 findings regarding the nature and occurrence of ground-water contaminants are supported and amplified by the Stage 2 results. The principal conclusions of the Stage 2 program are:

1. The principal ground-water contaminant in the upper zone is trichloroethene (TCE), with a variety of other organic compounds in lesser concentrations.
2. TCE occurs in upper zone wells downgradient (generally north and east) of the bermed area.

Zones of Contamination--The ground-water contamination at FDTA 2, is best illustrated in terms of TCE, which has consistently been detected in the upper zone. Figure 4.2.2-1 is a contour map of TCE concentrations in the upper zone for Flightline area sites, including FDTA 2. The contour map illustrates a plume of TCE outlined by, but not limited to, the 1,000  $\mu\text{g/L}$  TCE contour line that lies to the northeast of Site 12. Although levels of TCE occur in Site 12 downgradient wells, the distribution and level of contamination does not appear to be related to the large Flightline area plume. There are several reasons that may account for the distribution and concentration of contaminants at Site 12:

1. Boreholes directly under the site did not detect ground water (even though limited amounts may occur, considering the thin zone of saturation at 12A), thus reducing the opportunity for contaminants to become a part of the upper zone ground-water flow regime and move downgradient. Rather, the presence of hydrocarbon contamination in the sand strata is manifested by soil vapors and contaminants in the soil matrix.
2. Contamination in Site 12 wells appears to be localized in areas north of the bermed area in the vicinity of the drainageway leading to Farmers Branch. The introduction of contaminants to the ground water may be the result of recharge of runoff from the bermed area, which has been reported to be contaminated with JP-4.

#### 4.2.6.4 Baseline Risk Assessment

##### Summary of Indicator Chemicals

Results of the Stage 2 investigation indicate the presence of these indicator chemicals in at least one soil and/or ground water sample at the site:

<u>Metals</u>	<u>PNAs</u>	<u>VOCs</u>
Antimony	Bis(2-ethylhexyl)-	Benzene
Arsenic	phthalate	Chloroform
Barium		Methylene chloride
Beryllium		Tetrachloroethylene
Cadmium		Toluene
Chromium		Trichloroethene
Lead		Vinyl chloride
Nickel		
Selenium		
Silver		

Tables 3.8-2, 3.8-3, and 3.8-4 in Section 3.8 present important physical, chemical, and biological characteristics for these and all other indicator chemicals.

Some of the above indicator chemicals, particularly those at very low concentrations, may be due in part to matrix interferences or sample vial contamination. Nevertheless, these chemicals were included in the risk assessment process in order to ensure a conservative (stringent-case) evaluation of possible health risks.

#### Source and Release Characterization

Possible sources of contaminant release from Fire Department Training Area 2, as discussed previously for Landfill 3, include: 1) volatilization to the air, 2) fugitive dust generation, 3) recharge to ground water, 4) surface runoff, and 5) direct release to surface water. It is important to note that this site is an active fire department training area. The source of contamination includes periodic applications to the surface of the soil in conjunction with fire department training exercises as well as contaminated subsurface soil and ground water. The site is open; it is not covered with uncontaminated soil, vegetation, or impervious materials as is the case for other Flightline Area sites.

Volatilization to the Air--VOCs present in the soil are subject to volatilization to the air by virtue of high vapor pressures. PNAs generally have very low vapor pressures and are not subject to volatilization. Most metals are nonvolatile as well. Indicator chemicals detected at the site which can volatilize include benzene, chloroform, methylene chloride, tetrachloroethene, toluene, trichloroethene, and vinyl chloride.

Estimated emission rates for volatiles based conservatively on maximum concentrations detected in the soil or ground water at the site are:

<u>Indicator Chemical</u>	<u>Emission Rate</u> <u>(grams/second)</u>
Benzene	$8.80 \times 10^{-5}$
Chloroform	$1.94 \times 10^{-7}$
Methylene chloride	$3.70 \times 10^{-4}$
Tetrachloroethene	$5.20 \times 10^{-7}$
Toluene	$1.68 \times 10^{-4}$
Trichloroethene	$1.05 \times 10^{-5}$
Vinyl chloride	$1.30 \times 10^{-5}$

The methodology used to estimate emission rates is described in Section 3.8.

Fugitive Dust Generation--Contaminants must be present in surface soil uncovered by impervious materials or vegetation to be subject to fugitive dust generation. Because FDTA 2 is active and uncovered, contaminants present in the surface soil at this site are subject to fugitive dust generation.

Estimated emission rates for indicator chemicals adsorbed to soil particles are:

<u>Indicator Chemical</u>	<u>Emission Rate</u> <u>(grams/second)</u>
Antimony	$1.04 \times 10^{-7}$
Arsenic	$1.76 \times 10^{-7}$
Barium	$1.39 \times 10^{-7}$
Beryllium	$1.05 \times 10^{-9}$
Cadmium	$2.64 \times 10^{-9}$
Chromium	$6.17 \times 10^{-8}$
Lead	$4.76 \times 10^{-8}$
Nickel	$5.47 \times 10^{-8}$
Selenium	$1.05 \times 10^{-7}$
Silver	$1.76 \times 10^{-9}$
Bis(2-ethylhexyl)phthalate	$2.12 \times 10^{-6}$

The methodology used to estimate emission rates is described in Section 3.8.

Recharge to Ground Water--Indicator chemicals detected in the ground water near FDTA 2 include: antimony, arsenic, barium, beryllium, cadmium, chromium, lead, nickel, selenium, silver, bis(2ethylhexyl)phthalate, benzene, chloroform, tetrachloroethene, toluene, trichloroethene, and vinyl chloride. Section 4.2.6.3 summarizes and discusses the significance of the concentrations detected in the ground water at the site.

Surface Runoff--Contaminants must be present in surface soil uncovered by impervious materials to be subject to significant surface runoff during precipitation. Although FDTA 2 is surrounded by a low earthen berm which normally prevents surface runoff during slight to moderate precipitation events, heavy precipitation can potentially cause overflow or berm failure and runoff.

Discharge to Surface Water--There have been direct discharge of contaminants from this site to surface water, specifically a drainage ditch that leads to Farmers Branch.

#### Transport and Fate of Contaminants

FDTA 2 potentially releases VOCs, bis(2-ethylhexyl)phthalate, and metals to the air via volatilization and fugitive dust generation and to the ground and surface water via site leaching and surface runoff. Potentially significant contaminant transport and fate mechanisms in the air and ground and surface water media include: 1) air dispersion, 2) ground water migration, 3) transport in surface water, and 4) subsequent uptake by plants and animals.

Air Dispersion--Emissions of VOCs and dust-generated particulates from FDTA 2 occur at ground level. The gases and particulates disperse in the ambient atmosphere according to local meteorological conditions. Annual ambient air concentrations of both VOCs and particulates resulting from FDTA 2

emissions were estimated using the ISCLT model. The dispersion modeling methodology is discussed in Section 3.8.

Particulate emissions will deposit, or settle to the ground at a rate dependent on particle shape and density and atmospheric conditions. Particles in the 10-20  $\mu\text{m}$  size range deposit at a rate of approximately 0.0002 m/5. Larger dust particles in the 30-100  $\mu\text{m}$  range will tend to settle at a higher rate and deplete from the plume. A relatively high deposition velocity of 0.02 m/sec was assumed because dust generated emissions can involve fairly large particles. This deposition velocity was used to calculate deposition flux at selected receptor locations [deposition flux ( $\mu\text{g}/\text{m}^2/\text{s}$ ) - ground level concentration ( $\mu\text{g}/\text{m}^3$ ) per gm/sec of pollutant emitted x deposition velocity (m/sec)].

It should be noted that it was assumed that deposition has no effect on ground-level concentrations. In reality, as particles are removed by deposition, the plume becomes depleted and ground level concentrations decrease. This assumption is inherently conservative, overstating both ground-level air concentrations and particulate deposition, particularly at distant receptors.

Ground-Water Migration--The migration of ground water from FDTA 2 will follow the same pathways as described for Landfill 4 in Section 4.2.2.4. Refer to this section for details on ground-water migration.

Available water-level and geologic data indicate that all ground-water flow under Flightline Area sites moves toward Farmers Branch and is discharged in the vicinity of the creek.

Transport in Surface Water--As is true for all Flightline Area sites, contaminants which reach Farmers Branch via ground-water migration and/or surface runoff are subject to dilution and movement with the surface flow downstream to the West Fork of the Trinity River located east of the base. The West Fork of the Trinity River is downstream of Lake Worth, which



Exposure Pathways

Figure 4.2.6-6 depicts potential pathways for contaminants to move from FDTA 2 to human exposure points. Pathways which are not complete have been crossed out. Remaining pathways include:

1. Volatilization to the air and fugitive dust generation/air dispersion/inhalation of ambient air;
2. Volatilization to the air and fugitive dust generation/air dispersion/inhalation by animals/ingestion of meat and dairy products;
3. Fugitive dust generation/deposition on soil/ingestion of soil;
4. Fugitive dust generation/deposition on soil/skin contact with soil;
5. Fugitive dust generation/deposition on soil, water, and plants/ingestion by animals/ingestion of meat and dairy products;
6. Fugitive dust generation/deposition on soil/root uptake by plants/ingestion of fruits and vegetables;
7. Fugitive dust generation/deposition on surface water (potable source)/ingestion of and skin contact with drinking water;
8. Fugitive dust generation/deposition on surface water used to water or irrigate plants/root uptake by plants/ingestion of fruits and vegetables;

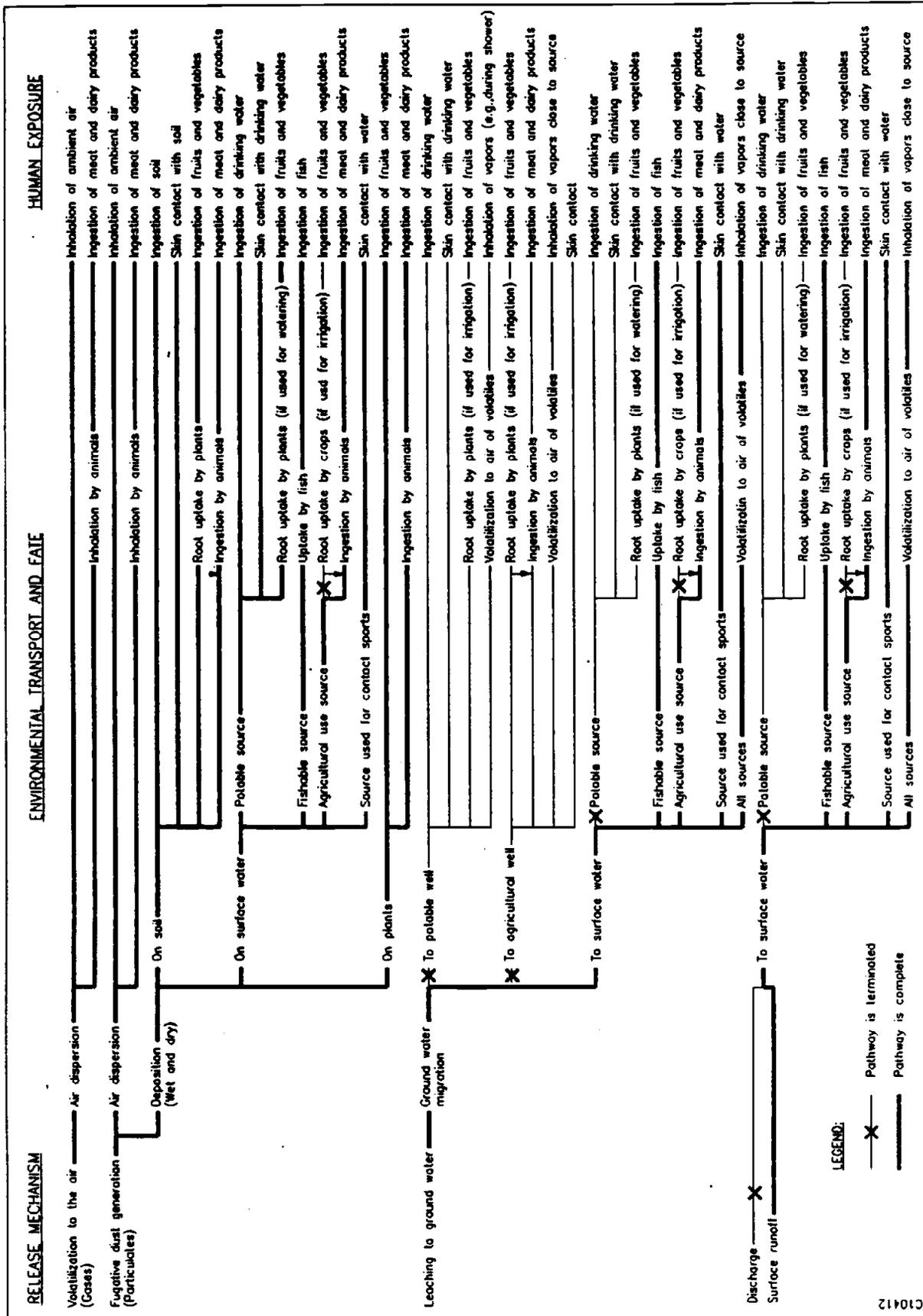


Figure 4.2.6-6. Potential Pathways to Human Exposure from Fire Department Training Area 2

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9. Fugitive dust generation/deposition on surface water (fishable source)/uptake by fish and other aquatic organisms/ingestion of aquatic organisms;
10. Fugitive dust generation/deposition on surface water used for contact sports/skin contact with water;
11. Fugitive dust generation/deposition on plants/ingestion of fruits and vegetables;
12. Leaching to ground water/ground-water migration to surface water (fishable source)/uptake by fish and other aquatic organisms/ingestion of aquatic organisms;
13. Leaching to ground water/ground-water migration to surface water (agricultural use source)/ingestion by animals/ingestion of meat and dairy products;
14. Leaching to ground water/ground-water migration to surface water (source used for contact sports)/skin contact with water; and
15. Leaching to ground water/ground-water migration to surface water/volatilization of volatiles/inhalation of vapors close to source.

As is also true for Landfill 5 and FDTA 1, contaminant contributions to surface water can also derive from surface runoff.

#### Identification of Receptors

Based on available exposure pathways, potential human receptors for exposure to contaminants originating from FDTA 2 include: 1) persons residing and/or working in nearby areas, particularly downwind of the site; 2) persons

ingesting meat and dairy products from animals exposed to contaminants in the ambient air, surface water, soil or plants; 3) persons ingesting fish or other aquatic organisms exposed to contaminated surface water; 4) persons ingesting or having skin contact with surface dust on which contaminants have deposited; 5) persons ingesting plants on which contaminants have deposited or which have accumulated contaminants present in the soil; 6) persons ingesting drinking water on which contaminants have deposited; and 7) persons swimming or participating in other contact sports in contaminated water.

Potential wildlife receptors include: 1) terrestrial organisms with habitats close to the site that inhale ambient air and ingest surface water, particularly from Farmers Branch, and otherwise come into contact with deposited particulates; and 2) aquatic organisms in Farmers Branch, West Fork of the Trinity River, and Lake Worth.

#### Threat to Human Health

Inhalation Exposure--Inhalation of ambient air is the most direct exposure pathway for contaminants to move from FDTA 2 to human receptors. Table 4.2.6-6 presents the on-site maximum and off-site maximum predicted annual ambient air concentrations resulting from estimated FDTA 2 emissions, and predicted concentrations at several discrete locations: site of the proposed base day care center, which is central to the largest on-base residential area, the Fort Worth National Fish Hatchery, and the closest dairy and beef operations. The table also lists Texas Air Control Board (TACB) health Effects Screening Levels (ESLs) which the agency uses to evaluate the impacts of air contaminants. TACB screening levels are based on occupational exposure limits (American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs), Occupational Health and Safety Administration (OSHA) standards, or National Institute for Occupational Safety and Health (NIOSH) recommendations), odor nuisance potential, vegetation effects, or corrosion effects. Generally, the annual ESL corresponds to 0.1% of the lowest occupational exposure limit.

