DEPARTMENT OF THE AIR FORCE
HEADQUARTERS 27TH FIGHTER WING (ACC)
CANNON AIR FORCE BASE NEW MEXICO

JUL 23 2007

Colonel Scott D. West
Commander
100 N DL Ingram Blvd, Ste 100
Cannon AFB NM 88103-5214

Mr. James Bearzi
Chief Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive, East Building 1
Santa Fe NM 87505-6303

RECEIVED
AUG 2007
NMED Hazardous Waste Bureau

Dear Mr. Bearzi,

Cannon Air Force Base (CAFB) hereby submits the attached response to all General and Specific Comments to the Notice of Disapproval (NOD), Final Construction Completion Report for the Remedial Action at Solid Waste Management Unit (SWMU) 97 Landfill 25 (LF – 25) for Cannon AFB, NM, EPA ID No. NM7572124454.

Please address any questions or comments to my Restoration Project Manager Ms. Kristi L. Doll, at 505-784-1091.

Sincerely

CHRISTINE M. TIMS, YF-02
Deputy Chief, Environmental Flight

Attachments:
1. Response to NMED's General and Specific Comments
2. Environmental Assessment – Laboratory Report
3. Project Description
4. Appendix G – Environmental Assessment

cc:
NMED HW Bureau (C. Frischkorn) w/ Atch
NMED HW Bureau (D. Cobrain) w/o Atch
NMED HW Bureau (S.L. Vonteddu) w/o Atch
EPA Region VI (B. Sturdivant) w/ Atch

1st Ind to 27 CES/CC, 23 Jul 07, Response to Mr. James Bearzi, NMED, NOD Final Construction Completion Report for the Remedial Action at SWMU 97 LF – 25

27 CES/CC

MEMORANDUM FOR 27 MSG/CC

Concur/~~Nonconcur.~~

STEPHEN D. WOOD, Lt Col, USAF
Commander, 27th Civil Engineer Squadron

2d Ind, 27 MSG/CC

AUG 0 1 2007

MEMORANDUM FOR 27 FW/CC

Concur/~~Nonconcur.~~

BABETTE M. LENFANT, Colonel, USAF
Commander, 27th Mission Support Group

3d Ind, 27 FW/CC

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who managed the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

AUG 0 2 2007

SCOTT D. WEST, Colonel, USAF
Commander, 27th Fighter Wing

Final Construction Completion Report
&
Remedial Action Work Plan
SWMU 97 - Landfill No. 25
Cannon AFB, NM

The New Mexico Environment Department (NMED) has received and reviewed the Cannon Air Force Base's (CAFB) *Final Construction Completion Report-for the Remedial Action at SMMU 97 -Landfill No. 25* (Report) dated November 2001 and *Remedial Action Work Plan for SWMU 97 -Landfill No. 25* (Work Plan) dated July 2000 (Volumes 1 & 2). NMED has determined that the Report is technically deficient. While NMED does not require resubmission of the entire Report, the Permittee must respond to the comments provided in this letter and supply the requested additional information within 60 days of the receipt of this letter. NMED will reevaluate the report once the requested information is provided.

Comment 1, Section 2.0
Section 2.0 of the Report presents a description and history of SWMU 97; however, this section gives a broader overview of past investigations. The Permittee must add an additional appendix to the Report to include details about the historical sampling events. The appendix must, at a minimum, contain maps (or pictures) showing the sampling locations and the laboratory analytical reports for the sampling results. The Permittee must also include references to the additional appendix in section 2.0 of the report.

Although most of this information is present in the *Petition for No Further Action for Landfill No.3 (LF-03/SWMU 105), Landfill No.4 (LF-04/SWMU 104) and Landfill No.25 (LF-25/SWMU 97)* dated May 2006 provided by CAFB as supplemental information, NMED requires CAFB to submit the actual Laboratory reports for the historic sampling events conducted at this site. The table of results generated by CAFB is not sufficient.

Response:
The historical sampling events at the SWMU 97 (LF-25) are as follows:

- An Environmental Assessment performed by U.S. Army Corps of Engineers, Tulsa District in 1991 investigated the rubble material pile, and trenching in the north end of the LF25. Their finding indicated that the only contamination above regulation was in trench 3, Cd and Ba and the organic compound Benzidine. Some TICs were also found in this trench but were associated with asphalt. No other contamination was found in these trenches, one background trench and the rubble. Refer to Appendix G (Enclosures 1 & 1a) for additional information.

- A phase IV report was performed by Woodward Clyde in 1992 which documented the field work performed in 1987 by Walk, Haydle & Associates.
  Samples obtained pertaining to this site was:

    a. Two (2) soil borings at the landfill and one of the borings at .5 ft had low concentrations of pesticides

b. Monitoring well K was placed in the center of the landfill and only had metal detects but were below Maximum Contaminant Levels (MCLs)

This information was documented in the RCRA Facility Investigation (RFI) final report performed by Radian in 1994. Refer to Appendix H (Enclosure 2) for documentation.

- Remedial Investigation results are shown on the following tables (Appendix H):

Table 4-4	Metals
Table 4-5	Pesticides and PCBs
Table 4-6	SVOC
Table 4-7	TPH, Herbicides, VOC

- Analytical Results – Appendix I (Enclosure 3)

Comment 2, Section 3.0

Section 3.0 of the Report states that *"Native Soil Cover/Debris Consolidation - The remaining exposed debris was consolidated to the extent possible, and 4 to 6 inches of on-site native soil was used as cover".*

The passage does not describe the type of debris and what was done to the debris that would constitute consolidation. The Permittee must clearly explain the type of debris and the meaning of the term *"consolidated"* in the sentence.

Response

The text in Section 3.0, 6th bullet, was clarified along with corresponding text in Section 3.1.6 as follows:

Section 3.0 revision

- Native Soil Cover/Debris Consolidation—The remaining exposed debris, consisting of large block of concrete and asphalt, was consolidated, to the extent possible, covered with a minimum of 6 inches of on-site native soil.

Section 3.1.6 revision

3.1.6 Native Soil Cover/Debris Consolidation

Heavy equipment was used to consolidate the remaining large blocks of concrete and asphalt in the northern portion of the landfill. A soil cover composed of clean material collected from the site was placed at a minimum depth of 6 inches over top of the debris that remained in place after consolidation.