TABLE 4.2.6-6. PREDICTED ANNUAL AVERAGE AMBIENT AIR CONCENTRATIONS RESULTING FROM ESTIMATED FIRE DEPARTMENT TRAINING AREA 2 EMISSIONS

Contaminant	Predicted Annual Average Ambient Air Concentration (ug/m <sup>3</sup> )						IACB Annual Effects <sup>3</sup> Screening Level (ug/m <sup>3</sup> )
	On-Site Maximum	Off-Site Maximum	Day Care	Fish Hatchery	Dairy Operation	Beef Operation	
Benzene	9.5x10 <sup>-4</sup>	3.9x10 <sup>-5</sup>	5.6x10 <sup>-5</sup>	2.9x10 <sup>-6</sup>	6.4x10 <sup>-7</sup>	2.2x10 <sup>-7</sup>	3
Chloroform	2.1x10 <sup>-6</sup>	8.7x10 <sup>-8</sup>	1.3x10 <sup>-7</sup>	6.0x10 <sup>-9</sup>	1.0x10 <sup>-9</sup>	< 10 <sup>-8</sup>	10
Methylene chloride	4.0x10 <sup>-3</sup>	1.7x10 <sup>-4</sup>	2.4x10 <sup>-4</sup>	1.2x10 <sup>-5</sup>	2.7x10 <sup>-6</sup>	9.5x10 <sup>-7</sup>	26
Tetrachloroethene	5.7x10 <sup>-6</sup>	2.3x10 <sup>-7</sup>	3.4x10 <sup>-7</sup>	1.7x10 <sup>-8</sup>	4.0x10 <sup>-9</sup>	1.0x10 <sup>-9</sup>	33.5
Toluene	1.6x10 <sup>-3</sup>	7.6x10 <sup>-5</sup>	1.1x10 <sup>-4</sup>	5.5x10 <sup>-6</sup>	1.2x10 <sup>-6</sup>	4.3x10 <sup>-7</sup>	375
Trichloroethene	1.1x10 <sup>-4</sup>	4.7x10 <sup>-6</sup>	6.7x10 <sup>-6</sup>	3.4x10 <sup>-7</sup>	7.7x10 <sup>-8</sup>	2.7x10 <sup>-8</sup>	135
Vinyl chloride	1.4x10 <sup>-4</sup>	5.9x10 <sup>-6</sup>	8.4x10 <sup>-6</sup>	4.3x10 <sup>-7</sup>	9.6x10 <sup>-8</sup>	3.3x10 <sup>-8</sup>	10
Antimony	1.1x10 <sup>-6</sup>	4.7x10 <sup>-8</sup>	6.7x10 <sup>-8</sup>	3.4x10 <sup>-9</sup>	7.6x10 <sup>-10</sup>	2.7x10 <sup>-10</sup>	0.5
Arsenic	1.9x10 <sup>-6</sup>	7.9x10 <sup>-8</sup>	1.1x10 <sup>-7</sup>	5.8x10 <sup>-9</sup>	1.3x10 <sup>-9</sup>	4.5x10 <sup>-10</sup>	0.010
Barium	1.5x10 <sup>-6</sup>	6.2x10 <sup>-8</sup>	8.9x10 <sup>-8</sup>	4.6x10 <sup>-9</sup>	1.0x10 <sup>-9</sup>	3.6x10 <sup>-10</sup>	0.5
Beryllium	1.1x10 <sup>-8</sup>	4.7x10 <sup>-10</sup>	6.6x10 <sup>-10</sup>	3.5x10 <sup>-11</sup>	7.9x10 <sup>-12</sup>	2.7x10 <sup>-12</sup>	0.01 (24 hour average)
Cadmium	2.9x10 <sup>-7</sup>	1.2x10 <sup>-9</sup>	1.7x10 <sup>-9</sup>	6.7x10 <sup>-11</sup>	1.9x10 <sup>-11</sup>	6.9x10 <sup>-12</sup>	0.01
Chromium	6.7x10 <sup>-7</sup>	2.6x10 <sup>-8</sup>	4.0x10 <sup>-8</sup>	2.0x10 <sup>-9</sup>	4.5x10 <sup>-10</sup>	1.6x10 <sup>-10</sup>	0.025 (+6 valence)
Lead	5.2x10 <sup>-7</sup>	2.1x10 <sup>-8</sup>	3.1x10 <sup>-8</sup>	1.6x10 <sup>-9</sup>	3.5x10 <sup>-10</sup>	1.2x10 <sup>-10</sup>	1.5 (quarterly average) <sup>a</sup>
Nickel	5.8x10 <sup>-7</sup>	2.4x10 <sup>-8</sup>	3.5x10 <sup>-8</sup>	1.8x10 <sup>-9</sup>	4.0x10 <sup>-10</sup>	1.4x10 <sup>-10</sup>	0.015
Selenium	1.1x10 <sup>-6</sup>	4.7x10 <sup>-8</sup>	6.8x10 <sup>-8</sup>	3.5x10 <sup>-9</sup>	7.6x10 <sup>-10</sup>	2.7x10 <sup>-10</sup>	0.2
Silver	1.9x10 <sup>-8</sup>	7.8x10 <sup>-10</sup>	1.1x10 <sup>-9</sup>	5.8x10 <sup>-11</sup>	1.3x10 <sup>-11</sup>	4.5x10 <sup>-12</sup>	0.01
Bis(2-ethylhexyl) phthalate	2.3x10 <sup>-5</sup>	9.5x10 <sup>-7</sup>	1.4x10 <sup>-6</sup>	6.9x10 <sup>-8</sup>	1.6x10 <sup>-8</sup>	5.4x10 <sup>-9</sup>	5

<sup>a</sup> National Ambient Air Quality Standard.

The maximum predicted annual average concentrations resulting from estimated FDTA 2 emissions for all indicator chemicals are lower than the conservative TACB Effects Screening Levels by orders of magnitude ranging from 3 to 7.

Table 4.2.6-7 shows estimates of average daily inhalation exposure (in mg/kg body weight/day) at the location of the on-site and off-site maximum predicted annual average concentration, and at the proposed on-site day care facility, and compares these values with inhalation Acceptable Daily Intakes (ADIs) for chronic (long-term) exposure. An inhalation ADI is an estimate of the dose of a chemical that can be inhaled daily for a lifetime without producing adverse noncarcinogenic health effects. Section 3.8 discusses the derivation of ADIs used in this assessment.

Average daily inhalation exposures for all indicator chemicals are lower than pollutant-specific ADIs in all cases by more than 4 orders of magnitude.

Ingestion Exposure--Potential ingestion exposures include ingestion of 1) meat and dairy products from animals exposed to contaminants in the ambient air, surface water, soil, or plants, 2) fish exposed to contaminated surface water, 3) plants on which particulates have deposited or which have accumulated contaminants present in the soil; 4) drinking water on which particulates have deposited, and 5) soil on which particulates have deposited.

FDTA 2 contributes very low concentrations of VOCs and particulates to the ambient air. At the sites of the nearest dairy and beef operations, concentrations are predicted on the order of 1/1,000,000  $\mu\text{g}/\text{m}^3$  and lower (see Table 4.2.6-6). Although cows, as humans, will absorb inhaled VOCs and metals, these chemicals do not tend to accumulate in milk or edible tissues which humans might consume. Bis(2-ethylhexyl)phthalate, however, is lipid-soluble and will accumulate in milk and meat products. Cattle are theoretically exposed to bis(2-ethylhexyl)phthalate originating from FDTA 2 in the

TABLE 4.2.6-7. ESTIMATED ANNUAL AVERAGE DAILY INHALATION EXPOSURES FOR CONTAMINANTS ORIGINATING FROM FIRE DEPARTMENT TRAINING AREA 2

Contaminant	On-Site Maximum			Off-Site Maximum			Day Care		
	Inhalation Acceptable Daily Intake <sup>a</sup> (mg/kg/day)	Inhalation Exposure <sup>b</sup> (mg/kg/day)	Safety Factor <sup>c</sup>	Inhalation Exposure <sup>b</sup> (mg/kg/day)	Safety Factor <sup>c</sup>	Inhalation Exposure <sup>b</sup> (mg/kg/day)	Safety Factor <sup>c</sup>	Inhalation Exposure <sup>b</sup> (mg/kg/day)	Safety Factor <sup>c</sup>
Benzene	1.90x10 <sup>-2</sup>	2.77x10 <sup>-7</sup>	6.87x10 <sup>4</sup>	1.13x10 <sup>-6</sup>	1.68x10 <sup>6</sup>	1.61x10 <sup>-6</sup>	1.68x10 <sup>6</sup>	1.01x10 <sup>-6</sup>	1.16x10 <sup>6</sup>
Chloroform	1.00x10 <sup>-2</sup>	6.10x10 <sup>-10</sup>	1.64x10 <sup>7</sup>	2.49x10 <sup>-11</sup>	4.01x10 <sup>8</sup>	3.55x10 <sup>-11</sup>	4.01x10 <sup>8</sup>	3.55x10 <sup>-11</sup>	2.61x10 <sup>8</sup>
Methylene chloride	6.00x10 <sup>-2</sup>	1.16x10 <sup>-6</sup>	5.16x10 <sup>4</sup>	4.76x10 <sup>-8</sup>	1.26x10 <sup>6</sup>	6.78x10 <sup>-8</sup>	1.26x10 <sup>6</sup>	6.78x10 <sup>-8</sup>	8.85x10 <sup>5</sup>
Tetrachloroethene	2.00x10 <sup>-2</sup>	1.63x10 <sup>-9</sup>	1.22x10 <sup>7</sup>	6.69x10 <sup>-11</sup>	2.99x10 <sup>8</sup>	9.52x10 <sup>-11</sup>	2.99x10 <sup>8</sup>	9.52x10 <sup>-11</sup>	2.10x10 <sup>8</sup>
Toluene	1.5	5.28x10 <sup>-7</sup>	2.84x10 <sup>6</sup>	2.16x10 <sup>-8</sup>	6.94x10 <sup>7</sup>	3.09x10 <sup>-8</sup>	6.94x10 <sup>7</sup>	3.09x10 <sup>-8</sup>	4.88x10 <sup>7</sup>
Trichloroethene	2.46x10 <sup>-2</sup>	3.30x10 <sup>-8</sup>	7.45x10 <sup>5</sup>	1.35x10 <sup>-9</sup>	1.82x10 <sup>7</sup>	1.92x10 <sup>-9</sup>	1.82x10 <sup>7</sup>	1.92x10 <sup>-9</sup>	1.28x10 <sup>7</sup>
Vinyl chloride	1.30x10 <sup>-3</sup>	4.09x10 <sup>-8</sup>	3.18x10 <sup>4</sup>	1.67x10 <sup>-9</sup>	7.78x10 <sup>5</sup>	2.38x10 <sup>-9</sup>	7.78x10 <sup>5</sup>	2.38x10 <sup>-9</sup>	5.46x10 <sup>5</sup>
Antimony	4.00x10 <sup>-4</sup>	3.27x10 <sup>-10</sup>	1.22x10 <sup>6</sup>	1.34x10 <sup>-11</sup>	2.99x10 <sup>7</sup>	1.90x10 <sup>-11</sup>	2.99x10 <sup>7</sup>	1.90x10 <sup>-11</sup>	2.10x10 <sup>7</sup>
Arsenic	1.70x10 <sup>-3</sup>	5.53x10 <sup>-10</sup>	3.07x10 <sup>6</sup>	2.26x10 <sup>-11</sup>	7.51x10 <sup>7</sup>	3.22x10 <sup>-11</sup>	7.51x10 <sup>7</sup>	3.22x10 <sup>-11</sup>	5.27x10 <sup>7</sup>
Barium	1.40x10 <sup>-4</sup>	4.37x10 <sup>-10</sup>	3.20x10 <sup>5</sup>	1.79x10 <sup>-11</sup>	7.83x10 <sup>6</sup>	2.55x10 <sup>-11</sup>	7.83x10 <sup>6</sup>	2.55x10 <sup>-11</sup>	5.50x10 <sup>6</sup>
Beryllium	5.00x10 <sup>-4</sup>	3.30x10 <sup>-12</sup>	1.52x10 <sup>8</sup>	1.35x10 <sup>-13</sup>	3.70x10 <sup>9</sup>	1.92x10 <sup>-13</sup>	3.70x10 <sup>9</sup>	1.92x10 <sup>-13</sup>	2.60x10 <sup>9</sup>
Cadmium	2.90x10 <sup>-4</sup>	6.30x10 <sup>-12</sup>	3.50x10 <sup>7</sup>	3.39x10 <sup>-13</sup>	8.54x10 <sup>8</sup>	4.83x10 <sup>-13</sup>	8.54x10 <sup>8</sup>	4.83x10 <sup>-13</sup>	6.00x10 <sup>8</sup>
Chromium	5.00x10 <sup>-3</sup>	1.84x10 <sup>-10</sup>	2.58x10 <sup>7</sup>	7.93x10 <sup>-12</sup>	6.30x10 <sup>8</sup>	1.13x10 <sup>-11</sup>	6.30x10 <sup>8</sup>	1.13x10 <sup>-11</sup>	4.42x10 <sup>8</sup>
Lead	4.30x10 <sup>-4</sup>	1.50x10 <sup>-10</sup>	2.87x10 <sup>7</sup>	6.12x10 <sup>-12</sup>	7.03x10 <sup>7</sup>	8.72x10 <sup>-12</sup>	7.03x10 <sup>7</sup>	8.72x10 <sup>-12</sup>	4.93x10 <sup>7</sup>
Nickel	1.00x10 <sup>-2</sup>	1.72x10 <sup>-10</sup>	5.82x10 <sup>7</sup>	7.03x10 <sup>-12</sup>	1.42x10 <sup>9</sup>	1.00x10 <sup>-11</sup>	1.42x10 <sup>9</sup>	1.00x10 <sup>-11</sup>	9.98x10 <sup>8</sup>
Selenium	1.00x10 <sup>-3</sup>	3.30x10 <sup>-10</sup>	3.03x10 <sup>6</sup>	1.35x10 <sup>-11</sup>	7.41x10 <sup>7</sup>	1.92x10 <sup>-11</sup>	7.41x10 <sup>7</sup>	1.92x10 <sup>-11</sup>	5.20x10 <sup>7</sup>
Silver	3.00x10 <sup>-3</sup>	5.53x10 <sup>-12</sup>	5.42x10 <sup>8</sup>	2.26x10 <sup>-13</sup>	1.33x10 <sup>10</sup>	3.22x10 <sup>-13</sup>	1.33x10 <sup>10</sup>	3.22x10 <sup>-13</sup>	9.31x10 <sup>9</sup>
Bis(2-ethylhexyl) phthalate	2.00x10 <sup>-2</sup>	6.66x10 <sup>-9</sup>	3.00x10 <sup>6</sup>	2.73x10 <sup>-10</sup>	7.34x10 <sup>7</sup>	3.88x10 <sup>-10</sup>	7.34x10 <sup>7</sup>	3.88x10 <sup>-10</sup>	5.15x10 <sup>7</sup>

<sup>a</sup> Estimate of the dose of a chemical that can be inhaled daily for a lifetime without producing adverse noncarcinogenic health effects.  
<sup>b</sup> Inhalation exposure assumes inhalation for 24 hours/day of predicted annual average ambient concentrations by an individual with an average body weight of 70 kg and with an average inhalation rate of 20 m<sup>3</sup>/day.  
<sup>c</sup> Inhalation Acceptable Daily Intake/Inhalation Exposure

ambient air at the closest dairy and beef operations and deposited on soil, plants, and surface water ingested by the cattle.

The most significant fishable resource in the vicinity of Carswell AFB is Lake Worth. The Fort Worth National Fish Hatchery is located at the western end of the lake. The only available pathway for contaminants to move from FDIA 2 to Lake Worth is via fugitive dust generation and deposition on the lake. Fish can then accumulate contaminants present in the water. There is also some theoretical potential for fish in the West Fork of the Trinity River to accumulate contaminants from FDIA 2 in the area downstream of the intersection of Farmers Branch with the river. However, contaminant contributions to the river from FDIA 2 via ground-water migration to Farmers Branch are likely to be very minimal due to the distance between the site and the river (more than 1 mile), dilution, and other factors. As the ground-water contribution to Farmers Branch is unknown and the potential for significant contaminant contributions from FDIA 2 to the river is low, concentrations of contaminants in the river which originate from this site were not quantified.

Particulates can also deposit on crops in the area as well as on fruits and vegetables grown in the backyards of nearby residents. Particulates deposited on the soil can enter edible plant tissue via root uptake as well. Particulates which deposit on Lake Worth theoretically can enter the Fort Worth drinking water supply, which provides drinking water to Carswell AFB and other area residents and businesses. Particulates which deposit on the soil can be directly ingested by humans.

Table 4.2.6-8 shows estimates of average daily ingestion exposures (in mg/kg body weight/day) based on assumptions outlined in Section 3.8 and listed in Table 3.8-8. The estimated ingestion exposures derive entirely from fugitive dusts generated at the site and deposited on the soil, surface water, and plants. Ingestion Acceptable Daily Intakes (ADIs) for chronic (long-term) exposure are also listed. An ingestion ADI is an estimate of the dose of a chemical that can be ingested daily for a lifetime without producing adverse

**TABLE 4.2.6-8. ESTIMATED ANNUAL AVERAGE DAILY INGESTION EXPOSURES FOR CONTAMINANTS ORIGINATING FROM FIRE DEPARTMENT TRAINING AREA 2**

Contaminant	On-Site Maximum			Off-Site Maximum			Dry Care		
	Ingestion Acceptable Daily Intake <sup>a</sup> (mg/kg/day)	Ingestion Exposure (mg/kg/day)	Safety Factor <sup>c</sup>						
Antimony	4.00x10 <sup>-4</sup>	6.73x10 <sup>-9</sup>	5.95x10 <sup>4</sup>	2.81x10 <sup>-10</sup>	1.42x10 <sup>6</sup>	3.97x10 <sup>-10</sup>	1.01x10 <sup>6</sup>	3.97x10 <sup>-10</sup>	1.01x10 <sup>6</sup>
Arsenic	1.70x10 <sup>-3</sup>	3.93x10 <sup>-8</sup>	4.32x10 <sup>5</sup>	2.61x10 <sup>-10</sup>	6.51x10 <sup>6</sup>	3.27x10 <sup>-10</sup>	5.19x10 <sup>6</sup>	3.27x10 <sup>-10</sup>	5.19x10 <sup>6</sup>
Barium	5.10x10 <sup>-2</sup>	8.41x10 <sup>-9</sup>	7.95x10 <sup>6</sup>	2.71x10 <sup>-10</sup>	1.89x10 <sup>6</sup>	3.81x10 <sup>-10</sup>	1.34x10 <sup>6</sup>	3.81x10 <sup>-10</sup>	1.34x10 <sup>6</sup>
Beryllium	5.00x10 <sup>-4</sup>	2.96x10 <sup>-11</sup>	2.43x10 <sup>7</sup>	1.12x10 <sup>-12</sup>	4.49x10 <sup>6</sup>	1.47x10 <sup>-12</sup>	3.41x10 <sup>6</sup>	1.47x10 <sup>-12</sup>	3.41x10 <sup>6</sup>
Cadmium	2.90x10 <sup>-4</sup>	4.49x10 <sup>-10</sup>	6.53x10 <sup>5</sup>	2.08x10 <sup>-11</sup>	1.49x10 <sup>7</sup>	2.84x10 <sup>-11</sup>	1.02x10 <sup>7</sup>	2.84x10 <sup>-11</sup>	1.02x10 <sup>7</sup>
Chromium	5.00x10 <sup>-3</sup>	1.22x10 <sup>-8</sup>	4.10x10 <sup>6</sup>	6.46x10 <sup>-11</sup>	7.75x10 <sup>7</sup>	8.54x10 <sup>-11</sup>	5.86x10 <sup>7</sup>	8.54x10 <sup>-11</sup>	5.86x10 <sup>7</sup>
Lead	1.40x10 <sup>-2</sup>	1.12x10 <sup>-9</sup>	1.25x10 <sup>6</sup>	7.59x10 <sup>-11</sup>	1.85x10 <sup>7</sup>	9.47x10 <sup>-11</sup>	1.48x10 <sup>7</sup>	9.47x10 <sup>-11</sup>	1.48x10 <sup>7</sup>
Nickel	1.00x10 <sup>-2</sup>	1.82x10 <sup>-9</sup>	5.50x10 <sup>6</sup>	1.08x10 <sup>-10</sup>	9.29x10 <sup>7</sup>	1.39x10 <sup>-10</sup>	7.22x10 <sup>7</sup>	1.39x10 <sup>-10</sup>	7.22x10 <sup>7</sup>
Selenium	3.00x10 <sup>-3</sup>	3.53x10 <sup>-8</sup>	8.51x10 <sup>5</sup>	1.69x10 <sup>-10</sup>	1.77x10 <sup>7</sup>	2.30x10 <sup>-10</sup>	1.31x10 <sup>7</sup>	2.30x10 <sup>-10</sup>	1.31x10 <sup>7</sup>
Silver	3.00x10 <sup>-3</sup>	2.63x10 <sup>-10</sup>	1.14x10 <sup>7</sup>	7.53x10 <sup>-11</sup>	3.99x10 <sup>7</sup>	7.87x10 <sup>-11</sup>	3.81x10 <sup>7</sup>	7.87x10 <sup>-11</sup>	3.81x10 <sup>7</sup>
Bis(2-ethylhexyl) phthalate	2.00x10 <sup>-2</sup>	1.57x10 <sup>-7</sup>	1.27x10 <sup>5</sup>	2.99x10 <sup>-8</sup>	6.69x10 <sup>5</sup>	3.22x10 <sup>-8</sup>	6.23x10 <sup>5</sup>	3.22x10 <sup>-8</sup>	6.23x10 <sup>5</sup>

<sup>a</sup> Estimate of the dose of a chemical that can be ingested daily for a lifetime without producing adverse noncarcinogenic health effects.

<sup>b</sup> See Table 3.8-6 in Section 3.6 for key assumptions used to estimate ingestion exposure.

<sup>c</sup> Ingestion Acceptable Daily Intake/Ingestion Exposure.

noncarcinogenic health effects. Section 3.8 discusses the derivation of ADIs used in this assessment.

Average ingestion exposures for all indicator chemicals associated with fugitive dust-generated emissions are lower than pollutant-specific ADIs in all cases by more than 4 orders of magnitude.

Dermal Exposure--Skin contact with contaminants originating from FDTA 2 can occur while swimming in (or otherwise in contact with) contaminated surface water. Lake Worth is the most highly utilized surface water body for swimming and other water contact sports in the area. Since particulates can deposit on the lake there is some potential for human exposure to contaminants originating from FDTA 2 via skin contact with lake water. Due to the size of the lake and very low level of emissions, exposure by this pathway is likely to be minimal. As discussed above, contaminant contributions to the West Fork of the Trinity River from FDTA 2 are theoretically possible as well but likely to be very minimal; therefore, skin contact with lake or river water is not considered a significant exposure pathway for this site. Skin contact with water in Farmers Branch, which is not amenable to swimming or other contact sports other than possibly wading, could contribute to dermal exposure. The exposure potential from this pathway is not quantified, however.

Dermal exposure can also occur by skin contact with particulates in the ambient air. Exposure by this pathway has been quantified and incorporated into the ingestion exposures presented in 4.2.6-8.

#### Carcinogenic Risks

Cancer potency estimates developed by EPA were used in conjunction with total daily contaminant doses to develop estimates of individual cancer risk:

$$\text{individual cancer risk} = \frac{\text{total daily dose}}{(\text{mg/kg/day})} \times \frac{\text{cancer potency}}{(\text{mg/kg/day})^{-1}}$$

Individual cancer risk is the increased probability of getting cancer in one's lifetime.

Total 70 year risk, including potential inhalation, ingestion, and dermal exposures are:

On-site maximum exposed individual	$1.056 \times 10^{-7}$
Off-site maximum exposed individual	$5.882 \times 10^{-9}$
Individual exposed at day care facility	$7.682 \times 10^{-9}$

The risk to the hypothetical maximally exposed on-site individual, which was calculated based on very conservative assumptions of transport, fate, and exposure (see Section 3.8), is one order of magnitude lower than a risk of one in one million, which is generally considered an "acceptable" risk by regulatory agencies. Results of the RRAM calculations for this site are included in Appendix J. Inhalation, ingestion, and dermal exposure risk are discussed individually in the paragraphs that follow.

Inhalation Risk--Of the 18 indicator chemicals estimated to be emitted to the air from FDTA 2, 12 are potential carcinogens if inhaled. These are benzene, chloroform, methylene chloride, tetrachloroethene, trichloroethene, vinyl chloride, arsenic, beryllium, cadmium, chromium, nickel, and bis(2-ethylhexyl)phthalate.

Table 4.2.6-9 shows estimates of individual inhalation cancer risk for the maximum on-site and maximum off-site exposed individual and for an individual inhaling ambient concentrations in the immediate vicinity of the proposed day care facility continuously for a lifetime. The highest of these risks totals 4.6 in 100 million.

TABLE 4.2.6-9. ESTIMATED INDIVIDUAL CANCER RISK ASSOCIATED WITH INHALATION OF POTENTIAL CARCINOGENS ORIGINATING FROM FIRE DEPARTMENT TRAINING AREA 2

Contaminant	Inhalation Potency Slope <sup>a</sup> (mg/kg/day)	Individual Inhalation Cancer Risk <sup>b</sup>		
		On-Site Maximum Exposed Individual	Off-Site Maximum Exposed Individual	Individual Exposed at Day Care Facility
Benzene	2.6x10 <sup>-2</sup>	7.2x10 <sup>-9</sup>	2.9x10 <sup>-10</sup>	4.2x10 <sup>-10</sup>
Chloroform	6.1x10 <sup>-2</sup>	4.9x10 <sup>-11</sup>	2.0x10 <sup>-12</sup>	2.9x10 <sup>-12</sup>
Methylene chloride	1.63x10 <sup>-3</sup>	1.9x10 <sup>-9</sup>	7.6x10 <sup>-11</sup>	1.1x10 <sup>-10</sup>
Tetrachloroethene	1.7x10 <sup>-3</sup>	2.8x10 <sup>-12</sup>	1.1x10 <sup>-13</sup>	1.6x10 <sup>-13</sup>
Trichloroethene	4.6x10 <sup>-3</sup>	1.5x10 <sup>-10</sup>	6.2x10 <sup>-12</sup>	8.6x10 <sup>-12</sup>
Vinyl chloride	2.5x10 <sup>-2</sup>	1.0x10 <sup>-9</sup>	4.2x10 <sup>-11</sup>	6.0x10 <sup>-11</sup>
Arsenic	5.0x10 <sup>+1</sup>	2.8x10 <sup>-9</sup>	1.1x10 <sup>-9</sup>	1.6x10 <sup>-9</sup>
Beryllium	8.4	2.8x10 <sup>-11</sup>	1.1x10 <sup>-12</sup>	1.6x10 <sup>-12</sup>
Cadmium	6.1x10 <sup>+1</sup>	5.1x10 <sup>-11</sup>	2.1x10 <sup>-12</sup>	2.9x10 <sup>-12</sup>
Chromium	4.1x10 <sup>-1</sup>	6.0x10 <sup>-9</sup>	3.3x10 <sup>-10</sup>	4.6x10 <sup>-10</sup>
Nickel	1.19	2.0x10 <sup>-10</sup>	8.4x10 <sup>-12</sup>	1.2x10 <sup>-11</sup>
Bis(2-ethylhexyl) phthalate	6.84x10 <sup>-4</sup>	4.6x10 <sup>-12</sup>	1.8x10 <sup>-13</sup>	2.7x10 <sup>-13</sup>
TOTAL 70 year risk		4.6x10 <sup>-8</sup>	1.9x10 <sup>-9</sup>	2.7x10 <sup>-9</sup>

<sup>a</sup> See Section 3.8 for discussion and documentation.

<sup>b</sup> Risk calculation assumes inhalation for 24 hours/day for a 70 year lifetime of predicted annual average ambient concentrations by an individual with an average body weight of 70 kg and with an average inhalation rate of 20 m<sup>3</sup>/day.

D R A F T

Ingestion Risk--Of the 11 indicator chemicals estimated to be emitted from FDTA 2 as dust-generated particulate emissions, three are potential carcinogens if ingested. These are arsenic, nickel, and bis(2-ethylhexyl)phthalate.

Table 4.2.6-10 shows estimates of individual ingestion cancer risk based on exposures associated with deposition of particulate emissions. The risk calculations assume: 1) residence at the site of the maximum on-site ambient air concentrations, the maximum off-site ambient air concentrations, or in the vicinity of the proposed base day care facility; 2) ingestion of fruits and vegetables from a backyard garden; 3) ingestion of fish from Lake Worth; 4) ingestion of beef and dairy products produced at the closest dairy and beef operations; 5) ingestion of water from Lake Worth; 6) ingestion of some soil at the place of residence; 7) dermal exposure to soil and dusts at the place of residence; and 8) ingestion of mother's milk for one year as an infant from a similiary exposed mother. Refer to Table 3.8-8 in Section 3.8 for other key assumptions used to estimate ingestion exposure. The highest of these risks totals 6.8 in 100 million. Almost all of this risk is associated with ingestion of arsenic.

The potential for ingestion exposure to contaminants originating from FDTA 2 via ground-water migration/surface water transport is theoretically possible but likely to be minimal. Ingestion risks by this pathway were not incorporated into the risk calculations.

Dermal Risk--The potential for dermal exposure to dust generated emissions originating from FDTA 2 was incorporated into the ingestion risk calculations presented in Table 4.2.6-10. The potential for dermal exposure by other pathways is remote. Unless an individual immersed frequently in the waters of Farmers Branch for a long period of time, skin contact exposure can be considered insignificant. The risk of dermal exposure by this pathway was therefore not quantified.

TABLE 4.2.6-10. ESTIMATED INDIVIDUAL CANCER RISK ASSOCIATED WITH INGESTION OF POTENTIAL CARCINOGENS ORIGINATING FROM FIRE DEPARTMENT TRAINING AREA 2

Contaminant	Ingestion Potency Slope <sup>a</sup> (mg/kg/day)	Individual Ingestion Cancer Risk <sup>b</sup>		
		On-Site Maximum Exposed Individual	Off-Site Maximum Exposed Individual	Individual Exposed at Day Care Facility
Arsenic	1.5x10 <sup>+1</sup>	5.9x10 <sup>-6</sup>	4.0x10 <sup>-9</sup>	4.9x10 <sup>-9</sup>
Nickel	1.19	3.0x10 <sup>-10</sup>	5.2x10 <sup>-11</sup>	5.6x10 <sup>-11</sup>
Bis(2-ethylhexyl) phthalate	6.84x10 <sup>-4</sup>	1.1x10 <sup>-10</sup>	2.1x10 <sup>-11</sup>	2.2x10 <sup>-11</sup>
TOTAL 70 year risk		6.0x10 <sup>-6</sup>	4.0x10 <sup>-9</sup>	5.0x10 <sup>-9</sup>

<sup>a</sup> See Section 3.8 for discussion and documentation.

<sup>b</sup> See Table 3.8-8 in Section 3.8 for key assumptions used to estimate ingestion exposure.

Threat to Wildlife

Contaminants originating from FDTA 2 pose some risk to terrestrial wildlife that use Farmers Branch as a source of drinking water as well as aquatic organisms in Farmers Branch. In the past, there have been some instances of fish kills in Farmers Branch. The potential contribution of FDTA 2 to contaminant concentrations in Farmers Branch was not estimated because neither the ground-water inflow to Farmers Branch nor existing contaminant concentrations in Farmers Branch is known. Sampling and analysis of Farmers Branch water at several points in its flow across the base to the West Fork of the Trinity River would provide more useful data with which to evaluate the threat to area wildlife.

Because of the potential for dust-generated emissions, contaminants originating from this site can be transported a greater distance from Carswell AFB and deposited on aquatic and terrestrial habitats. However, because emission rates are so low, the potential risk to wildlife by this pathway can be considered insignificant.

4.3 East Area Investigation

The investigation of the East Area included the analysis of soil obtained from 7 hand-augered holes, 10 surface-sediment samples, 1 soil boring, and soil collected during the drilling of 10 ground water monitor wells. Water samples were collected from four surface water sites and from the monitor wells. Two soil gas surveys were also performed at Sites 17 and BSS in the East Area. The results and significance of data collected are discussed in the following paragraphs.

Topography

The East Area is located on land that gently slopes eastward to the West Fork of the Trinity River and southward to Farmers Branch. Elevations range from 595 feet MSL west of the POL Tank Farm to 560 feet MSL on the flood plain above the Trinity River. No abrupt elevation changes occur within this area except close to the Trinity River and Farmers Branch.

Geology

The results of monitor well installation and soil boring drilling show that the geologic settings of the Flightline Area and the East Area are similar. Locations of monitor wells and soil borings in the East Area are shown in Figure 4.3-1. The major elements of the shallow geologic setting are illustrated in a series of cross-sections (Plate 4). The geology of the East Area consists of a thin veneer of alluvial material (upper zone) overlying the Goodland Limestone. The alluvium consists of clay, sand, and gravel. The Goodland Limestone contains limestone, weathered limestone, and shale. No wells were drilled in the East Area that penetrated through the Goodland/Walnut Formations into the Paluxy Formation.

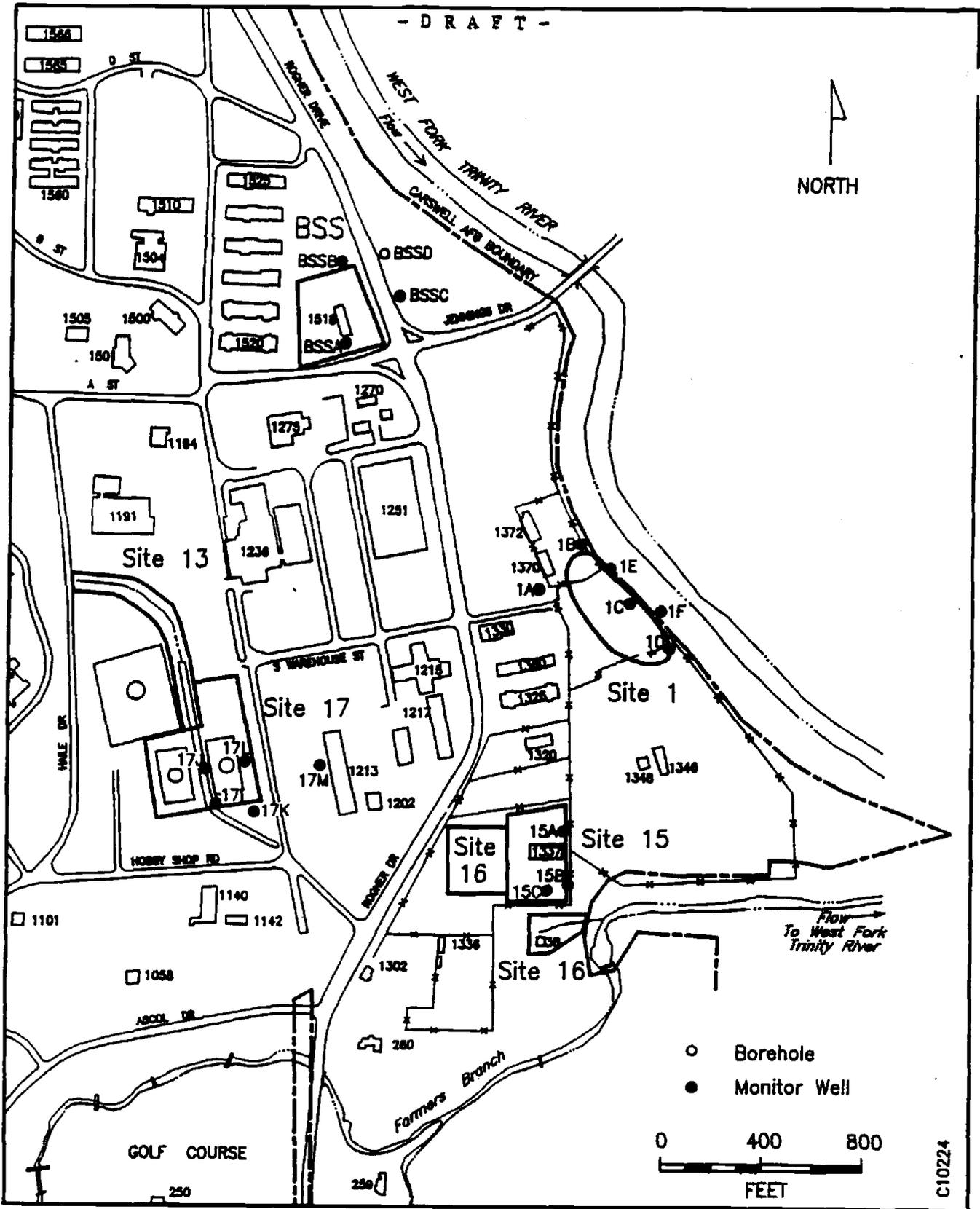


Figure 4.3-1. Monitor Wells and Boreholes at the East Area, Carswell AFB, TX

The upper zone in the East Area generally consists of 5 to 15 feet of gray to black clay overlying 2 to 10 feet of fine-grained sand and up to 5 feet of gravel. The clay is often sandy and occasionally contains pebbles, freshwater gastropod shells, and gravel stringers. Limonite stains occur in some clay beds. Two types of sand occur in the alluvium and are distinguished on the basis of their color. One sand is tan to pink and the other is light gray. Both sands are predominantly fine-grained, though medium-grained sand is a common subsidiary constituent. The gravel ranges from 1/8 inch to over 1 inch in diameter. Sand is a common accessory in gravel layers, and clay is sometimes present.

The continuity of the permeable sand and gravel beds across the East Area is shown on the geologic cross-sections (Plate 4). The east-west dip oriented section H-H' shows that an approximately 5-foot thick sand/gravel layer probably reaches from the POL Tank Farm to close to Farmers Branch. The other dip oriented section, I-I', shows the sand/gravel layer pinching out before it reaches the West Fork of the Trinity River. At Site 1, the strike-oriented section (K-K') does not show any sand and gravel layers near the Trinity River. The other strike oriented section, J-J', shows a continuous sand/gravel layer beneath the POL Tank Farm.