APPENDIX G

ENVIRONMENTAL ASSESSMENT

CONCRETE RUBBLE FILE, SWMU 97
(LANDFILL NO. 25)

CANNON AIR FORCE BASE
NEW MEXICO

PREPARED BY
U.S. ARMY CORPS OF ENGINEERS
TULSA DISTRICT
FEBRUARY 1991

ENCLOSURE 1

SCANNED

CANNON AIR FORCE BASE, NEW MEXICO
ENVIRONMENTAL ASSESSMENT
CONCRETE RUBBLE PILE, SWMU 97

EXECUTIVE SUMMARY

Construction to enlarge the munitions facility required that the north portion of the rubble pile, SWMU 97, be moved. The RCRA Facilities Investigation (FI) of SWMU 97 is scheduled in 1992 or 1993. An environmental assessment was made of the rubble pile to determine if it could be moved safely. Various samples taken from excavated trenches at the site were analyzed for volatiles, semivolatiles, metals, PCBs, TCLP, and asbestos.

The rubble at the north end of the rubble pile shows no evidence of serious contamination. There is some evidence of soil contamination as indicated by the high metals, Barium and Cadmium, and the semivolatile Benzidine found in one trench. Old burn trenches dating from the early 1940s were encountered and may be contributing to the soil contamination. Very little data is known about the burn trenches, their contents, size, location or their contribution to possible soil contamination. Investigations should be undertaken to establish the characteristics of the burn trenches either as part of the RCRA FI or separately prior to movement of the rubble. An accelerated FI could be completed in one to one and a half years.

Recommend the construction be delayed until the completion of the RCRA Facilities Investigation.

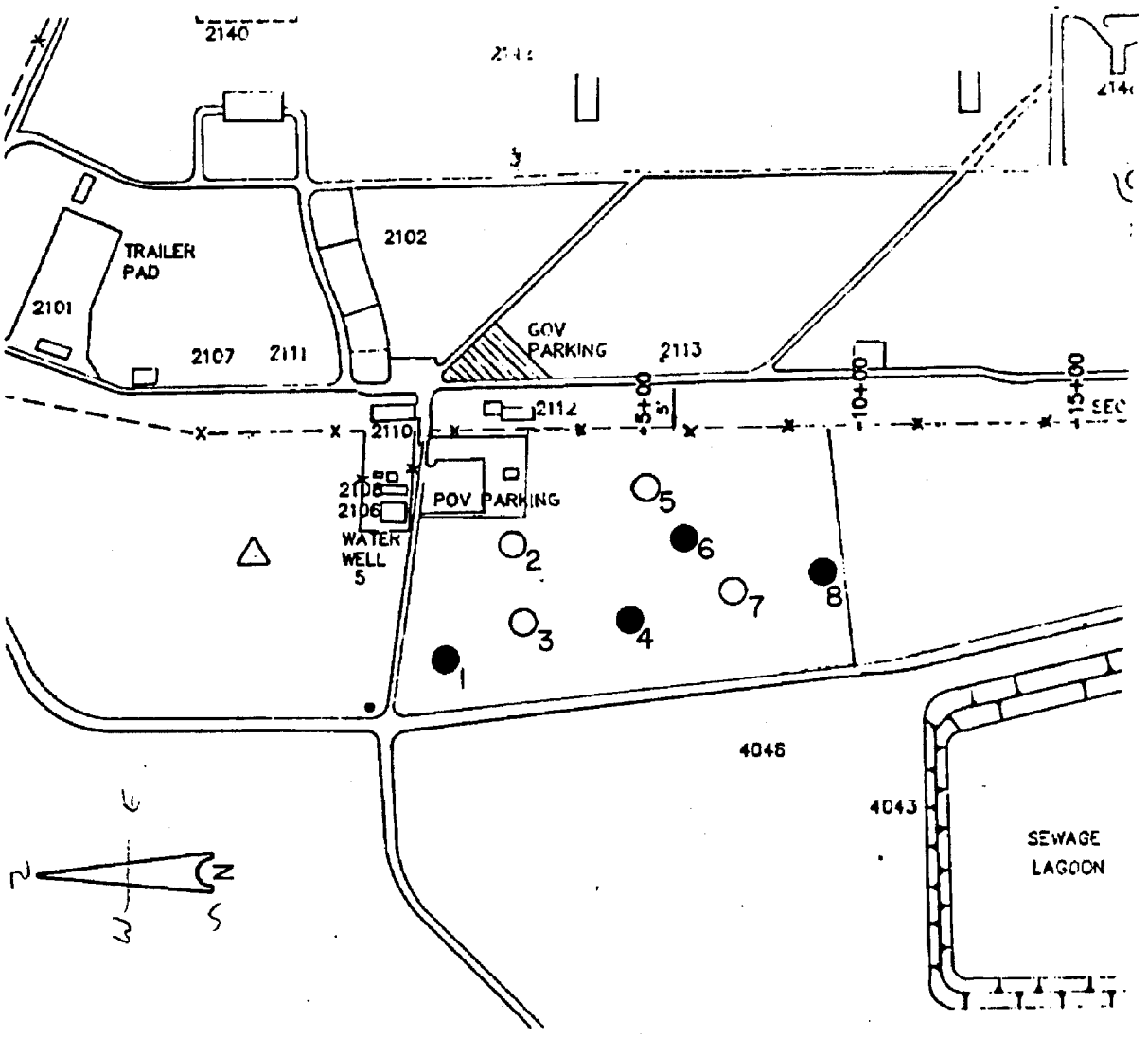
CANNON AIR FORCE BASE, NEW MEXICO
ENVIRONMENTAL ASSESSMENT
CONCRETE RUBBLE PILE, SWMU 97

1. **General**. The United States Army Corps of Engineers (USACE), Tulsa District was requested by USACE, Albuquerque District to perform an environmental assessment on a portion of the Rubble Pile at Cannon Air Force Base (AFB), New Mexico. The purpose of the investigation is to determine the degree of contamination, if any, in the Rubble pile prior to the start of construction on the site. This report provides the results of the environmental assessment.