The Goodland Formation in the East Area is usually encountered between 7 and 20 feet, though it is deeper in some wells. In general, the depth to the Goodland decreases as the Trinity River is approached. The exception to this trend is found immediately adjacent to the Trinity, where the depths to the Goodland exceed 20 feet. The Goodland in the East Area occurs as gray, hard limestone and as blue-gray, mottled shale. A contour map of the elevation of the base of the upper zone is shown in Figure 4.3-2. Most of the East Area occurs on a fairly level limestone surface. However, the Goodland dips steeply eastward within 400 feet of the Trinity River. In the southern part of the East Area, the limestone surface also dips southward, at

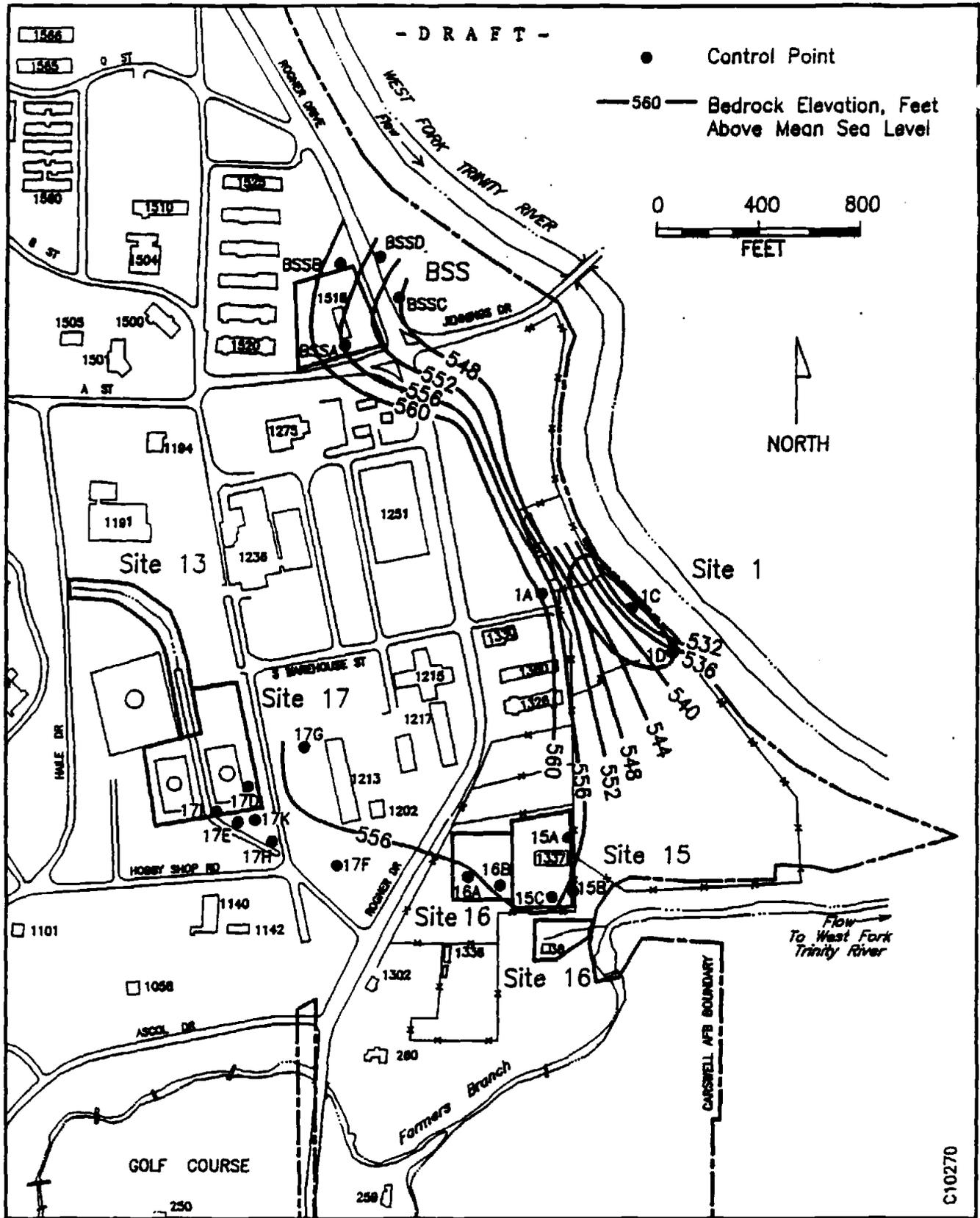


Figure 4.3-2. Contour Map of the Top of Bedrock, East Area, Carswell AFB, Texas



TABLE 4.3-1. RESULTS OF STAGE 2 WATER-LEVEL MEASUREMENTS,  
EAST AREA WELLS, CARSWELL AFB, TEXAS

Monitor Well	Groundwater Elevation <sup>1</sup>	
	Round 1 (23 February-4 March 1988)	Round 2 (5-15 April 1988)
1A	562.16	560.27
1B	541.99	541.34
1C	540.76	540.46
1D	540.81	540.54
1E	540.76	540.42
1F	540.20	539.96
17I	564.96	564.72
17J	564.75	564.45
17K	563.90	563.61
17L	564.55	564.17
17M	563.30	562.86
BSS-A	562.30	560.41
BSS-B	559.28	558.84
BSS-C	548.72	549.02

<sup>1</sup> Elevations in feet (MSL).



TABLE 4.3-2. SUMMARY OF UPPER ZONE HYDRAULIC CONDUCTIVITY VALUES,  
EAST AREA, CARSWELL AFB, TEXAS

Location	Hydraulic Conductivity (cm/sec)
1D	$1.0 \times 10^{-5}$
1F	$1.4 \times 10^{-3}$
17J	$6.1 \times 10^{-4}$
17K	$5.4 \times 10^{-4}$
17L	$1.2 \times 10^{-2}$
17M	$2.5 \times 10^{-4}$





4.3.1 Landfill 1 (Site 1)

Site 1 is located at the DRMO yard. The locations of the upper zone monitor wells installed at Site 1 are shown on Figure 4.3.1-1. The upgradient well, 1A, is located in the southeast corner of the park bordering the DRMO to the west. Well 1A is the most shallow of the Site 1 wells, with the Goodland Limestone only 7 feet below the surface. Wells 1B and 1C are located inside of the DRMO yard. Wells 1E and 1F are located east of the DRMO yard. Wells number 1B, 1E, and 1F were completed without encountering limestone. Well 1C, located in the south yard, was completed upon reaching a shale member of the Goodland Limestone at a depth of 33 feet. Well 1D, located south of the DRMO compound, encountered the Goodland Limestone at 23 feet. Wells 1B and 1C were completed flush to the ground surface, in meter boxes. Wells 1A, 1D, 1E, and 1F were completed above ground.

4.3.1.1 Site Description

Topography

Site 1 is located on a gently sloping terrace immediately west of the West Fork of the Trinity River. Elevations range from approximately 567 feet outside the west boundary of the DRMO compound to approximately 560 feet on the levee above the river.

Geology

The upper zone deposits encountered during drilling at Site 1 are somewhat different than those encountered elsewhere in the East Area. The material beneath Site 1 is finer grained, consisting entirely of fill, clay, and sandy clay. The sand and gravel layers penetrated in the other East Area wells and borings are absent beneath the DRMO. The large amount of fill material (asphalt, concrete, tar, wood chips) encountered in the clay beneath the DRMO indicates that the area has been extensively modified by human activities. This evidence, and considering that sand and gravel layers pinch

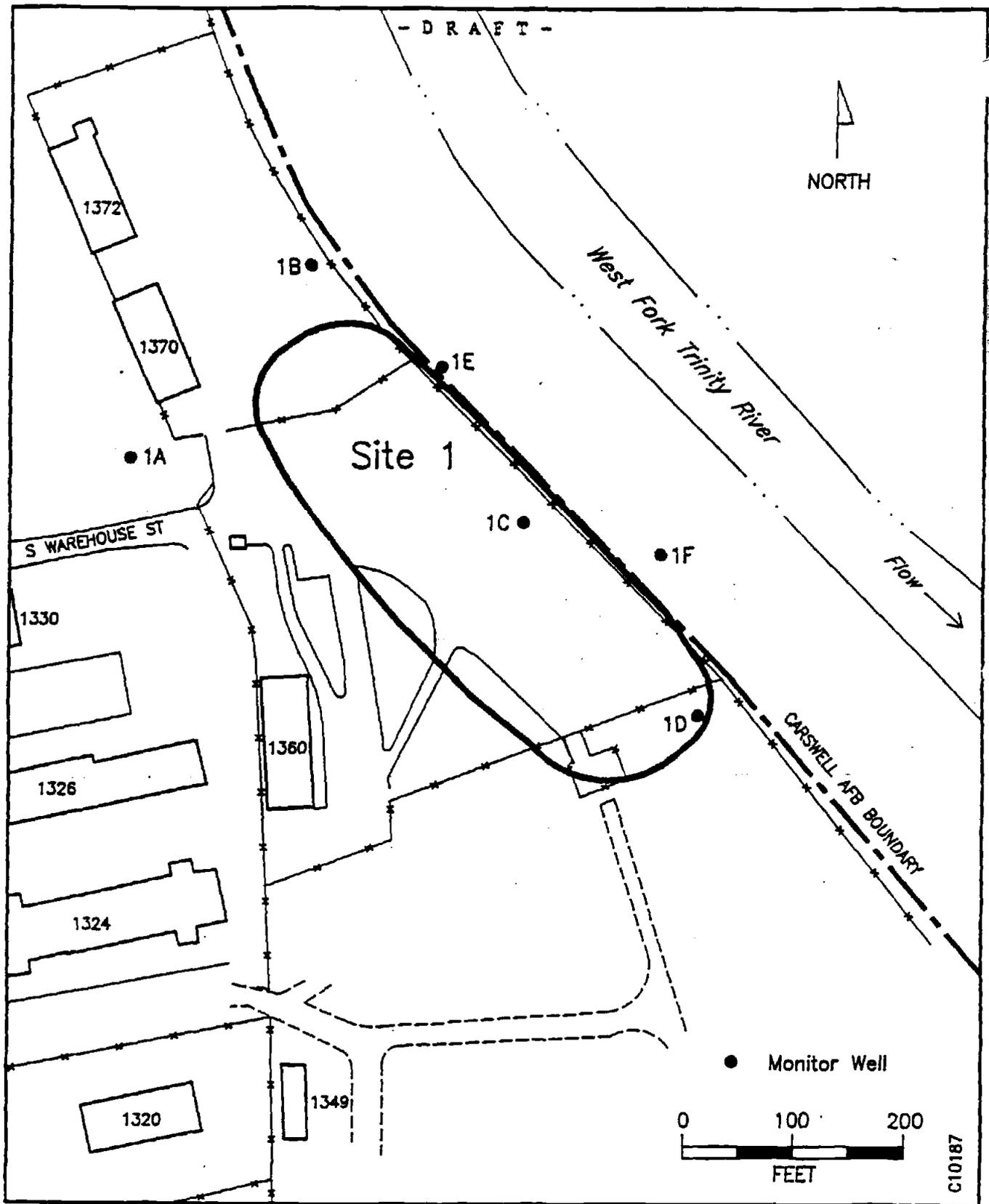


Figure 4.3.1-1. Location of Monitor Wells at Site 1, Carwell, AFB, TX

out from both the dip and strike oriented directions (Plate 4, cross-sections 1-1' and K-K'), suggests that the upper zone materials at the DRMO are the result of construction fill or rechanneling of the Trinity River.

The surface of the Goodland Limestone dips relatively steeply to the east beneath Site 1 (Figure 4.3.1-2), reflecting channel cutting and erosion of the limestone by the West Fork of the Trinity River. The land surface elevation does not dip eastwards as steeply as the limestone; therefore, the lower elevation of the top of the Goodland at wells 1E, and 1F accounts for the relatively greater thicknesses of alluvium at these wells as compared to the other wells in the East Area.

#### Hydrogeology

The depth to water at Site 1 ranges from about 5 feet at the upgradient well, 1A, to a fairly consistent measurement of about 20 feet below land surface at all other locations at Site 1. The elevation of the water table is contoured in Figure 4.3.1-3. The closely spaced contours of the water table in the Landfill 1 area is similar to that of the surface of the Goodland Limestone. This similarity in limestone and water table surfaces is expected because the water in the upper zone is perched on top of the Goodland. Ground-water flow beneath Site 1 is eastward to northeastward, directly to the West Fork of the Trinity River.

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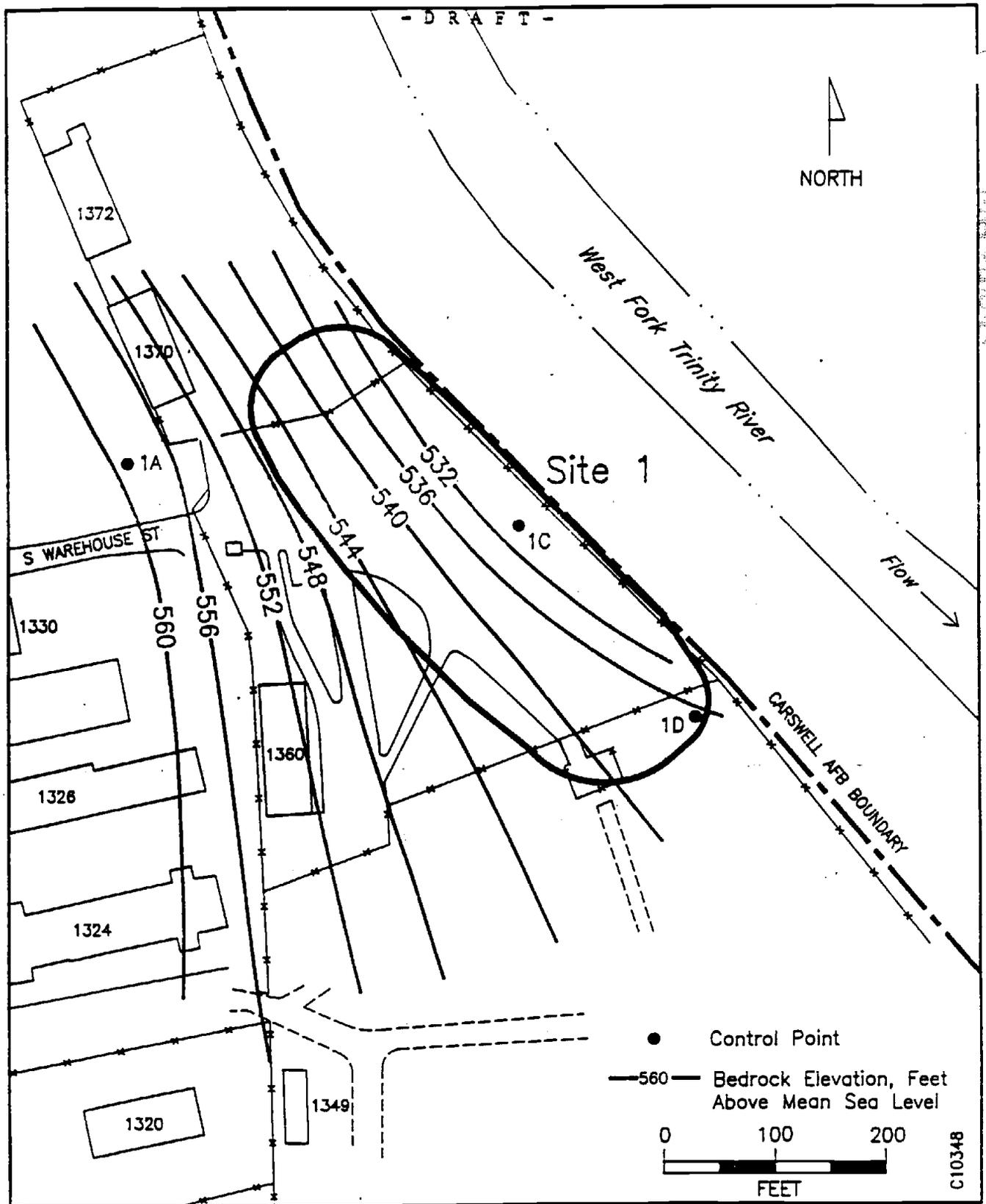


Figure 4.3.1-2. Contour Map of the Top of Bedrock, Site 1 (Landfill 1), Carswell AFB, Texas

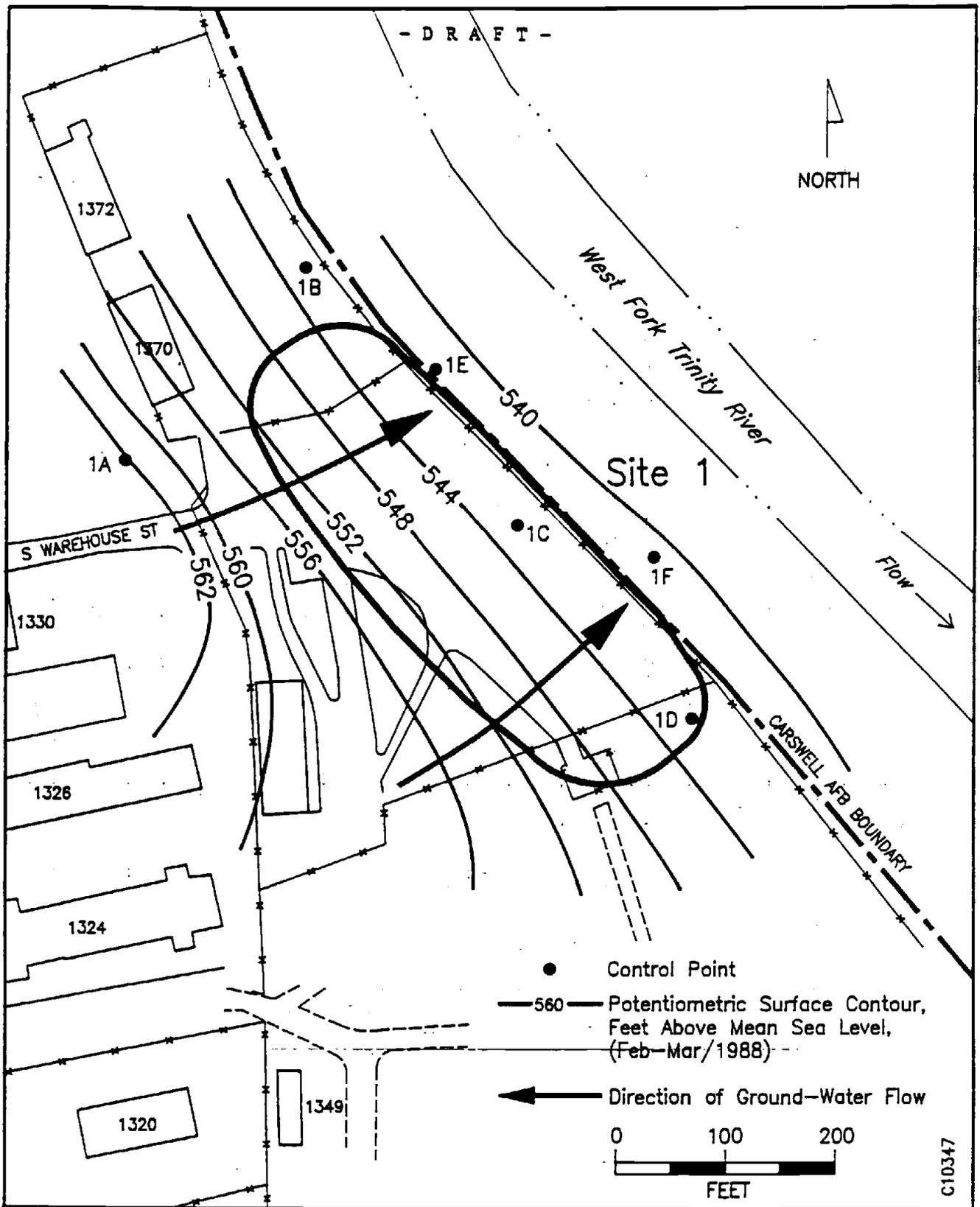


Figure 4.3.1-3. Potentiometric Surface Map of the Upper Zone, Site 1 (Landfill 1), Carswell AFB, Texas

Based on the hydraulic conductivity values calculated from slug test results at Landfill 1 and the hydraulic gradient of approximately 0.09 feet/foot (from Figure 4.3-3), the average ground-water flow velocity at Landfill 1 may be calculated to be approximately 2 feet per day. This velocity represents an average seepage velocity, as opposed to particle velocity that would be considered in contaminant transport evaluations. This estimate is derived from a simplification of Darcy's Law:

$$\bar{v} = \frac{k i}{\phi}$$

where:  $\bar{v}$  - average ground-water flow velocity,  
k - hydraulic conductivity of upper zone deposits,  
(average  $7 \times 10^{-4}$  cm/sec or 2 feet/day)  
i - hydraulic gradient (0.09) in the upper zone; and  
 $\phi$  - estimated porosity of upper zone deposits  
(assume 0.10)

Well 1B did not produce sufficient water to analyze for all of the constituents desired. Water was noted in the sediments of 1B at a depth of 9 feet during drilling, so the screened interval between 10 and 20 feet below surface was believed to intercept the uppermost 10 feet of water. The water levels of other wells downgradient of 1A (1C, 1D, 1E and 1F) suggest that well 1B was completed at too shallow a depth to encounter the main body of water in the upper zone, accounting for the almost dry nature of the well.

Though well 1D contained sufficient water for all required sampling, the time of water-level recovery in well 1D was markedly longer than the recovery time for well 1C. The difference in recovery time is best explained by the sandier nature of the clay encountered in well 1C as compared to 1D. Though both wells are completed in clay layers, the permeability of the clay at well 1C appears to be substantially higher than that of the clay around well 1D.

4.3.1.2 Chemical Analytical Results

Soil Chemistry

Soil samples resulting from the drilling of wells 1E and 1F were analyzed for moisture content, heavy metals, oil and grease, volatile organic compounds, and semivolatile organic compounds. Results of soil analyses are provided in Tables 4.3.1-1 (inorganic parameters) and 4.3.1-2 (organic parameters).

Heavy Metals--Since there are no generally accepted standards or regulations governing heavy metal content in soils the metals concentrations were compared with mean values of metals concentrations in U.S. soils (Table 4.1-3). Concentrations above normal ranges include arsenic (both wells), cadmium (both wells), and silver (well 1E).

Oil and Grease--Oil and grease were not detected in soil samples from 1E and 1F.

Volatile Organic Compounds--Toluene was detected in soil samples taken at 1E and 1F.

Semivolatile Organic Compounds--Di-n-butylphthalate was confirmed in soil samples at locations 1E and 1F, with a maximum concentration of 0.38 mg/kg at 1F.

Water Quality

Samples of ground water were collected and analyzed from the six Site 1 wells in February and April 1988. Ground-water samples were analyzed for water quality indicators, heavy metals, oil and grease, purgeable halocarbons, purgeable aromatics, and extractable priority pollutants. When sufficient water was not encountered at well 1B, only those tests deemed most appropriate were performed. The results of these tests are presented in

174-3000

174-3000

TABLE 4.3.1-1 RESULTS OF INORGANIC ANALYSES FOR SOIL SAMPLES, SITE 1 (LANDFILL 1), CARSWELL AFB, TEXAS.

Primary Results

Monitor Well

Sample ID

Date Sampled

Beg. Depth - End Depth

1E

1F

1F-4

1F-6

1E

1F

1F-6

14-Feb-88

14-Feb-88

(20 - 25)

(10 - 15)

(20 - 25)

PARAMETER

Soil Moisture & MOISTURE

Dry Weight Determination

	9.0	13.0	9.0	11.0
Metals MG/KG				
Arsenic, graphite AA	6.9	5.1R	3.9	7.6
Mercury	ND	ND	ND	ND
Selenium, graphite AA	ND	ND	ND	ND
Metal Screen (ICP) MG/KG				
Ag Silver	1.8	ND	ND	ND
Al Aluminum	5800.0	4800.0	5100.0	5900.0
As Arsenic	60.0	ND	ND	30.0
B Boron	ND	ND	ND	ND
Ba Barium	54.0	39.0	36.0	55.0
Be Beryllium	0.5	0.3	0.3	0.4
Ca Calcium	29000.0	35000.0	32000.0	30000.0
Cd Cadmium	0.4	ND	ND	0.5
Co Cobalt	2.4	1.9	1.4	2.8
Cr Chromium	9.2	8.4	7.8	9.1
Cu Copper	4.7	3.4	3.0	5.6
Fe Iron	11000.0	7000.0	5800.0	9200.0
K Potassium	710.0	640.0	700.0	830.0
Mg Magnesium	1000.0	910.0	1100.0	1100.0
Mn Manganese	170.0	140.0	110.0	140.0
Mo Molybdenum	ND	ND	ND	ND
Na Sodium	46.0	75.0	83.0	97.0
Ni Nickel	8.0	5.0	5.0	7.0

R: Indicates that the matrix spike recovery for this analysis was not within acceptance limits indicating an interferent present.

ND: Not detected at specified detection limit

( ): Detection limit

TABLE 4.3.1-1 RESULTS OF INORGANIC ANALYSES FOR SOIL SAMPLES, SITE 1 (LANDFILL 1), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	Monitor Well					
	1E		1F		1F-6	
	Sample ID	Date Sampled	Sample ID	Date Sampled	Sample ID	Date Sampled
	1E-4	14-Feb-88	1F-4	14-Feb-88	1F-6	14-Feb-88
	(10 - 15)	(20 - 25)	(10 - 15)	(20 - 25)	(20 - 25)	(20 - 25)
Pb	11.0	(4.9)	ND	(4.9)	5.0	(4.9)
Sb	ND	(5.8)	ND	(5.9)	ND	(5.8)
Se	ND	(29.0)	ND	(29.0)	ND	(29.0)
Si	340.0	(29.0)	400.0	(29.0)	380.0	(29.0)
Tl	ND	(8.7)	ND	(8.8)	ND	(8.7)
V	18.0	(1.9)	18.0	(2.0)	12.0	(1.9)
Zn	14.0	(0.58)	13.0	(0.59)	10.0	(0.58)

D R A F T -

R: Indicates that the matrix spike recovery for this analysis was not within acceptance limits indicating an interferent present.  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

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TABLE 4.3.1-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 1 (LANDFILL 1), CARSWELL AFB, TEXAS.

Primary Results	Monitor Well					
	Sample ID					
	Date Sampled					
PARAMETER	1E	1E-4	1E	1E-4	1F	1F-6
	14-Feb-88	14-Feb-88	14-Feb-88	14-Feb-88	14-Feb-88	14-Feb-88
	10 - 15	20 - 25	10 - 15	20 - 25	10 - 15	20 - 25
	Beg. Depth	End Depth	Beg. Depth	End Depth	Beg. Depth	End Depth
Oil & Grease MG/KG	ND	(5.0)	ND	(5.0)	ND	(5.0)
Oil and grease, infrared						
Volatile Organic Compounds MG/KG						
1,1,1-trichloroethane	ND	(0.0042)	ND	(0.0043)	ND	(0.0042)
1,1,2,2-tetrachloroethane	ND	(0.0077)	ND	(0.0079)	ND	(0.0077)
1,1,2-trichloroethane	ND	(0.0036)	ND	(0.0057)	ND	(0.0056)
1,2-dichloroethane	ND	(0.0031)	ND	(0.0032)	ND	(0.0031)
1,2-dichloropropane	ND	(0.0067)	ND	(0.0068)	ND	(0.0067)
2-butanone	ND	(0.028)	ND	(0.029)	ND	(0.028)
2-chloroethylvinyl ether	ND	(0.0056)	ND	(0.0057)	ND	(0.0056)
2-hexanone	ND	(0.040)	ND	(0.041)	ND	(0.040)
4-methyl-2-pentanone	ND	(0.051)	ND	(0.052)	ND	(0.051)
Benzene	ND	(0.0049)	ND	(0.0050)	ND	(0.0049)
Ethylbenzene	ND	(0.0080)	ND	(0.0082)	ND	(0.0080)
Toluene	0.0016J	(0.0067)	0.0024J	(0.0068)	0.0039J	(0.0067)
Trichloroethene	ND	(0.0021)	ND	(0.0022)	ND	(0.0021)
acetone	0.0094B	(0.0083)	0.0051BJ	(0.0086)	0.0099B	(0.0083)
bromodichloromethane	ND	(0.0024)	ND	(0.0025)	ND	(0.0024)
bromoform	ND	(0.0052)	ND	(0.0054)	ND	(0.0052)
bromomethane	ND	(0.0056)	ND	(0.0057)	ND	(0.0056)
carbon disulfide	ND	(0.0019)	ND	(0.0019)	ND	(0.0019)
carbon tetrachloride	ND	(0.0031)	ND	(0.0032)	ND	(0.0031)
chlorobenzene	ND	(0.0067)	ND	(0.0068)	ND	(0.0067)
chloroethane	ND	(0.0056)	ND	(0.0057)	ND	(0.0056)

B: Detected in Reagent Blank; background subtraction not performed  
 BJ: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

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TABLE 4.3.1-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 1 (LANDFILL 1), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well			
	Sample ID			
	Date Sampled			
	Beg. Depth	End Depth	1E	1F
			1E-6	1F-6
			14-Feb-88	14-Feb-88
			20 - 25	20 - 25
chloroform	ND (0.0018)	ND (0.0018)	ND (0.0018)	ND (0.0018)
chloromethane	ND (0.0056)	ND (0.0057)	ND (0.0056)	ND (0.0056)
cis-1,3-Dichloropropene	ND (0.0056)	ND (0.0057)	ND (0.0056)	ND (0.0056)
dibromochloromethane	ND (0.0034)	ND (0.0035)	ND (0.0034)	ND (0.0034)
methylene chloride	0.00268J	0.00268J	0.00188J	ND (0.0031)
styrene	ND (0.0033)	ND (0.0034)	ND (0.0033)	ND (0.0033)
tetrachloroethene	ND (0.0046)	ND (0.0047)	ND (0.0046)	ND (0.0046)
total xylenes	ND (0.0051)	ND (0.0052)	ND (0.0051)	ND (0.0051)
trans-1,2-Dichloroethene	ND (0.0018)	ND (0.0018)	ND (0.0018)	ND (0.0018)
trans-1,3-Dichloropropene	ND (0.0056)	ND (0.0057)	ND (0.0056)	ND (0.0056)
trichlorofluoromethane	ND (0.0056)	ND (0.0057)	ND (0.0056)	ND (0.0056)
vinyl acetate	ND (0.0077)	ND (0.0079)	ND (0.0077)	ND (0.0077)
vinyl chloride	ND (0.0056)	ND (0.0057)	ND (0.0056)	ND (0.0056)
Semivolatile Organic Compounds MC/KG				
1,2,4-trichlorobenzene	ND (0.14)	ND (0.15)	ND (0.14)	ND (0.14)
1,2-dichlorobenzene	ND (0.14)	ND (0.15)	ND (0.14)	ND (0.14)
1,3-dichlorobenzene	ND (0.14)	ND (0.15)	ND (0.14)	ND (0.14)
1,4-dichlorobenzene	ND (0.32)	ND (0.34)	ND (0.32)	ND (0.33)
2,4,5-trichlorophenol	ND (0.73)	ND (0.77)	ND (0.73)	ND (0.75)
2,4,6-trichlorophenol	ND (0.20)	ND (0.21)	ND (0.20)	ND (0.20)
2,4-dichlorophenol	ND (0.20)	ND (0.21)	ND (0.20)	ND (0.20)
2,4-dimethylphenol	ND (0.20)	ND (0.21)	ND (0.20)	ND (0.20)
2,4-dinitrophenol	ND (3.1)	ND (3.2)	ND (3.1)	ND (3.2)
2,4-dinitrotoluene	ND (0.41)	ND (0.44)	ND (0.41)	ND (0.43)

B: Detected in Reagent Blank; background subtraction not performed  
 BJ: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

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TABLE 4.3 1-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 1 (LANDFILL 1), CARSWELL AFB, TEXAS.

Primary Results	Monitor Well					
	Sample ID					
	Date Sampled					
PARAMETER	1E 1E-4 14-Feb-88 10 - 15	1E 1E-6 14-Feb-88 20 - 25	1F 1F-4 14-Feb-88 10 - 15	1F 1F-6 14-Feb-88 20 - 25		
2,6-dinitrotoluene	ND (0.14)	ND (0.15)	ND (0.14)	ND (0.14)	ND	(0.14)
2-chloronaphthalene	ND (0.14)	ND (0.15)	ND (0.14)	ND (0.14)	ND	(0.14)
2-chlorophenol	ND (0.24)	ND (0.25)	ND (0.24)	ND (0.24)	ND	(0.25)
2-methylnaphthalene	ND (0.73)	ND (0.77)	ND (0.73)	ND (0.73)	ND	(0.75)
2-methylphenol	ND (0.73)	ND (0.77)	ND (0.73)	ND (0.73)	ND	(0.75)
2-nitroaniline	ND (3.6)	ND (3.9)	ND (3.7)	ND (3.7)	ND	(3.8)
2-nitrophenol	ND (0.26)	ND (0.28)	ND (0.26)	ND (0.26)	ND	(0.27)
3,3'-dichlorobenzidine	ND (1.2)	ND (1.3)	ND (1.2)	ND (1.2)	ND	(1.2)
3-nitroaniline	ND (3.6)	ND (3.9)	ND (3.7)	ND (3.7)	ND	(3.8)
4,6-dinitro-2-methylphenol	ND (1.7)	ND (1.8)	ND (1.8)	ND (1.8)	ND	(1.8)
4-bromophenyl-phenylether	ND (0.14)	ND (0.15)	ND (0.14)	ND (0.14)	ND	(0.14)
4-chloro-3-methylphenol	ND (0.22)	ND (0.23)	ND (0.22)	ND (0.22)	ND	(0.23)
4-chloroaniline	ND (0.73)	ND (0.77)	ND (0.73)	ND (0.73)	ND	(0.75)
4-chlorophenyl-phenylether	ND (0.31)	ND (0.32)	ND (0.31)	ND (0.31)	ND	(0.32)
4-methylphenol	ND (0.73)	ND (0.77)	ND (0.73)	ND (0.73)	ND	(0.75)
4-nitroaniline	ND (3.6)	ND (3.9)	ND (3.7)	ND (3.7)	ND	(3.8)
4-nitrophenol	ND (0.17)	ND (0.18)	ND (0.18)	ND (0.18)	ND	(0.18)
acenaphthene	ND (0.14)	ND (0.15)	ND (0.14)	ND (0.14)	ND	(0.14)
acenaphthylene	ND (0.25)	ND (0.27)	ND (0.26)	ND (0.26)	ND	(0.26)
aniline	ND (0.73)	ND (0.77)	ND (0.73)	ND (0.73)	ND	(0.75)
anthracene	ND (0.14)	ND (0.15)	ND (0.14)	ND (0.14)	ND	(0.14)
benzidine	ND (3.2)	ND (3.4)	ND (3.2)	ND (3.2)	ND	(3.3)
benzo(a)anthracene	ND (0.57)	ND (0.60)	ND (0.57)	ND (0.57)	ND	(0.59)
benzo(a)pyrene	ND (0.18)	ND (0.19)	ND (0.18)	ND (0.18)	ND	(0.19)
benzo(b)fluoranthene	ND (0.35)	ND (0.37)	ND (0.35)	ND (0.35)	ND	(0.36)

B: Detected in Reagent Blank; background subtraction not performed  
 BJ: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

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TABLE 4.3.1-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 1 (LANDFILL 1), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	Monitor Well					
	Sample ID					
	Date Sampled					
	1E		1F		1F-6	
1E-4	1E-6	1F-4	1F-6	1F-6	1F-6	
14-Feb-88		14-Feb-88		14-Feb-88		
10 - 15		20 - 25		10 - 15		
Beg. Depth - End Depth		Beg. Depth - End Depth		Beg. Depth - End Depth		
benzo(k)fluoranthene	ND (0.18)	ND (0.19)	ND (0.18)	ND (0.19)	ND (0.19)	
benzoic acid	ND (3.6)	ND (3.9)	ND (3.7)	ND (3.7)	ND (3.8)	
benzyl alcohol	ND (3.6)	ND (3.9)	ND (3.7)	ND (3.7)	ND (3.8)	
bis(2-chloroethoxy)methane	ND (0.39)	ND (0.41)	ND (0.39)	ND (0.39)	ND (0.40)	
bis(2-chloroethyl) ether	ND (0.41)	ND (0.44)	ND (0.42)	ND (0.42)	ND (0.43)	
bis(2-chloroisopropyl) ether	ND (0.41)	ND (0.44)	ND (0.42)	ND (0.42)	ND (0.43)	
bis(2-ethylhexyl) phthalate	0.27B (0.18)	0.21B (0.19)	0.26B (0.18)	0.23B (0.19)	0.23B (0.19)	
butylbenzylphthalate	ND (0.18)	ND (0.19)	ND (0.18)	ND (0.18)	ND (0.18)	
chrysene	ND (0.18)	ND (0.19)	ND (0.18)	ND (0.18)	ND (0.18)	
di-n-butylphthalate	ND (0.18)	ND (0.19)	ND (0.18)	ND (0.18)	ND (0.18)	
di-n-octyl phthalate	ND (0.18)	ND (0.19)	ND (0.18)	ND (0.18)	ND (0.18)	
dibenzo(a,h)anthracene	0.34 (0.18)	ND (0.19)	0.27 (0.18)	0.38 (0.18)	0.38 (0.18)	
dibenzofuran	ND (0.18)	ND (0.19)	ND (0.18)	ND (0.18)	ND (0.18)	
diethylphthalate	ND (0.73)	ND (0.77)	ND (0.73)	ND (0.73)	ND (0.73)	
dimethyl phthalate	ND (0.14)	ND (0.15)	ND (0.14)	ND (0.14)	ND (0.14)	
fluoranthene	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	
fluorene	ND (0.16)	ND (0.17)	ND (0.16)	ND (0.16)	ND (0.17)	
hexachlorobenzene	ND (0.14)	ND (0.15)	ND (0.14)	ND (0.14)	ND (0.14)	
hexachlorobutadiene	ND (0.14)	ND (0.15)	ND (0.14)	ND (0.14)	ND (0.14)	
hexachlorocyclopentadiene	ND (0.066)	ND (0.069)	ND (0.066)	ND (0.066)	ND (0.068)	
hexachloroethane	ND (0.44)	ND (0.46)	ND (0.44)	ND (0.44)	ND (0.45)	
Indeno(1,2,3-cd)pyrene	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)	
isophorone	ND (0.27)	ND (0.28)	ND (0.27)	ND (0.27)	ND (0.28)	
n-nitroso-di-n-propylamine	ND (0.16)	ND (0.17)	ND (0.16)	ND (0.16)	ND (0.17)	
n-nitrosodimethylamine	ND (0.87)	ND (0.92)	ND (0.88)	ND (0.88)	ND (0.90)	
	ND (0.73)	ND (0.77)	ND (0.73)	ND (0.73)	ND (0.75)	

B: Detected in Reagent Blank; background subtraction not performed  
 BJ: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

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TABLE 4.3.1-2 RESULTS OF ORGANIC ANALYSES FOR SOIL SAMPLES, SITE 1 (LANDFILL 1), CARSWELL AFB, TEXAS.