2. **Background**. The rubble pile is Solid Waste Management Unit (SWMU) 97 under the provisions of Cannon AFB Resources Conservation and Recovery Act (RCRA) permit. The RCRA Facilities Assessment gave the area a low priority for further action and the Facilities Investigation (FI) is not scheduled until 1992 or 1993. The rubble pile is located near the northeast corner of the base between the munitions facility on the east and the sewage lagoon and perimeter road on the west as shown on Figure 2.1. The proposed expansion of the munitions facility requires clearing the rubble from the north end of the site to accommodate new construction. The site consists of construction debris, bricks, concrete blocks, tiles, asbestos tiles, concrete culverts, asphalt roofing shingles etc. and what appears to be asphalt and concrete paving and sub-base material. Only minor amounts of wood were observed. It is believed that the majority

of the rubble comes from demolition of World War II age buildings and the runways. The older, higher piles of rubble on the west and north sides of the site are overgrown with grass, shrubs and small trees as shown on photograph 1, Appendix B. The newer piles appeared as individual piles dumped out over the area still in small conical heaps as shown on photograph 2, Appendix B.

3. **Investigation**. The investigations were conducted according to the approved work plan. Two specific wastes, friable asbestos and PCBs, were thought to be possible contaminants from the building and runway demolition. Eight trenches were excavated during the period 4-5 December 1990 as shown on Figure 3.1. A trackhoe with a long arm was used to excavate the trenches and a bull dozer was used to clear trails, provide working platforms and backfill the trenches. The bucket on the trackhoe was steam cleaned between holes to prevent cross contamination. A rinsate sample off the bucket was collected after it was cleaned at trench 4. Two types of trenches were excavated. Type A trenches were excavated only through the rubble. Representative samples were taken from the rubble in these trenches to analyze for asbestos and PCBs. Type B trenches were excavated through the rubble and five feet into the undisturbed soil below. Type B trenches also had samples taken to analyze for asbestos and PCBs. In addition, representative rubble samples from the four type B trenches were tested using the Toxicity Characteristic Leaching Procedure (TCLP). The soil from the type B trenches was sampled



● TYPE "A" TRENCHES

○ TYPE "B" TRENCHES

△ BACKGROUND TRENCH

0 200 400 600 800 1000
Scale of feet

Figure 3.1 - Trench Location Map

from 0 to 1 feet and 4 to 5 feet measured downward from the natural ground surface. The soil samples were analyzed for volatiles (VOA), semivolatiles (SVOA), pesticides and PCBs and selected transition metals. Two of the type B sampling locations, 2 and 7, were located under the proposed foundations of buildings to be constructed during the expansion of the munitions facility. No rubble was encountered in trench 7. The asbestos and PCB samples were taken from the surface soils and dust, approximately 0 to 1 inch. The TCLP sample was collected from the ash encountered in trench 8. A quality control sample was collected in the 0 to 1 foot zone in trench 5. A background soil trench was excavated about 400 feet north of the site in an open field. Geologic logs were made of the materials encountered in the trenches. These logs are included in Appendix A. Photographs of each of the trenches and the general site conditions are included in Appendix B. The trenches were staked on completion for future survey.

4. **Results**.

a. **Trenching**. The trenching indicates that the majority of the material in the rubble pile is airfield paving and sub-grade material. The second most prevalent waste encountered was building demolition rubble. Mostly this material was surficial and was piled in individual heaps in the southeastern quadrant of the site or on top of the airfield material. The third type of

waste encountered was cinders, ash, other burned material, glass, and metal in what appears to be burn trenches. This material was not reported as being in this area. The burn trenches date from the earliest days of the base. An unburned portion of a newspaper had the date of December 28, 1943. The burn trenches and ash were encountered in trenches 4 and 8. The burn trench in trench 8 appears to be excavated about ten feet wide and about three feet deep below the original ground line. Soil was mounded on either side of the burn trench to make a trench four feet deep. When the burn trench was full excess soil was used to cover the trench. In the soil cover observed in trench 8, there is an indication of a second trench to the east. In the trench 4, airfield paving and sub-grade were placed over the soil cover. No obvious friable asbestos or oily material which may contain PCBs were encountered in any of the trenches. Photographs of each of the trenches is presented in Appendix B.

b. **Analytical.** Copies of the original laboratory data sheets are provided in Appendix C.

1). Rubble and Burn Trench Material. The analytical results of the samples for asbestos, PCBs, and TCLP are summarized in Table 4.1.

a). Asbestos. The asbestos samples were analyzed using polarized light microscopy. The only sample which contained detectable asbestos was from trench 1. It contained less than 0.25 percent actinolite asbestos. The sample was

Table 4.1 - Summary of Analytical Results of Rubble and Burn Trench Ash

			TCLP				
	Asbestos	PCBs	Extractable Organics	Volatile Organics	Herbicides	Pesticides	Metals
	percent	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
Trench 1	< 0.25 percent*	ND					
Trench 2	ND	ND	ND	ND	ND	ND	Ba - 0.8 Hg - 0.002
Trench 3	ND	ND	ND	ND	ND	ND	Ba - 1.3 Cd - 0.01
Trench 4	ND	ND					
Trench 5	ND	ND	ND	ND	ND	ND	Ba - 0.8
Trench 6	ND	ND					
Trench 7	ND	ND					
Trench 8	ND	ND	ND	ND	ND	ND	Ba - 0.2

* <0.25 percent actinolite asbestos

collected from a pocket of broken concrete blocks and crumbly mortar. Other samples were taken from such places as just below a piece of asbestos tile, old gypsum wallboard, and from the natural soil surface. The sample from the natural soil, at trench 7, was taken to determine if asbestos fibers had been blown around in the area. The sample from trench 8 was taken from the burn trench ash.

b). PCBs. PCBs were analyzed using method 8080. There were no PCBs detected in the rubble or burn trench material.

c). TCLP. The samples were prepared using EPA TCLP extraction method 1311. The extract was then analyzed for VOA

using method 8240, for SVOA using method 8270, for herbicides using method 8150, for pesticides using method 8080, and for metals using method 6010 (ICP) except for Arsenic, Selenium and Mercury which used methods 7060, 7740 and 7471 respectively. There were no detections of VOAs, SVOAs, herbicides or pesticides. Only low levels of three metals were detected. Barium was detected in every sample ranging from 1.3 to 0.2 mg/l. Mercury was detected at 0.002 mg/l in trench 2 and Cadmium was detected in trench 3 at 0.01 mg/l. Except for the Barium at 1.3 mg/l, these metals concentrations are at or below maximum safe drinking water standards. The drinking water standard for Barium is 1.0 mg/l.