PARAMETER	Monitor Well			
	Sample ID			
	Date Sampled			
	1E	1F	1F-6	1F-6
	1E-4	1F-4	14-Feb-88	14-Feb-88
	10 - 15	10 - 15	20 - 25	20 - 25
n-nitrosodiphenylamine	ND (0.14)	ND (0.15)	ND (0.14)	ND (0.14)
naphthalene	ND (0.12)	ND (0.12)	ND (0.12)	ND (0.12)
nitrobenzene	ND (0.14)	ND (0.15)	ND (0.14)	ND (0.14)
pentachlorophenol	ND (0.26)	ND (0.28)	ND (0.26)	ND (0.27)
phenanthrene	ND (0.39)	ND (0.42)	ND (0.40)	ND (0.41)
phenol	ND (0.11)	ND (0.12)	ND (0.11)	ND (0.11)
pyrene	ND (0.14)	ND (0.15)	ND (0.14)	ND (0.14)

B: Detected in Reagent Blank; background subtraction not performed  
 BJ: Analyte detected in blank. Estimated value below detection limit.  
 J: Estimated value (GC test codes)  
 ND: Not detected at specified detection limit  
 ( ): Detection limit

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Tables 4.3.1-3 (inorganic parameters) and 4.3.1-4 (organic parameters), and are summarized in the following paragraphs. Field chemistry results are provided in Table 4.3.1-5.

Water Quality Indicators--Total dissolved solids (TDS) concentrations for most samples were in the vicinity of the 500 mg/L MCLG level, with the exception of Round 1 results for wells 1D (1,100 mg/L) and 1E (1,300 mg/L). However, TDS results from both of these wells were less than 1,000 mg/L in the second round. Sulfate concentrations greater than the recommended standard were noted at well 1D for Round 1 (460 mg/L) and Round 2 (360 mg/L). There did not appear to be any trend in the water quality indicators between the two sampling events. Water quality indicators were not evaluated at well 1B because of insufficient water at the time of sampling.

Heavy Metals--Several heavy metals detected in the ground water at Site 1 exceeded MCL levels. MCLs were exceeded for arsenic (1E and 1F), barium (1E and 1F), cadmium (1E and 1F), chromium (1C, 1D, 1E, and 1F), lead (1E and 1F), and selenium (1E and 1F). MCLGs were surpassed by iron and manganese at all Site 1 wells. Other MCLGs exceeded were lead at well 1C and cadmium at wells 1C and 1E. There was insufficient ground water to test for metals concentrations at well 1B.

Trends in heavy metal concentrations at Site 1 are apparent on a well-by-well comparison. Wells 1A, 1E, and 1F show a marked decline in metals concentrations between the two sampling rounds. However, metals concentrations in well 1D appeared to remain fairly stable from the first to the second sampling round. Conversely, well 1C shows an almost uniform increase in concentrations for all metals. The upgradient well, 1A, had the fewest number of metals detected while the furthest downgradient wells, 1E and 1F, had the most metals detected above MCLs.

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11/10/00

TABLE 4.3.1-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 1 (LANDFILL 1), CARSHILL AFB, TEXAS.

Primary Results

PARAMETER	EPA Standards		Criteria		Monitor Well	
	1A 02-159 26-Feb-88	1A 04-12 07-Apr-88	1A 02-159 26-Feb-88	1A 04-12 07-Apr-88	1B 02-158 26-Feb-88	1B 04-15 07-Apr-88
Total Dissolved Solids MG/L		500.0 (1.0)		460.0 (1.0)		
Fluoride MG/L						
Fluoride	4.0(M)	2.0(G)	0.27	0.28		
Chloride MG/L						
Chloride	250.0(G)		25.0	22.0		
Nitrate MG/L						
Nitrate + Nitrite	10.0(M)		ND	(0.040)		
Nitrate, colorimetric						
Orthophosphate MG/L						
Orthophosphate			ND	(0.020)	0.020	(0.020)
Sulfate MG/L						
Sulfate, nephelometry	250.0(G)		26.0		29.0	
Metals MG/L						
Arsenic, graphite AA	0.050(M)		0.018		0.0050	
Mercury	0.0020(M)		ND	(0.00012)	ND	(0.00012)
Lead, graphite AA	0.050(M)		0.017		0.0080	
Selenium, graphite AA	0.010(M)		ND	(0.0030)	ND	(0.0030)
Metals (ICP) MG/L						
Ag			ND	(0.0090)	ND	(0.0090)
Silver						

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), C-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

R+: Matrix spike recovery and % difference (MS and MS dup) outside control limits.

ND: Not detected at specified detection limit

( ): Detection limit

- D R A F T -

0000 # 444

TABLE 4.3.1-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 1 (LANDFILL 1), CARSWELL AFB, TEXAS.

Primary Results

PARAMETER	EPA Standards,		Criteria		1A		1A		1B		1B	
	02-159	26-Feb-88	07-Apr-88	26-Feb-88	04-12	07-Apr-88	02-158	26-Feb-88	04-15	07-Apr-88		
Al	10.0	(0.20)	4.3	(0.20)	ND	(0.30)	ND	(0.30)	ND	(0.30)	ND	(0.30)
As	0.050(M)	(0.30)	ND	(0.30)	ND	(0.60)	ND	(0.60)	ND	(0.60)	ND	(0.60)
B												
Ba	1.0(M)	(0.0090)	0.22	(0.0090)	ND	(0.0010)	ND	(0.0010)	ND	(0.0010)	ND	(0.0010)
Be												
Ca	300.0	(0.060)	170.0	(0.060)	ND	(0.0030)	ND	(0.0030)	ND	(0.0030)	ND	(0.0030)
Cd	0.015	(0.010)	ND	(0.010)	ND	(0.010)	ND	(0.010)	ND	(0.010)	ND	(0.010)
Co												
Cr	0.050(M)	(0.0090)	0.013	(0.0090)	ND	(0.010)	ND	(0.010)	ND	(0.010)	ND	(0.010)
Cu	1.0(G)	(0.010)	ND	(0.010)	ND	(0.030)	ND	(0.030)	ND	(0.030)	ND	(0.030)
Fe	0.30(G)	(0.30)	2.2	(0.30)	1.5	(0.10)	1.5	(0.10)	4.4	(0.10)	4.4	(0.10)
K												
Mg												
Mn												
Mo	0.050(G)	(0.0030)	0.85	(0.0030)	ND	(0.050)	ND	(0.050)	ND	(0.050)	ND	(0.050)
Ni												
Pb	0.050(M)	(0.020)	17.0	(0.020)	ND	(0.080)	16.0	(0.080)	ND	(0.020)	ND	(0.020)
Sb												
Se												
Si	0.010(M)	(0.060)	0.14	(0.060)	ND	(0.30)	ND	(0.30)	ND	(0.30)	ND	(0.30)
Sn												
Tl												
V												
Zn	5.0(G)	(0.0060)	0.031	(0.0060)	25.0	(0.30)	12.0	(0.30)	ND	(0.090)	ND	(0.090)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

Rt: Matrix spike recovery and X difference (MS and MS dup) outside control limits.

ND: Not detected at specified detection limit

( ): Detection Limit

- D R A F T -

04-15



TABLE 4.3.1-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 1 (LANDFILL 1), CARSWELL AFB, TEXAS.

PARAMETER	Primary Results				Monitor Well				
	EPA Standards,		Criteria		Sample ID		Date Sampled		ID
	1C	1C	1C	1C	1C	1C	1C	1C	
Ag Silver	ND	(0.0090)	ND	(0.0090)	ND	(0.0090)	ND	(0.0090)	ND (0.0090)
Al Aluminum	22.0	(0.20)	44.0	(0.20)	9.7	(0.20)	14.0R	(0.20)	14.0R (0.20)
As Arsenic	ND	(0.30)	ND	(0.30)	ND	(0.30)	ND	(0.30)	NDR (0.30)
B Boron	ND	(0.60)	ND	(0.60)	ND	(0.60)	ND	(0.60)	ND (0.60)
Ba Barium	0.26	(0.0090)	0.38	(0.0090)	0.11	(0.0090)	0.10	(0.0090)	0.10 (0.0090)
Be Beryllium	ND	(0.0010)	0.0020	(0.0010)	ND	(0.0010)	ND	(0.0010)	ND (0.0010)
Ca Calcium	340.0	(0.060)	520.0	(0.060)	620.0	(0.060)	650.0B	(0.060)	650.0B (0.060)
Cd Cadmium	0.0060	(0.0030)	ND	(0.0030)	0.0040	(0.0030)	ND	(0.0030)	ND (0.0030)
Co Cobalt	ND	(0.010)	ND	(0.010)	ND	(0.010)	ND	(0.010)	ND (0.010)
Cr Chromium	0.049	(0.0090)	0.075	(0.0090)	0.051	(0.0090)	0.049	(0.0090)	0.049 (0.0090)
Cu Copper	0.019	(0.010)	0.010	(0.010)	ND	(0.010)	ND	(0.010)	ND (0.010)
Fe Iron	36.0	(0.030)	61.0	(0.030)	16.0	(0.030)	16.0	(0.030)	16.0 (0.030)
K Potassium	5.9	(0.30)	9.1	(0.30)	3.9	(0.30)	4.0	(0.30)	4.0 (0.30)
Mg Magnesium	11.0	(0.10)	16.0	(0.10)	21.0	(0.10)	19.0	(0.10)	19.0 (0.10)
Mn Manganese	0.65	(0.0030)	0.94	(0.0030)	0.76	(0.0030)	0.82	(0.0030)	0.82 (0.0030)
Mo Molybdenum	ND	(0.050)	ND	(0.050)	ND	(0.050)	ND	(0.050)	ND (0.050)
Na Sodium	25.0	(0.080)	28.0	(0.080)	17.0	(0.080)	14.0	(0.080)	14.0 (0.080)
Ni Nickel	ND	(0.020)	0.070	(0.020)	ND	(0.020)	ND	(0.020)	ND (0.020)
Pb Lead	0.067	(0.050)	ND	(0.050)	ND	(0.050)	ND	(0.050)	ND (0.050)
Sb Antimony	0.18	(0.060)	ND	(0.060)	0.19	(0.060)	NDR	(0.060)	NDR (0.060)
Se Selenium	ND	(0.30)	ND	(0.30)	ND	(0.30)	ND	(0.30)	ND (0.30)
Si Silicon	48.0	(0.30)	85.0	(0.30)	29.0	(0.30)	26.0B	(0.30)	26.0B (0.30)
Tl Thallium	ND	(0.090)	ND	(0.090)	ND	(0.090)	ND	(0.090)	ND (0.090)
V Vanadium	0.074	(0.020)	0.12	(0.020)	0.063	(0.020)	0.040	(0.020)	0.040 (0.020)
Zn Zinc	0.064	(0.0060)	0.11	(0.0060)	0.031	(0.0060)	ND	(0.0060)	ND (0.0060)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

B: Detected in Reagent Blank; background subtraction not performed

R: Indicates that the matrix spike recovery for this analysis was not within acceptance limits indicating an interferent present.

ND: Not detected at specified detection limit

( ): Detection limit

07-APR-88

TABLE 4.3.1-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 1 (LANDFILL 1), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards, Criteria		Monitor Well	
	IE	IE	Sample ID	Date Sampled
Total Dissolved Solids MG/L	1300.0	(1.0)	700.0	(1.0)
Total Dissolved Solids			800.0	(1.0)
Fluoride MG/L				
Fluoride	4.0(M)	2.0(G)	0.21	0.21
Chloride MG/L				
Chloride	250.0(G)		16.0	21.0
Nitrate MG/L				
Nitrate + Nitrite	10.0(M)		ND	(0.20)
Nitrate, colorimetric				
Orthophosphate MG/L				
Orthophosphate	0.020	(0.020)	0.020	(0.020)
Sulfate MG/L				
Sulfate, nephelometry	250.0(G)		24.0	24.0
Metals MG/L				
Arsenic, graphite AA	0.050(M)		0.047	0.12
Mercury	0.0020(M)		ND	(0.00012)
Lead, graphite AA	0.050(M)		0.18	0.14
Selenium, graphite AA	0.010(M)		ND	(0.0030)
Metal Screen (ICP) MG/L				
Ag Silver			ND	(0.0090)
Al Aluminum	270.0	(0.20)	270.0	(0.20)
			220.0	(0.20)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

ND: Not detected at specified detection limit

( ): Detection limit



TABLE 4.3.1-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 1 (LANDFILL 1), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards, Criteria		Monitor Well	
	0.050(M)	1.0(M)	Sample ID	
			02-163	04-18
As	0.050(M)	ND	ND	ND
B		ND	0.70	0.70
Ba	1.0(M)	2.1	2.0	1.6
Be		0.013	0.0090	0.0070
Ca		720.0	800.0	610.0
Cd	0.010(M)	0.011	0.012	0.0090
Co		0.12	0.090	0.090
Cr	0.050(M)	0.33	0.33	0.26
Cu	1.0(G)	0.19	0.18	0.12
Fe	0.30(G)	270.0	250.0	210.0
K		36.0	36.0	28.0
Mg		50.0	50.0	41.0
Mn		8.2	9.0	7.8
Mo	0.050(G)	ND	ND	ND
Na		23.0	22.0	21.0
Ni		0.27	0.31	0.26
Pb		0.32	0.33	0.18
Sb	0.050(M)	0.15	ND	ND
Se		0.94	1.0	0.50
Si	0.010(H)	36.0	100.0	110.0
Tl		ND	ND	ND
V		0.50	0.47	0.37
Zn	5.0(G)	0.66	0.62	0.50

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

ND: Not detected at specified detection limit  
( ): Detection Limit





TABLE 4.3.1-3 RESULTS OF INORGANIC ANALYSES FOR WATER SAMPLES, SITE 1 (LANDFILL 1), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards, Criteria		Monitor Well	
	02-162		Sample ID	
	0.050(M)	1.0(M)	07-Feb-88	04-19
As	ND	ND	ND	ND
B	ND	ND	ND	ND
Ba	2.9	1.8	1.8	1.8
Be	0.022	0.010	0.010	0.010
Ca	1300.0	890.0	890.0	890.0
Cd	0.021	0.015	0.015	0.015
Co	0.20	0.11	0.11	0.11
Cr	0.50	0.38	0.38	0.38
Cu	0.34	0.18	0.18	0.18
Fe	420.0	300.0	300.0	300.0
K	52.0	42.0	42.0	42.0
Mg	77.0	56.0	56.0	56.0
Mn	7.4	5.4	5.4	5.4
Mo	ND	ND	ND	ND
Na	34.0	32.0	32.0	32.0
Ni	0.43	0.34	0.34	0.34
Pb	0.44	0.34	0.34	0.34
Sb	0.48	ND	ND	ND
Se	1.5	1.2	1.2	1.2
Si	47.0	100.0	100.0	100.0
Tl	ND	ND	ND	ND
V	0.79	0.57	0.57	0.57
Zn	0.94	0.65	0.65	0.65

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

ND: Not detected at specified detection limit

( ): Detection limit

07-03-88

TABLE 4.3.1-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 1 (LANDFILL 1), CARSWELL AFB, TEXAS.

Primary Results	EPA Standards,		1A		1B		Monitor Well	
	Criteria	26-Feb-88	07-Apr-88	04-12	02-158	04-15	Sample ID	Date Sampled
Oil & Grease MG/L		ND	(0.20)	ND	(0.20)	ND		
Oil and grease, Infrared		ND	(0.20)	ND	(0.20)	ND		
Purgeable Halocarbons UG/L								
1,1,1-Trichloroethane	200.0(M)	200.0(G)	ND	(0.090)	ND	(0.090)	ND	(0.090)
1,1,2,2-Tetrachloroethane			ND	(0.12)	ND	(0.12)	ND	(0.12)
1,1,2-Trichloroethane			ND	(0.070)	ND	(0.070)	ND	(0.070)
1,1-Dichloroethane			ND	(0.090)	ND	(0.090)	ND	(0.090)
1,1-Dichloroethene	7.0(M)	7.0(G)	ND	(0.10)	ND	(0.10)	ND	(0.10)
1,2-Dichlorobenzene	620.0(G)		ND	(0.50)	ND	(0.50)	ND	(0.50)
1,2-Dichloroethane	5.0(M)	0.0(G)	ND	(0.030)	ND	(0.030)	ND	(0.030)
1,2-Dichloropropane			ND	(0.10)	ND	(0.10)	ND	(0.10)
1,3-Dichlorobenzene	400.0(G)		ND	(0.30)	ND	(0.30)	ND	(0.30)
1,4-Dichlorobenzene	750.0(M)	750.0(G)	ND	(0.40)	ND	(0.40)	ND	(0.40)
2-Chloroethylvinyl ether			ND	(0.20)	ND	(0.20)	ND	(0.20)
Bromodichloromethane			ND	(0.10)	ND	(0.10)	ND	(0.10)
Bromoform			ND	(0.30)	ND	(0.30)	ND	(0.30)
Bromomethane			ND	(1.2)	ND	(1.2)	ND	(1.2)
Carbon tetrachloride	5.0(M)	0.0(G)	ND	(0.10)	ND	(0.10)	ND	(0.10)
Chlorobenzene	60.0(G)		ND	(0.30)	ND	(0.30)	ND	(0.30)
Chloroethane			ND	(0.50)	ND	(0.50)	ND	(0.50)
Chloroform			ND	(0.050)	ND	(0.050)	ND	(0.050)
Chloromethane			ND	(0.30)	ND	(0.30)	ND	(0.30)
Dibromochloromethane			NDQ	(0.20)	ND	(0.20)	ND	(0.20)
Methylene chloride			ND	(0.30)	ND	(0.30)	ND	(0.30)
Tetrachloroethene	8.0(G)		ND	(0.030)	ND	(0.030)	ND	(0.030)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

t: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ): Detection limit

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TABLE 4.3.1-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 1 (LANDFILL 1), CARSHELL AFB, TEXAS.

PARAMETER	EPA Standards, Criteria		Monitor Well Sample ID	
	1A	1B	1A	1B
2,4-dichlorophenol	3090.0(G)	ND (2.9)	04-12	04-15
2,4-dimethylphenol	400.0(G)	ND (2.9)	07-Apr-88	07-Apr-88
2,4-dinitrophenol		ND (45.0)	02-158	
2,4-dinitrotoluene		ND (6.0)	26-Feb-88	
2,6-dinitrotoluene		ND (2.0)		
2-chloronaphthalene		ND (2.0)		
2-chlorophenol		ND (3.5)		
2-methylnaphthalene		ND (11.0)		
2-methylphenol		ND (11.0)		
2-nitroaniline		ND (53.0)		
2-nitrophenol		ND (3.8)		
3,3'-dichlorobenzidine		ND (17.0)		
4,6-dinitro-2-methylphenol		ND (25.0)		
4-bromophenyl-phenylether		ND (2.0)		
4-chloro-3-methylphenol		ND (3.2)		
4-chloroaniline		ND (11.0)		
4-chlorophenyl-phenylether		ND (4.5)		
4-methylphenol		ND (11.0)		
4-nitroaniline		ND (53.0)		
4-nitrophenol		ND (2.5)		
acenaphthene		ND (2.0)		
acenaphthylene		ND (3.7)		
aniline		ND (11.0)		
anthracene		ND (2.0)		
benzidine		ND (47.0)		
benzo(a)anthracene		ND (8.3)		

- D R A F T -

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

1: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

2: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ): Detection limit

07-APR-88

TABLE 4.3.1-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 1 (LANDFILL 1), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards, Criteria		Monitor Well	
	1A	1B	Sample ID	Date Sampled
benzo(a)pyrene	02-159	04-12	1A	1B
benzo(b)fluoranthene	26-Feb-88	07-Apr-88	04-12	02-158
benzo(g,h,i)perylene	ND (2.7)	ND (2.7)	07-Apr-88	26-Feb-88
benzo(k)fluoranthene	ND (5.1)	ND (5.1)		
benzoic acid	ND (4.3)	ND (4.3)		
benzyl alcohol	ND (2.7)	ND (2.7)		
bis(2-chloroethoxy)methane	ND (53.0)	ND (53.0)		
bis(2-chloroethyl) ether	ND (5.6)	ND (5.6)		
bis(2-chloroisopropyl) ether	ND (6.0)	ND (6.0)		
bis(2-ethylhexyl) phthalate	ND (6.0)	ND (6.0)		
butylbenzylphthalate	4.1	(2.7)		
chrysene	ND (2.7)	ND (2.7)		
di-n-butylphthalate	ND (2.7)	ND (2.7)		
di-n-octyl phthalate	ND (2.7)	ND (2.7)		
dibenzo(a,h)anthracene	ND (2.7)	ND (2.7)		
dibenzofuran	ND (11.0)	ND (11.0)		
diethylphthalate	ND (42.0)	ND (42.0)		
dimethyl phthalate	ND (1.7)	ND (1.7)		
fluoranthene	ND (2.3)	ND (2.3)		
fluorene	ND (2.0)	ND (2.0)		
hexachlorobenzene	ND (2.0)	ND (2.0)		
hexachlorobutadiene	ND (0.95)	ND (0.95)		
hexachlorocyclopentadiene	ND (6.4)	ND (6.4)		
hexachloroethane	ND (1.7)	ND (1.7)		
indeno(1,2,3-cd)pyrene	ND (3.9)	ND (3.9)		
isophorone	ND (2.3)	ND (2.3)		

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

δ: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ): Detection limit

3000

TABLE 4.3.1-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 1 (LANDFILL 1), CARSWELL AFB, TEXAS.

PARAMETER	EPA Standards,		Monitor Well	
	Criteria	1A	1A	1B
n-nitroso-di-n-propylamine	ND	ND	04-12	04-15
n-nitrosodimethylamine	ND	ND	07-Apr-88	07-Apr-88
n-nitrosodiphenylamine	ND	ND	02-158	02-158
naphthalene	620.0(G)	ND	26-Feb-88	26-Feb-88
nitrobenzene	200.0(G)	ND		
pentachlorophenol	0.030(G)	ND		
phenanthrene	3500.0(G)	ND		
phenol	0.030(G)	ND		
pyrene	0.030(G)	ND		

- D R A F T -

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ) : Detection limit

TABLE 4.3.1-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 1 (LANDFILL 1), CARSWELL AFB, TEXAS.

Primary Results	1C		1D	
	02-160 26-Feb-88	04-17 07-Apr-88	02-161 26-Feb-88	04-16 07-Apr-88
PARAMETER	EPA Standards, Criteria			
Oil & Grease MG/L	0.30	ND (0.20)	0.30	ND (0.20)
Oil and grease, Infrared				
Purgeable Halocarbons UG/L				
1,1,1-Trichloroethane	200.0(H)	ND (0.090)	ND (0.090)	ND (0.090)
1,1,2,2-Tetrachloroethane		ND (0.12)	ND (0.12)	ND (0.12)
1,1,2-Trichloroethane		ND (0.070)	ND (0.070)	ND (0.070)
1,1-Dichloroethane		ND (0.090)	ND (0.090)	ND (0.090)
1,1-Dichloroethene	7.0(H)	ND (0.10)	ND (0.10)	ND (0.10)
1,2-Dichlorobenzene	620.0(G)	ND (0.50)	ND (0.50)	ND (0.50)
1,2-Dichloroethane	5.0(H)	ND (0.030)	ND (0.030)	ND (0.030)
1,2-Dichloropropane		ND (0.10)	ND (0.10)	ND (0.10)
1,3-Dichlorobenzene	400.0(G)	ND (0.30)	ND (0.30)	ND (0.30)
1,4-Dichlorobenzene	750.0(M)	ND (0.40)	ND (0.40)	ND (0.40)
2-Chloroethylvinyl ether		ND (0.20)	ND (0.20)	ND (0.20)
Bromodichloromethane		ND (0.10)	ND (0.10)	ND (0.10)
Bromoform		ND (0.30)	ND (0.30)	ND (0.30)
Bromomethane		ND (1.2)	ND (1.2)	ND (1.2)
Carbon tetrachloride	5.0(H)	ND (0.10)	ND (0.10)	ND (0.10)
Chlorobenzene	60.0(G)	ND (0.30)	ND (0.30)	ND (0.30)
Chloroethane		ND (0.50)	ND (0.50)	ND (0.50)
Chloroform		ND (0.050)	ND (0.050)	ND (0.050)
Chloromethane		ND (0.30)	ND (0.30)	ND (0.30)
Dibromochloromethane		NDQ (0.20)	NDQ (0.20)	ND (0.20)
Methylene chloride		ND (0.30)	ND (0.30)	ND (0.30)
Tetrachloroethene	8.0(G)	ND (0.030)	ND (0.030)	ND (0.030)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

±: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ): Detection limit

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TABLE 4.3 1-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 1 (LANDFILL 1), CARSWELL AFB, TEXAS.

Primary Results	EPA Standards,		Monitor Well	
	Criteria	1E	Sample ID	Date Sampled
PARAMETER	26-Feb-88	02-163	1E	1E
Oil & Grease MG/L			04-18	04-20
Oil and grease, infrared			07-Apr-88	07-Apr-88
Purgeable Halocarbons UG/L		0.70	ND (0.20)	ND (0.20)
1,1,1-Trichloroethane	200.0(M)	200.0(G)	ND (0.090)	ND (0.090)
1,1,2,2-Tetrachloroethane			ND (0.12)	ND (0.12)
1,1,2-Trichloroethane			ND (0.070)	ND (0.070)
1,1-Dichloroethane			ND (0.090)	ND (0.090)
1,1-Dichloroethene	7.0(M)	7.0(G)	ND (0.10)	ND (0.10)
1,2-Dichlorobenzene	620.0(G)		ND (0.50)	ND (0.50)
1,2-Dichloroethane	5.0(M)	0.0(G)	ND (0.030)	ND (0.030)
1,2-Dichloropropane			ND (0.10)	ND (0.10)
1,3-Dichlorobenzene	400.0(G)		ND (0.30)	ND (0.30)
1,4-Dichlorobenzene	750.0(M)	750.0(G)	ND (0.40)	ND (0.40)
2-Chloroethylvinyl ether			ND (0.20)	ND (0.20)
Bromodichloromethane			ND (0.10)	ND (0.10)
Bromoform			ND (0.30)	ND (0.30)
Bromomethane			ND (1.2)	ND (1.2)
Carbon tetrachloride	5.0(M)	0.0(G)	ND (0.10)	ND (0.10)
Chlorobenzene	60.0(G)		ND (0.30)	ND (0.30)
Chloroethane			ND (0.50)	ND (0.50)
Chloroform			ND (0.050)	ND (0.050)
Chloromethane			ND (0.30)	ND (0.30)
Dibromochloromethane			ND (0.20)	ND (0.20)
Methylene chloride			ND (0.30)	ND (0.30)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

t: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

B: Detected in Reagent Blank; background subtraction not performed

J: Estimated value (GC test codes)

ND: Not detected at specified detection limit

( ) : Detection limit

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TABLE 4.3.1-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 1 (LANDFILL 1), CARSWELL AFB, TEXAS.

PARAMETER	1F		1F	
	EPA Standards, Criteria	02-162 26-Feb-88	04-19 07-Apr-88	Monitor Well Sample ID Date Sampled
Oil & Grease MG/L		0.60	ND	(0.20)
Oil and grease, Infrared				
Purgeable Halocarbons UG/L				
1,1,1-Trichloroethane	200.0(M)	200.0(G)	ND	(0.090)
1,1,2,2-Tetrachloroethane			ND	(0.12)
1,1,2-Trichloroethane			ND	(0.070)
1,1-Dichloroethane			ND	(0.090)
1,1-Dichloroethene	7.0(M)	7.0(G)	ND	(0.10)
1,2-Dichlorobenzene	620.0(G)		ND	(0.50)
1,2-Dichloroethane	5.0(M)	0.0(G)	ND	(0.030)
1,2-Dichloropropane			ND	(0.10)
1,3-Dichlorobenzene	400.0(G)		ND	(0.30)
1,4-Dichlorobenzene	750.0(M)	750.0(G)	ND	(0.40)
2-Chloroethylvinyl ether			ND	(0.20)
Bromodichloromethane			ND	(0.10)
Bromoform			ND	(0.30)
Bromomethane			ND	(1.2)
Carbon tetrachloride	5.0(M)	0.0(G)	ND	(0.10)
Chlorobenzene	60.0(G)		ND	(0.30)
Chloroethane			ND	(0.50)
Chloroform			ND	(0.050)
Chloromethane			ND	(0.30)
Dibromochloromethane			NDQ	(0.20)
Methylene chloride			ND	(0.30)
Tetrachloroethene	8.0(G)		ND	(0.030)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

S: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ): Detection limit

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TABLE 4.3.1-4 RESULTS OF ORGANIC ANALYSES FOR WATER SAMPLES, SITE 1 (LANDFILL 1), CARSWELL AFB, TEXAS.

Primary Results	IF		IF	
	EPA Standards, Criteria	02-162 26-Feb-88	04-19 07-Apr-88	Monitor Well Sample ID Date Sampled
Trichloroethene	5.0(M)	0.0(G)	ND (0.20)	ND (0.20)
Trichlorofluoromethane			ND (0.10)	ND (0.10)
Vinyl chloride	2.0(M)	0.0(G)	ND (0.20)	0.30 (0.20)
cis-1,3-Dichloropropene			ND&	ND&
trans-1,2-Dichloroethene	70.0(G)		ND (0.20)	ND (0.20)
trans-1,3-Dichloropropene			ND (0.30)	ND (0.30)
Purgeable Aromatics UG/L				
1,2-Dichlorobenzene	620.0(G)		ND (0.40)	ND (0.40)
1,3-Dichlorobenzene	400.0(G)		ND (0.40)	ND (0.40)
1,4-Dichlorobenzene	750.0(M)	750.0(G)	ND (0.30)	ND (0.30)
Benzene	5.0(M)	0.0(G)	ND (0.20)	ND (0.20)
Chlorobenzene	60.0(G)		ND (0.30)	ND (0.30)
Ethylbenzene	680.0(G)		ND (0.30)	ND (0.30)
Toluene	2000.0(G)		2.4 (0.20)	5.6 (0.20)
m-Xylene			ND (0.20)	ND (0.20)
o-Xylene			ND (0.10)	ND (0.10)
p-Xylene			ND (0.20)	ND (0.20)

EPA Standards and Criteria are designated: M-Maximum Contaminant Level (MCL), G-Maximum Contaminant Level Goal (MCLG) or other secondary or proposed standard (Refer to Tables 4.1-1 and 4.1-2).

Q: cis-1,3-Dichloropropene cannot be quantitated due to coelution.

Q: Daily EPA QC recovery outside 95% confidence limit.

ND: Not detected at specified detection limit

( ): Detection limit

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TABLE 4.3.1-5. RESULTS OF FIELD ANALYSES FOR WATER SAMPLES, SITE 1 (LANDFILL 1), CARSWELL AFB, TEXAS

Monitor Well

Sample ID  
Date Sampled

Analyte	Unit of Measure	Monitor Well	
		Sample ID	Date Sampled
		1A	1B
		02-159	02-158
		26-Feb-88	26-Feb-88
		07-Apr-88	07-Apr-88
Alkalinity	mg/L	410.0 (5.0)	675.0 (5.0)
Specific Conductance	µMHOS/CM	700.0 (10.0)	800.0 (10.0)
Temperature	C	14.0 (1.0)	19.0 (1.0)
pH	S.U.	5.8 (0.010)	5.7 (0.010)

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TABLE 4.3.1-5. RESULTS OF FIELD ANALYSES FOR WATER SAMPLES, SITE 1 (LANDFILL 1), CARSWELL AFB, TEXAS

Analyte	Unit of Measure	Monitor Well			
		IC	IC	ID	ID
		Sample ID	Date Sampled	Sample ID	Date Sampled
Alkalinity	mg/L	02-160	04-17	02-161	04-16
Specific Conductance	µMHOS/CM	26-Feb-88	07-Apr-88	26-Feb-88	07-Apr-88
Temperature	C				
pH	S.U.				
		810.0	520.0	790.0	1560.0
		(10.0)	(5.0)	(10.0)	(5.0)
		21.5	790.0	20.0	1310.0
		(0.10)	(10.0)	(1.0)	(1.0)
		5.9	20.0	6.7	19.0
		(0.010)	(0.010)	(0.010)	(0.010)
			6.7	5.7	6.5

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( ) : Detection Limit

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TABLE 4.3.1-5. RESULTS OF FIELD ANALYSES FOR WATER SAMPLES, SITE 1 (LANDFILL 1), CARSWELL AFB, TEXAS

Monitor Well

Sample ID  
Date Sampled

Analyte	Unit of Measure	1E	1F	1F
		02-163	04-18	04-19
		26-Feb-88	07-Apr-88	07-Apr-88
Alkalinity	mg/L	605.0 (5.0)	645.0 (5.0)	645.0 (5.0)
Specific Conductance	µMHOS/CM	860.0 (10.0)	880.0 (10.0)	830.0 (10.0)
Temperature	C	20.0 (1.0)	21.0 (1.0)	20.0 (1.0)
pH	S.U.	6.9 (0.010)	7.0 (0.010)	6.2 (0.010)

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Oil and Grease--Oil and grease were found in concentrations less than 1 mg/L in ground water collected during Round 1, from monitor wells 1C, 1D, 1E, and 1F. Round 2 samples did not have detectable concentrations of oil and grease at any of these locations.

Purgeable Halocarbons--Trichloroethene was detected at a low level in 1B (0.70  $\mu\text{g/L}$ ) and 1F (0.30  $\mu\text{g/L}$ ). Vinyl chloride was detected in 1C (0.40  $\mu\text{g/L}$ ) during Round 2. These occurrences exceeded the MCLGs for these substances.

Purgeable Aromatics--Toluene was detected during both sampling rounds in all wells except 1B. The maximum value was 26  $\mu\text{g/L}$  during the Round 1 sampling of well 1C. Section 4.5 documented the occurrence of toluene in trip and ambient conditions blanks, which may account for toluene observed in Site 1 ground water. The only other purgeable aromatic compound detected was chlorobenzene during both sampling events at well 1C.