2). Soils. The analytical results of the soil samples are presented in Table 4.2.

a). Volatile Organics. The VOAs were analyzed using method 8240. There were no volatile organics detected in the soils.

b). Semivolatile Organics. The SVOAs were analyzed using method 8270. Two samples detected SVOAs on the Target Compound List. The trench 2 sample from 0 to 1 foot had 3400 ug/kg bis(2-ethyl-hexyl) phthalate (Bis). This is a common laboratory contaminant, however none of the other samples had Bis detected as would be expected if the contamination came from the laboratory. The trench 3 sample from 4 to 5 feet had 2000 ug/kg Benzidine detected. There were also 14 tentatively identified compounds (TICs) from 13,000 to 1100 ug/kg detected. Most of

Table 4.2 - Summary of Analytical Results of Soils

	0 to 1 Feet Below Natural Ground				4 to 5 Feet Below Natural Ground				
	VOA	SVOA	Pest/PCBs	Metals	VOA	SVOA	Pest/PCBs	Metals	Notes
	ug/kg	ug/kg	ug/kg	mg/kg	ug/kg	ug/kg	ug/kg	mg/kg	
Trench 1									Soil samples were not collected from Trench 1
Trench 2	ND	Bis- 3400	ND	As- 2.4 Mn- 85.0 Ba- 63.9 Mo- 28.0 Cd- 1.8 Ni- 7.9 Co- 3.1 V - 12.8 Cr- 5.9 Zn- 14.6 Cu- 5.0 Hg- 0.03	ND	ND	ND	As- 1.7 Mn- 57.0 Ba-121 Mo- 47.8 Cd- 2.9 Ni- 7.1 Co- 3.3 Se- 1.6 Cr- 9.6 V - 17.7 Cu- 4.5 Zn- 19.6 Hg- 0.01	Bis= Bis(2-ethyl-hexyl) phthalate
Trench 3	ND	ND	ND	As- 1.7 Mn-138 Ba- 82.1 Ni- 7.8 Cd- 8.5 Se- 0.6 Co- 3.8 V - 17.8 Cr- 10.3 Zn- 31.6 Cu- 20.2 Hg- 0.02	ND	Ben- 2000	ND	As- 3.0 Mn- 68.2 Ba-705 Ni- 9.2 Cd- 33.3 Se- 1.5 Co- 5.2 V - 27.0 Cr- 9.4 Zn- 23.1 Cu- 2.3 Hg- 0.02	Ben= Benzidine 14 SVOA Tentatively identified compounds were also detected in the 4-5 foot sample.
Trench 4									Soil samples were not collected from Trench 4
Trench 5	ND	ND	ND	As- 2.9 Mn-198 Ba-108 Mo-106 Cd- 4.7 Ni- 13.1 Co- 6.7 V - 27.9 Cr- 15.4 Zn- 36.9 Cu- 8.3 Hg- 0.65	ND	ND	ND	As- 2.9 Mo- 57.9 Ba-537 Ni- 9.6 Cd- 3.2 Se- 1.8 Co- 5.3 V - 21.7 Cr- 8.0 Zn- 18.9 Cu- 4.5 Mn- 78.7	
Trench 5 (QC Sample)	ND	ND	ND	As- 2.4 Mn-175 Ba- 85.9 Mo- 32.7 Cd- 1.8 Ni- 11.8 Co- 3.8 Se- 0.3 Cr- 9.1 V - 19.2 Cu- 6.6 Zn- 23.5 Hg- 0.03					

294 11

Table 4.2 - Summary of Analytical Results of Soils (continued)

	0 to 1 Feet Below Natural Ground				4 to 5 Feet Below Natural Ground				
	VOA	SVOA	Pest/PCBs	Metals	VOA	SVOA	Pest/PCBs	Metals	Notes
	ug/kg	ug/kg	ug/kg	mg/kg	ug/kg	ug/kg	ug/kg	mg/kg	
Trench 6									Soil samples were not collected from Trench 6.
Trench 7	ND	ND	ND	As- 2.2 Mn- 89.6 Ba-408 Mo- 47.0 Cd- 3.0 Ni- 9.7 Co- 4.3 Se- 1.0 Cr- 9.3 V - 16.4 Cu- 8.8 Zn- 24.6 Hg- 0.07	ND	ND	ND	As- 2.7 Mn-155 Ba-199 Mo- 69.0 Cd- 45.5 Ni- 11.1 Co- 5.4 Se- 2.7 Cr- 12.3 V - 20.8 Cu- 6.1 Zn- 30.1 Hg- 0.02	
Trench 8									Soil samples were not collected from Trench 8.
Back-ground Trench	ND	ND	ND	As- 2.8 Mn-176 Ba- 94.7 Mo- 83.2 Cd- 4.6 Ni- 11.7 Co- 5.9 Se- 1.9 Cr- 11.6 V - 22.3 Cu- 6.5 Zn- 30.7 Hg- 0.07	ND	ND	ND	As- 2.3 Mn- 48.8 Ba-106 Mo- 46.9 Cd- 2.8 Ni- 8.3 Co- 3.2 Se- 1.9 Cr- 7.8 V - 15.4 Cu- 4.1 Zn- 18.1 Hg- 0.03	1 SVOA Tentatively identified compound was also detected in the 0 to 1 foot sample.