Extractable Priority Pollutants--Bis(2-ethylhexyl)phthalate was found in wells 1A and 1E, but was also noted as being detected in the reagent blank. Background subtraction of this phthalate compound was not performed. Di-n-butylphthalate also was detected in the second-round sample of well 1E (again noted in the reagent blank).

#### 4.3.1.3 Significance of Findings

The principal effort for the Stage 2 field program at Site 1 was to evaluate ~~the ground-water conditions downgradient of Landfill 1~~ and determine if waste materials or contaminated soil occur east of the landfill. The following paragraphs contain a discussion of the significance of the findings for soil and ground-water contamination.

Soil--Based on a review of the soil chemistry data, the samples collected and analyzed from boreholes 1E and 1F did not indicate the presence of contaminants or waste materials.

Ground Water--The principal conclusions of the Stage 2 program are:

1. Very low levels of volatile organic compounds (TCE, vinyl chloride) were detected in some wells. However, the sporadic occurrences of these compounds at concentrations below their respective MCLs does not suggest that a defined plume of contamination exists.
2. Metals in concentrations above the MCLs appears to be the primary ground-water contamination at Landfill 1. The source of metals in the ground water appears to be materials in Landfill 1, judging by the increasing concentration levels in downgradient wells.

Contaminant Migration--The Stage 2 results lead to the following statements regarding the source and migration of contaminants at Landfill 1.

1. In the area of Landfill 1, ground-water flow paths as indicated by a review of the potentiometric surface map (Figure 4.3.1-3) is to the east, toward the Trinity River. Considering the hydraulic gradient (0.09 feet/feet), the range of hydraulic conductivities (Table 4.3-2), and an assumed porosity of 0.10, the rate of ground-water flow in the upper zone is calculated to be approximately 2 ft/day. However, the wide variability of saturated thickness and gradients in upper zone materials suggest a significant uncertainty in assigning average seepage velocity values at Landfill 1.
2. Contaminants in the upper zone ground water would be expected to move off-base, since the east side of Landfill 1 is part of the base boundary and ground-water in the upper zone flows toward the Trinity River. However, no seeps or springs in the material forming the banks of the Trinity River have been observed, suggesting that ground-water discharge from the upper



Source and Release Characterization

Possible sources of contaminant release from Landfill 1, as for the Flightline area sites, include: 1) volatilization to the air, 2) fugitive dust generation, 3) recharge to ground water, 4) surface runoff and 5) direct release to surface water.

Volatilization to the Air--VOCs present in the soil are subject to volatilization to the air by virtue of high vapor pressures. PNAs generally have very low vapor pressures and are not subject to volatilization. Most metals are nonvolatile as well. Indicator chemicals detected at the site which can volatilize include methylene chloride, toluene, trichloroethene, and vinyl chloride.

Estimated emission rates based conservatively on maximum concentrations detected in the soil or ground water at the site are:

<u>Indicator Chemical</u>	<u>Emission Rate</u> <u>(grams/second)</u>
Methylene chloride	$7.38 \times 10^{-8}$
Toluene	$5.64 \times 10^{-8}$
Trichloroethene	$4.62 \times 10^{-9}$
Vinyl chloride	$7.71 \times 10^{-8}$

The methodology used to estimate emission rates is described in Section 3.8.

Fugitive Dust Generation--Contaminants must be present in surface soil uncovered by impervious materials or vegetation to be subject to fugitive dust generation. Because Landfill 1 has been paved over with impervious material, contaminants present in the soil at this site are not subject to fugitive dust generation.

Recharge to Ground Water--Indicator chemicals detected in the ground water near Landfill 1 include: antimony, arsenic, barium, beryllium, cadmium, chromium, lead, nickel, selenium, silver, bis(2-ethylhexyl)phthalate, toluene, trichloroethene, and vinyl chloride. Section 4.1 summarizes and discusses the significance of the concentrations detected in the ground water at the site.

Surface Runoff--Contaminants must be present in surface soil uncovered by impervious materials to be subject to significant surface runoff during precipitation. Because Landfill 1 has been paved, contaminants present in the soil at this site are not subject to surface runoff.

Discharge to Surface Water--There is no direct discharge of contaminants from this site to surface water.

#### Transport and Fate of Contaminants

Landfill 1 potentially releases VOCs to the air via volatilization and VOCs, bis(2-ethylhexyl)phthalate, and metals to the ground water via site leaching. Potentially significant contaminant transport and fate mechanisms in the air and ground water media include: 1) air dispersion, 2) ground water migration, 3) transport in surface water, and 4) subsequent uptake by plants and animals.

Air Dispersion--Emissions of VOCs from Landfill 1 occur at ground level in the gaseous phase. The gases disperse in the ambient atmosphere according to local meteorological conditions. Annual ambient air concentrations of methylene chloride, toluene, trichloroethene, and vinyl chloride resulting from Landfill 1 emissions were estimated using the ISCLT model. The dispersion modeling methodology is discussed in Section 3.8.

Ground Water Migration--At Landfill 1, as at all East Area sites, available water-level and geologic data indicate that ground water in the upper zone flows to the east, toward the Trinity River. The subsurface conditions at the east area are similar to those at the Flightline Area;

ground water remains in the upper zone above the bedrock and flows to the nearest surface water drainage. As ground-water flow nears the Trinity River, discharge will be directly to the river or as broadly diffuse seepage that is consumed by evapotranspiration, perhaps without evidence of direct flow at the land surface. Ground-water flow will not be toward deeper aquifers or beyond the Trinity River or Farmers Branch. The evident path of ground-water flow precludes migration of contaminants from Landfill 1 to any domestic or agricultural use wells in the area.

Transport in Surface Water--Since VOCs remain in a gaseous state and do not deposit on the ground, surface water in the area is not subject to contamination via emissions to the air from Landfill 1. Contaminants which reach the West Fork of the Trinity River via ground-water migration are subject to dilution and movement with the surface flow downstream. The West Fork of the Trinity River is downstream of Lake Worth, which is the source of drinking water for Fort Worth and Carswell AFB. The path of surface water drainage precludes the transport of contaminants from Landfill 1 to the sole surface water source of drinking water in the area. VOCs present in surface water may volatilize to the air.

Uptake by Plants and Animals--Food crops, including commercial agricultural crops and backyard gardens, are subject to accumulation of contaminants originating at Landfill 1 via root uptake of any contaminants present in the water used for watering or irrigation. Migration of ground water to a surface water source used for watering or irrigation is the only significant pathway for contaminants to move from Landfill 1 to plants. However, farming operations in the area generally rely on natural precipitation or irrigation of crops with ground water, which removes this potential pathway to human exposure (South, J., 1988b). Since emissions to the air from Landfill 1 are limited to VOCs, which remain in a gaseous state in ambient air, they will not deposit on above-ground plant surfaces or on the soil or surface water so as to be available for root uptake.

Terrestrial organisms, including farm animals and wildlife, are subject to accumulation of contaminants originating at Landfill 1 by: 1) inhalation of ambient air and 2) ingestion of surface water contaminated via ground-water migration. As discussed above, farm operations in the area do not use surface water to irrigate crops. Therefore, farm animals are not subject to ingestion of plants irrigated or watered with surface water contaminated via ground-water migration.

Aquatic organisms, including fish, are subject to accumulation of contaminants originating at Landfill 1 by uptake from surface water contaminated via ground-water migration/surface transport. Contaminants can bioaccumulate in the food chain of both terrestrial and aquatic organisms.

#### Exposure Pathways

Figure 4.3.1-4 depicts potential pathways for contaminants to move from Landfill 1 to human exposure points. Pathways which are not complete have been crossed out. Remaining pathways include:

1. Volatilization to the air/air dispersion/inhalation of ambient air;
2. Volatilization to the air/air dispersion/inhalation by animals/ingestion of meat and dairy products;
3. Leaching to ground water/ground-water migration to surface water (fishable source)/~~uptake by fish and other aquatic organisms/ingestion of aquatic organisms;~~
4. Leaching to ground water/ground-water migration to surface water (agricultural use source)/ingestion by animals/ingestion of meat and dairy products;



5. Leaching to ground water/ground-water migration to surface water (source used for contact sports)/skin contact with water; and
6. Leaching to ground water/ground-water migration to surface water/volatilization of volatiles/inhalation of vapors close to source.

#### Identification of Receptors

Based on available exposure pathways, potential human receptors for exposure to contaminants originating from Landfill 1 include: 1) persons residing and/or working in nearby areas, particularly downwind of the site; 2) persons ingesting meat and dairy products from animals exposed to contaminants in the ambient air or contaminated surface water; 3) persons ingesting fish or other aquatic organisms exposed to contaminated surface water; and 4) persons swimming or participating in other contact sports in contaminated water. Landfill 1 and the other East area sites are located farther from the primary southeast base housing areas than are the Flightline area sites. However, they are closer to base office buildings and occupied work areas and to off-base residential areas to the east of the West Fork of the Trinity River and bordering on State Highway 183.

Potential wildlife receptors include: 1) terrestrial organisms with habitats close to Landfill 1 that inhale ambient air and ingest surface water, particularly from West Fork of the Trinity River, and 2) aquatic organisms in West Fork of the Trinity River.

#### Threat to Human Health

Inhalation Exposure--Inhalation of ambient air is the most direct exposure pathway for contaminants to move from Landfill 1 to human receptors. Table 4.3.1-6 presents the on-site maximum and off-site maximum predicted annual ambient air concentrations resulting from estimated Landfill 1

TABLE 4.3.1-6. PREDICTED ANNUAL AVERAGE AMBIENT AIR CONCENTRATIONS RESULTING FROM ESTIMATED LANDFILL 1 EMISSIONS

Contaminant	Predicted Annual Average Ambient Air Concentration (ug/m <sup>3</sup> )							IACB Annual Effects Screening Level (ug/m <sup>3</sup> )
	On-Site Maximum	Off-Site Maximum	Day Care	Fish Hatchery	Dairy Operation	Beef Operation		
Methylene chloride	1.2x10 <sup>-6</sup>	3.7x10 <sup>-6</sup>	5.0x10 <sup>-9</sup>	2.3x10 <sup>-8</sup>	< 10 <sup>-9</sup>	< 10 <sup>-9</sup>	< 10 <sup>-9</sup>	26
Toluene	9.0x10 <sup>-7</sup>	2.8x10 <sup>-6</sup>	4.0x10 <sup>-9</sup>	1.8x10 <sup>-8</sup>	< 10 <sup>-9</sup>	< 10 <sup>-9</sup>	< 10 <sup>-9</sup>	375
Trichloroethene	7.4x10 <sup>-8</sup>	2.3x10 <sup>-7</sup>	> 10 <sup>-9</sup>	1.0x10 <sup>-9</sup>	< 10 <sup>-9</sup>	< 10 <sup>-9</sup>	< 10 <sup>-9</sup>	135
Vinyl chloride	1.2x10 <sup>-6</sup>	3.9x10 <sup>-6</sup>	6.0x10 <sup>-9</sup>	2.4x10 <sup>-8</sup>	< 10 <sup>-9</sup>	< 10 <sup>-9</sup>	< 10 <sup>-9</sup>	10

emissions, and predicted concentrations at several discrete locations: site of the proposed base day care center, which is central to the largest on-base residential area, the Fort Worth National Fish Hatchery, and the closest dairy and beef operations. The table also lists Texas Air Control Board (TACB) health Effects Screening Levels (ESLs) which the agency uses to evaluate the impacts of air contaminants. TACB screening levels are based on occupational exposure limits (American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs), Occupational Health and Safety Administration (OSHA) standards, or National Institute for Occupational Safety and Health (NIOSH) recommendations), odor nuisance potential, vegetation effects, or corrosion effects. Generally, the annual ESL corresponds to 0.1% of the lowest occupational exposure limit.

The maximum predicted annual average concentrations resulting from estimated Landfill 1 emissions for methylene chloride, toluene, trichloroethene, and vinyl chloride are lower than the conservative TACB Effects Screening Levels by 7, 8, 9, and 7 orders of magnitude, respectively. Note that maximum concentrations occur off-base due to the location of the site at the east base perimeter and the prevailing wind direction.

Table 4.3.1-7 shows estimates of average daily inhalation exposure (in mg/kg body weight/day) at the location of the on-site and off-site maximum predicted annual average concentration, and at the proposed on-site day care facility, and compares these values with inhalation Acceptable Daily Intakes (ADIs) for chronic (long-term) exposure. An inhalation ADI is an estimate of the dose of a chemical that can be inhaled daily for a lifetime without producing adverse noncarcinogenic health effects. Section 3.8 discusses the derivation of ADIs used in this assessment.

Average daily inhalation exposures for methylene chloride, toluene, trichloroethene, and vinyl chloride are lower than pollutant-specific ADIs in all cases by more than 6 orders of magnitude.



Ingestion Exposure--Potential ingestion exposures include ingestion of meat and dairy products from animals exposed to contaminants in the ambient air or contaminated surface water and fish exposed to contaminated surface water.

Landfill 1 contributes very low concentrations of VOCs to the ambient air. At the sites of the nearest dairy and beef operations, concentrations are predicted to be less than 1/1,000,000,000  $\mu\text{g}/\text{m}^3$  (see Table 4.3.1-6). Although cows, as humans, will absorb inhaled VOCs, these compounds do not tend to accumulate in milk or fatty tissues which humans might consume. Likewise, livestock consumption of surface water containing contaminants originating from Landfill 1 is theoretically possible, if livestock consumes water from the West Fork of the Trinity River; however, any exposure can be expected to be minimal due to the distance from Carswell AFB to the nearest dairy and beef operations. Consumption of locally produced beef and dairy products therefore does not represent a significant pathway of human exposure to contaminants originating from Landfill 1.

The most significant fishable resource in the vicinity of Carswell AFB is Lake Worth. The Fort Worth National Fish Hatchery is located at the western end of the lake. Since there is no available pathway for contaminants to move from Landfill 1 to Lake Worth, there is no potential for human exposure to contaminants originating at Landfill 1 via ingestion of fish caught in the lake. There is some potential for fish in the West Fork of the Trinity River to accumulate contaminants from Landfill 1 due to its location at the base perimeter adjacent to the river and the evident direction of ground-water flow toward the river. Contaminant contributions to the river from Landfill 1 via ground-water migration could be significant; however, contaminants will be readily diluted and dispersed downstream. As the ground-water contribution to the West Fork of the Trinity River is unknown, concentrations of contaminants in the river which originate from Landfill 1 were not estimated.

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Dermal Exposure--The potential for skin contact with contaminants originating from Landfill 1 is limited to exposures while swimming in (or otherwise in contact with) contaminated surface water. Lake Worth is the most highly utilized surface water body for swimming and other water contact sports in the area. Again, since there is no available pathway for contaminants to move from Landfill 1 to Lake Worth, there is no potential for human exposure to contaminants originating from Landfill 1 via skin contact with lake water. As discussed above, contaminant contributions to the West Fork of the Trinity River from Landfill 1 probably do occur; therefore, skin contact with river water close to the landfill site is considered a possible exposure pathway for this site. However, because the river is not widely used for swimming and water contact sports, the exposure potential from this pathway was not quantified.

#### Carcinogenic Risks

Inhalation Risk--Of the four contaminants emitted to the air from Landfill 1, methylene chloride, trichloroethene, and vinyl chloride are potential carcinogens. Cancer potency estimates developed by EPA were used in conjunction with total daily contaminant doses to develop estimates of individual cancer risk:

$$\text{individual cancer risk} = \text{total daily dose} \times \text{cancer potency} \\ (\text{mg/kg/day}) \quad (\text{mg/kg/day})^{-1}$$

Individual cancer risk is the increased probability of getting cancer in one's lifetime.

Table 4.3.1-8 shows estimates of individual cancer risk for the maximum on-site and maximum off-site exposed individual and for an individual inhaling ambient concentrations in the immediate vicinity of the proposed day care facility continuously for a lifetime. These risks, the highest of which is 3 in 100 billion, can be dismissed as inconsequential.

TABLE 4.3.1-8. ESTIMATED INDIVIDUAL CANCER RISK ASSOCIATED WITH INHALATION OF POTENTIAL CARCINOGENS ORIGINATING FROM LANDFILL 1

Contaminant	Potency Slope <sup>a</sup> (mg/kg/day)	Individual Cancer Risk <sup>b</sup>		
		On-Site Maximum Exposed Individual	Off-Site Maximum Exposed Individual	Individual Exposed at Day Care Facility
Methylene chloride	$1.65 \times 10^{-3}$	$5.6 \times 10^{-13}$	$1.7 \times 10^{-12}$	$2.5 \times 10^{-15}$
Trichloroethene	$4.6 \times 10^{-3}$	$9.7 \times 10^{-14}$	$3.0 \times 10^{-13}$	$4.3 \times 10^{-16}$
Vinyl chloride	$2.5 \times 10^{-2}$	$6.6 \times 10^{-12}$	$2.9 \times 10^{-11}$	$3.9 \times 10^{-14}$
TOTAL 70 year risk		$9.5 \times 10^{-12}$	$3.0 \times 10^{-11}$	$4.2 \times 10^{-14}$

<sup>a</sup> See Section 3.8 for discussion and documentation.

<sup>b</sup> Risk calculation assumes inhalation for 24 hours/day for a 70 year lifetime of predicted annual average ambient concentrations by an individual with an average body weight of 70 kg and with an average inhalation rate of 20 m<sup>3</sup>/day.

Ingestion Risk--The potential for ingestion exposure to contaminants originating from Landfill 1 is limited to ingestion of fish from the West Fork of the Trinity River. The risk of ingestion exposure by this pathway was not quantified because residents are more likely to fish in close by Lake Worth than in the river and ground-water contributions to the river from landfill 1 are not known.

Dermal Risk--The potential for dermal exposure to contaminants originating from Landfill 1 is remote. Unless an individual immersed frequently in the West Fork of the Trinity River for a long period of time, skin contact exposure can be considered insignificant. The risk of dermal exposure was therefore not quantified.

Threat to Wildlife

Contaminants originating from Landfill 1 pose some risk to terrestrial wildlife that use the West Fork of the Trinity River as a source of drinking water as well as aquatic organisms in the river. The potential contribution of Landfill 1 to contaminant concentrations in the river was not estimated because neither the ground-water inflow to the river nor existing contaminant concentrations in the river is known.

**FINAL PAGE**

**ADMINISTRATIVE RECORD**

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CAUTION

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