294 12

these TICs are long chain alkanes such as might be associated with asphalt. The shallow background soil sample had one TIC detected at 700 ug/kg. This TIC was not detected in any other sample.

c). Pesticides/PCBs. The pesticides/PCBs were analyzed using method 8080. There were no pesticides/PCBs detected in any of the soil samples.

d). Metals. The metals were analyzed using method 6010 (ICP) except for Arsenic, Selenium, and Mercury which used methods 7060, 7740 and 7471 respectively. Thirteen metals were detected in most samples. These metals are Arsenic, Barium, Cadmium, Cobalt, Chromium, Copper, Mercury, Manganese, Molybdenum, Nickel, Selenium, Vanadium, and Zinc. Selenium was not detected in almost half of the samples. Mercury was not detected in one sample. Silver, Beryllium, Lead, Antimony and Thallium were analyzed for but not detected in any of the samples. There were three metals with anomalous high values. Barium was detected in the trench 3 deep soil sample at 705 mg/kg, in the trench 5 deep soil sample at 537 mg/kg, and in the trench 6 shallow soil sample at 408 mg/kg. Cadmium was detected at almost ten times the background level in trench 3 deep soil sample at 33.3 mg/kg and in the trench 7 deep soil sample at 45.5 mg/kg. Mercury was detected at an order of magnitude greater than the background sample in the trench 5 shallow soil sample at 0.65 mg/kg. Trench 3 had anomalous high values in both Barium and Cadmium in the TCLP analysis and the soils.

3). Rinsate Sample. The rinsate sample results are summarized in Table 4.3.

a). Volatile Organics. The VOAs were analyzed using method 8240. There were no VOAs detected in the rinsate water.

b). Semivolatile Organics. The SVOAs were analyzed using method 8270. There were four TICs detected in the rinsate water. All were below 100 ug/l and were probably related to residual compounds in the steam cleaner's water tank. None of these TICs were detected in any other sample.

c). Pesticides/PCBs. The pesticides/PCBs were analyzed using method 8080. There were no pesticides or PCBs detected in the rinsate water.

d). Metals. The metals were analyzed using methods 6010 (ICP) except for Arsenic, Selenium and Mercury which used methods 7060, 7740 and 7471 respectively. Only one metal, Zinc, was detected in the rinsate water at 0.02 mg/l. This value is low enough so as not to affect soils, rubble or ash metals concentrations. These results are shown in Table 4.3.

Table 4.3 - Summary of Analytical Results of the Rinsate Sample

	VOA	SVOA	Pest/PCBs	Metals	Notes
	ug/l	ug/l	ug/l	mg/l	
Rinsate Sample	ND	ND	ND	Zn- 0.02	4 SVOA Tentatively identified compounds detected in the rinsate sample

5. **Quality Control Review**. A review of the field sampling procedures indicates that the sampling procedures were satisfactory. A review of the laboratory data indicates that there is sufficient correlation between the surrogate compound spike level and the percent recovery. The holding times are within the standard periods. Only one parameter, Mercury, does not compare well with the duplicate sample, T 505QC. The duplicate Mercury does compare well with the other Mercury analyses.

6. **Conclusions**. The rubble at the north end of the rubble pile shows no evidence of serious contamination. There should be no hazard in moving the rubble. There is some evidence of soil contamination in trench 3 below the ash as evidenced by the high metals, Barium and Cadmium, and semivolatiles, Benzidine. The burn trenches at the site, which are part of the SWMU, were unexpected. The number of trenches, length, location and variation in material placed in the trenches is unknown. Prior to movement of the rubble, investigations should be undertaken to establish the characteristics of the burn trenches and the soil below. However, even if the rubble is moved prior to completion of the RCRA Facilities Investigation (FI), the site will remain a solid waste management unit (SWMU). The status of the site and corrective actions, if any, will be determined by the Environmental Protection Agency upon completion of the FI. An accelerated FI would provide the necessary information on the

site and burn trenches. The accelerated FI could be completed within one to one and a half years after it is started.

7. **Recommendations**. Recommend the construction at the site be delayed until the completion of the FI.

ENVIRONMENTAL ASSESSMENT

CONCRETE RUBBLE FILE, SWMU 97
(LANDFILL NO. 25)

COPIES OF ORIGINAL LABORATORY REPORT

CANNON AIR FORCE BASE
NEW MEXICO

PREPARED BY
U.S. ARMY CORPS OF ENGINEERS
TULSA DISTRICT
FEBRUARY 1991

ENCLOSURE 1a

Appendix C
Table of Contents

Trench No.	Page No.
Trench 1	1
Trench 2	3
Trench 3	29
Trench 4	55
Trench 5	57
Trench 5QC	83
Trench 6	95
Trench 7	97
Trench 8	117
Background Trench	125
Rinsate	143
Chain of Custody Forms	153

CANNON AFB
ASBESTOS SAMPLE ANALYSIS
SWDED-GL REPORT NO. 15263

1. REFERENCE: Reference is made to Tulsa Test Request MIL 90-113 requesting testing of possible asbestos samples.

2. SAMPLES: On December 5 and 10, 1990 nine bulk samples were received for analysis by Polarized Light Microscopy.

SWD LAB NO.	FIELD SAMPLE NO.	LOCATION	TOTAL VOLUME (liters)
A-1413	T-101	Rubble Pile - Trench 1	N/A
A-1414	T-301	Rubble Pile - Trench 3	N/A
A-1417	T-201	Rubble Pile - Trench 2	N/A
A-1418	T-401	Rubble Pile - Trench 4	N/A
A-1419	T-501	Rubble Pile - Trench 5	N/A
A-1420	T-501QC	Rubble Pile - Trench 5	N/A
A-1421	T-601	Rubble Pile - Trench 6	N/A
A-1422	T-701	Rubble Pile - Trench 7	N/A
A-1423	T-801	Rubble Pile - Trench 8	N/A

3. RESULTS OF PLM ANALYSIS:

SWD LAB NO.	FIELD SAMPLE NO.	TYPE MATERIAL	ASBESTOS TYPE	PERCENT ASBESTOS
A-1413	T-101	Soil	Actinolite	Trace
A-1414	T-301	Soil	None	Detected
A-1417	T-201	Soil	None	Detected
A-1418	T-401	Soil	None	Detected
A-1419	T-501	Soil	None	Detected
A-1420	T-501QC	Soil	None	Detected
A-1421	T-601	Soil	None	Detected
A-1422	T-701	Soil	None	Detected
A-1423	T-801	Soil	None	Detected

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 5-DEC-1990

REPORT NUMBER: D90-30984
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Janice Stewart

SAMPLE MATRIX: SOIL
ID MARKS: T-102 0-3892

TEST REQUESTED	DETECTION LIMIT			RESULTS	
PCB by EPA Method 8080					
Arochlor 1016	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1221	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1232	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1242	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1248	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1254	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1260	0.1	mg/Kg	<	0.1	mg/Kg

NDRC Laboratories, Inc.

David R. Godwin, Ph.D.
Chief Executive Officer

2

CANNON AFB
ASBESTOS SAMPLE ANALYSIS
SWDED-GL REPORT NO. 15263

1. REFERENCE: Reference is made to Tulsa Test Request MIL 90-113 requesting testing of possible asbestos samples.

2. SAMPLES: On December 5 and 10, 1990 nine bulk samples were received for analysis by Polarized Light Microscopy.

SWD LAB NO.	FIELD SAMPLE NO.	LOCATION	TOTAL VOLUME (liters)
A-1413	T-101	Rubble Pile - Trench 1	N/A
A-1414	T-301	Rubble Pile - Trench 3	N/A
A-1417	T-201	Rubble Pile - Trench 2	N/A
A-1418	T-401	Rubble Pile - Trench 4	N/A
A-1419	T-501	Rubble Pile - Trench 5	N/A
A-1420	T-501QC	Rubble Pile - Trench 5	N/A
A-1421	T-601	Rubble Pile - Trench 6	N/A
A-1422	T-701	Rubble Pile - Trench 7	N/A
A-1423	T-801	Rubble Pile - Trench 8	N/A

3. RESULTS OF PLM ANALYSIS:

SWD LAB NO.	FIELD SAMPLE NO.	TYPE MATERIAL	ASBESTOS TYPE	PERCENT ASBESTOS
A-1413	T-101	Soil	Actinolite	Trace
A-1414	T-301	Soil	None	Detected
A-1417	T-201	Soil	None	Detected
A-1418	T-401	Soil	None	Detected
A-1419	T-501	Soil	None	Detected
A-1420	T-501QC	Soil	None	Detected
A-1421	T-601	Soil	None	Detected
A-1422	T-701	Soil	None	Detected
A-1423	T-801	Soil	None	Detected

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 6-DEC-1990

REPORT NUMBER: D90-31110
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Cathy Hutchins

SAMPLE MATRIX: SOIL
ID MARKS: T202 0-3912

TEST REQUESTED	DETECTION LIMIT			RESULTS	
PCB by EPA Method 8080					
Arochlor 1016	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1221	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1232	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1242	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1248	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1254	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1260	0.1	mg/Kg	<	0.1	mg/Kg

NDRC Laboratories, Inc. David R. Godwin, Ph.D.
David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 6-DEC-1990

REPORT NUMBER: D90-31111
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Cathy Hutchins

SAMPLE MATRIX: SOIL
ID MARKS: T203 0-3913

TEST REQUESTED	DETECTION LIMIT			RESULTS	
EPA 8270 TCLP - Extractable Organics					
o-Cresol	0.04	mg/L	<	0.04	mg/L
m-Cresol	0.04	mg/L	<	0.04	mg/L
p-Cresol	0.04	mg/L	<	0.04	mg/L
2,4-Dinitrotoluene	0.02	mg/L	<	0.02	mg/L
Hexachlorobenzene	0.02	mg/L	<	0.02	mg/L
Hexachlorobutadiene	0.02	mg/L	<	0.02	mg/L
Hexachloroethane	0.02	mg/L	<	0.02	mg/L
Nitrobenzene	0.02	mg/L	<	0.02	mg/L
Pentachlorophenol	0.10	mg/L	<	0.10	mg/L
Pyridine	0.02	mg/L	<	0.02	mg/L
2,4,5-Trichlorophenol	0.02	mg/L	<	0.02	mg/L
2,4,6-Trichlorophenol	0.02	mg/L	<	0.02	mg/L

QUALITY CONTROL DATA

SURROGATE COMPOUND	SPIKE LEVEL(µg/L)	PERCENT RECOVERED
Nitrobenzene-d5(SS)	50	70.1
2-Fluorobiphenyl(SS)	50	74.3
Terphenyl-d14(SS)	50	77.4
Phenol-d6(SS)	100	58.4
2-Fluorophenol(SS)	100	61.8
2,4,6-Tribromophenol(SS)	100	53.0

NDRC Laboratories, Inc. David R. Godwin

David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 6-DEC-1990

REPORT NUMBER: D90-31111
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Cathy Hutchins

SAMPLE MATRIX: SOIL
ID MARKS: T203 0-3913

TEST REQUESTED	DETECTION LIMIT			RESULTS	
EPA 8240 TCLP - Volatile Organics					
Benzene	0.01	mg/L	<	0.01	mg/L
Carbon tetrachloride	0.01	mg/L	<	0.01	mg/L
Chlorobenzene	0.01	mg/L	<	0.01	mg/L
Chloroform	0.01	mg/L	<	0.01	mg/L
1,4-Dichlorobenzene	0.01	mg/L	<	0.01	mg/L
1,2-Dichloroethane	0.01	mg/L	<	0.01	mg/L
1,1-Dichloroethene	0.01	mg/L	<	0.01	mg/L
Methyl ethyl ketone	0.05	mg/L	<	0.05	mg/L
Tetrachloroethene	0.01	mg/L	<	0.01	mg/L
Trichloroethene	0.01	mg/L	<	0.01	mg/L
Vinyl chloride	0.02	mg/L	<	0.02	mg/L

QUALITY CONTROL DATA

SURROGATE COMPOUND	SPIKE LEVEL(µg/L)	PERCENT RECOVERED
1,2-Dichloroethane-d4(SS)	50	106
Toluene-d8(SS)	50	94.2
Bromofluorobenzene(SS)	50	98.6

NDRC Laboratories, Inc. David R. Godwin
David R. Godwin, Ph.D.
Chief Executive Officer

6

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 6-DEC-1990

REPORT NUMBER: D90-31111
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Cathy Hutchins

SAMPLE MATRIX: SOIL
ID MARKS: T203 0-3913

TEST REQUESTED	DETECTION LIMIT		RESULTS		
TCLP Herbicides					
2,4-D	5.0	mg/L	<	5.0	mg/L
2,4,5-TP Silvex	0.5	mg/L	<	0.5	mg/L

NDRC Laboratories, Inc. David R. Godwin

David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 6-DEC-1990

REPORT NUMBER: D90-31111
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Cathy Hutchins

SAMPLE MATRIX: SOIL
ID MARKS: T203 0-3913

TEST REQUESTED	DETECTION LIMIT		RESULTS		
TCLP Pesticides					
chlordane	0.014	mg/L	<	0.014	mg/L
Heptachlor	0.0010	mg/L	<	0.0010	mg/L
Heptachlor epoxide	0.0010	mg/L	<	0.0010	mg/L
Endrin	0.006	mg/L	<	0.006	mg/L
Lindane	0.004	mg/L	<	0.004	mg/L
Methoxychlor	0.18	mg/L	<	0.18	mg/L
Toxaphene	0.24	mg/L	<	0.24	mg/L

NDRC Laboratories, Inc. David R. Godwin, Ph.D.
David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 6-DEC-1990

REPORT NUMBER: D90-31111
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Cathy Hutchins

SAMPLE MATRIX: SOIL
ID MARKS: T203 0-3913

TEST REQUESTED	DETECTION LIMIT		RESULTS		
TCLP METALS:					
Silver	0.01	mg/L	<	0.01	mg/L
Arsenic	0.05	mg/L	<	0.05	mg/L
Barium	0.1	mg/L		0.8	mg/L
Cadmium	0.01	mg/L	<	0.01	mg/L
Chromium	0.05	mg/L	<	0.05	mg/L
Mercury	0.001	mg/L		0.002	mg/L
Lead	0.02	mg/L	<	0.02	mg/L
Selenium	0.05	mg/L	<	0.05	mg/L

NDRC Laboratories, Inc. David R. Godwin VZ
David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 6-DEC-1990

REPORT NUMBER: D90-31112
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Cathy Hutchins

SAMPLE MATRIX: SOIL
ID MARKS: T204 0-3914

TEST REQUESTED	DETECTION LIMIT			RESULTS	
EPA 8240 Volatile Organics					
Acrolein	10.0	µg/Kg	<	10.0	µg/Kg
Acrylonitrile	10.0	µg/Kg	<	10.0	µg/Kg
Benzene	5.0	µg/Kg	<	5.0	µg/Kg
Bromodichloromethane	5.0	µg/Kg	<	5.0	µg/Kg
Bromoform	5.0	µg/Kg	<	5.0	µg/Kg
Bromomethane	10.0	µg/Kg	<	10.0	µg/Kg
Carbon tetrachloride	5.0	µg/Kg	<	5.0	µg/Kg
Chlorobenzene	5.0	µg/Kg	<	5.0	µg/Kg
Chlorodibromomethane	5.0	µg/Kg	<	5.0	µg/Kg
Chloroethane	10.0	µg/Kg	<	10.0	µg/Kg
2-Chloroethyvinyl ether	10.0	µg/Kg	<	10.0	µg/Kg
Chloroform	5.0	µg/Kg	<	5.0	µg/Kg
Chloromethane	10.0	µg/Kg	<	10.0	µg/Kg
1,2-Dichlorobenzene	5.0	µg/Kg	<	5.0	µg/Kg
1,3-Dichlorobenzene	5.0	µg/Kg	<	5.0	µg/Kg
1,4-Dichlorobenzene	5.0	µg/Kg	<	5.0	µg/Kg
1,1-Dichloroethane	5.0	µg/Kg	<	5.0	µg/Kg
1,2-Dichloroethane	5.0	µg/Kg	<	5.0	µg/Kg
1,1-Dichloroethene	5.0	µg/Kg	<	5.0	µg/Kg
trans-1,2-Dichloroethene	5.0	µg/Kg	<	5.0	µg/Kg
1,2-Dichloropropane	5.0	µg/Kg	<	5.0	µg/Kg
cis-1,3-Dichloropropene	5.0	µg/Kg	<	5.0	µg/Kg
trans-1,3 Dichloropropene	5.0	µg/Kg	<	5.0	µg/Kg
Ethylbenzene	5.0	µg/Kg	<	5.0	µg/Kg
Methylene chloride	10.0	µg/Kg	<	10.0	µg/Kg
1,1,2,2-Tetrachloroethane	5.0	µg/Kg	<	5.0	µg/Kg
Tetrachloroethene	5.0	µg/Kg	<	5.0	µg/Kg
Toluene	5.0	µg/Kg	<	5.0	µg/Kg
1,1,1-Trichloroethane	5.0	µg/Kg	<	5.0	µg/Kg
1,1,2-Trichloroethane	5.0	µg/Kg	<	5.0	µg/Kg

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

REPORT NUMBER: D90-31112

TEST REQUESTED	DETECTION LIMIT			RESULTS	
EPA 8240 (Continued) Volatile Organics					
Trichloroethene	5.0	µg/Kg	<	5.0	µg/Kg
Trichlorofluoromethane	10.0	µg/Kg	<	10.0	µg/Kg
Vinyl chloride	10.0	µg/Kg	<	10.0	µg/Kg
Xylenes	5.0	µg/Kg	<	5.0	µg/Kg

QUALITY CONTROL DATA

SURROGATE COMPOUND	SPIKE LEVEL(µg/Kg)	PERCENT RECOVERED
1,2-Dichloroethane-d4 (SS)	50	113
Toluene-d8 (SS)	50	114
Bromofluorobenzene (SS)	50	77.0

NDRC Laboratories, Inc. David R. Godwin, Ph.D.
Chief Executive Officer

11

294 50

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 6-DEC-1990

REPORT NUMBER: D90-31112
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Cathy Hutchins

SAMPLE MATRIX: SOIL
ID MARKS: T204 0-3914

TEST REQUESTED	DETECTION LIMIT			RESULTS	
EPA 8270 Acid Extractable Organics					
4-Chloro-3-methylphenol	660	µg/Kg	<	660	µg/Kg
2-Chlorophenol	660	µg/Kg	<	660	µg/Kg
2,4-Dichlorophenol	660	µg/Kg	<	660	µg/Kg
2,4-Dimethylphenol	660	µg/Kg	<	660	µg/Kg
4,6-Dinitro-2-methylphenol	660	µg/Kg	<	660	µg/Kg
2,4-Dinitrophenol	3300	µg/Kg	<	3300	µg/Kg
2-Methylphenol	660	µg/Kg	<	660	µg/Kg
2-Nitrophenol	660	µg/Kg	<	660	µg/Kg
4-Nitrophenol	3300	µg/Kg	<	3300	µg/Kg
Pentachlorophenol	3300	µg/Kg	<	3300	µg/Kg
Phenol	660	µg/Kg	<	660	µg/Kg
2,4,6-Trichlorophenol	660	µg/Kg	<	660	µg/Kg

QUALITY CONTROL DATA

SURROGATE COMPOUND	SPIKE LEVEL(µg/Kg)	PERCENT RECOVERED
Phenol-d5 (SS)	100	40.7
2-Fluorophenol (SS)	100	46.4
2,4,6-Tribromophenol (SS)	100	32.4

NDRC Laboratories, Inc. David R. Godwin
David R. Godwin, Ph.D.
Chief Executive Officer

12

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 6-DEC-1990

REPORT NUMBER: D90-31112
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Cathy Hutchins

SAMPLE MATRIX: SOIL
ID MARKS: T204 0-3914

TEST REQUESTED	DETECTION LIMIT			RESULTS	
EPA 8270 Base-Neutral Extractable Organics					
Acenaphthene	660	µg/Kg	<	660	µg/Kg
Acenaphthylene	660	µg/Kg	<	660	µg/Kg
Anthracene	660	µg/Kg	<	660	µg/Kg
Benzidine	660	µg/Kg	<	660	µg/Kg
Benzo(a)anthracene	660	µg/Kg	<	660	µg/Kg
Benzo(b)fluoranthene	660	µg/Kg	<	660	µg/Kg
Benzo(k)fluoranthene	660	µg/Kg	<	660	µg/Kg
Benzo(g,h,i)perylene	660	µg/Kg	<	660	µg/Kg
Benzo(a)pyrene	660	µg/Kg	<	660	µg/Kg
Bis(2-chloroethoxy)methane	660	µg/Kg	<	660	µg/Kg
Bis(2-chloroethyl)ether	660	µg/Kg	<	660	µg/Kg
Bis(2-chloroisopropyl)ether	660	µg/Kg	<	660	µg/Kg
Bis(2-ethylhexyl)phthalate	660	µg/Kg		3400	µg/Kg
4-Bromophenylphenyl ether	660	µg/Kg	<	660	µg/Kg
Butyl benzyl phthalate	660	µg/Kg	<	660	µg/Kg
2-Chloronaphthalene	660	µg/Kg	<	660	µg/Kg
4-Chlorophenylphenyl ether	660	µg/Kg	<	660	µg/Kg
Chrysene	660	µg/Kg	<	660	µg/Kg
Dibenz(a,h)anthracene	660	µg/Kg	<	660	µg/Kg
Di-n-butylphthalate	660	µg/Kg	<	660	µg/Kg
1,3-Dichlorobenzene	660	µg/Kg	<	660	µg/Kg
1,4-Dichlorobenzene	660	µg/Kg	<	660	µg/Kg
1,2-Dichlorobenzene	660	µg/Kg	<	660	µg/Kg
3,3'-Dichlorobenzidine	1300	µg/Kg	<	1300	µg/Kg
Diethylphthalate	660	µg/Kg	<	660	µg/Kg
Dimethylphthalate	660	µg/Kg	<	660	µg/Kg
2,4-Dinitrotoluene	660	µg/Kg	<	660	µg/Kg
2,6-Dinitrotoluene	660	µg/Kg	<	660	µg/Kg
Di-n-octylphthalate	660	µg/Kg	<	660	µg/Kg
Fluoranthene	660	µg/Kg	<	660	µg/Kg

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592

Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

REPORT NUMBER: D90-31112

TEST REQUESTED	DETECTION LIMIT			RESULTS	
EPA 8270 (Continued) Base-Neutral Extractable Organics					
Fluorene	660	µg/Kg	<	660	µg/Kg
Hexachlorobenzene	660	µg/Kg	<	660	µg/Kg
Hexachlorobutadiene	660	µg/Kg	<	660	µg/Kg
Hexachlorocyclobutandiene	660	µg/Kg	<	660	µg/Kg
Hexachloroethane	660	µg/Kg	<	660	µg/Kg
Indeno(1,2,3-cd)pyrene	660	µg/Kg	<	660	µg/Kg
Isophorone	660	µg/Kg	<	660	µg/Kg
Naphthalene	660	µg/Kg	<	660	µg/Kg
Nitrobenzene	660	µg/Kg	<	660	µg/Kg
N-Nitrosodimethylamine	660	µg/Kg	<	660	µg/Kg
N-Nitrosodiphenylamine	660	µg/Kg	<	660	µg/Kg
N-Nitrosodipropylamine	660	µg/Kg	<	660	µg/Kg
Phenanthrene	660	µg/Kg	<	660	µg/Kg
Pyrene	660	µg/Kg	<	660	µg/Kg
1,2,4-Trichlorobenzene	660	µg/Kg	<	660	µg/Kg

QUALITY CONTROL DATA

SURROGATE COMPOUND	SPIKE LEVEL(µg/Kg)	PERCENT RECOVERED
Nitrobenzene-d5 (SS)	50	49.9
2-Fluorobenzene (SS)	50	63.8
Terphenyl-d14 (SS)	50	74.5

NDRC Laboratories, Inc. David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 6-DEC-1990

REPORT NUMBER: D90-31112
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Cathy Hutchins

SAMPLE MATRIX: SOIL
ID MARKS: T204 0-3914

TENTATIVELY IDENTIFIED COMPOUNDS

COMPOUND	RETENTION TIME	FRACTION	RESULTS	
Tentatively Identified Compounds - ABN				
No compounds detected		ABN	660	µg/Kg

NDRC Laboratories, Inc. David R. Godwin
David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 6-DEC-1990

REPORT NUMBER: D90-31112
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Cathy Hutchins

SAMPLE MATRIX: SOIL
ID MARKS: T204 0-3914

TENTATIVELY IDENTIFIED COMPOUNDS

COMPOUND	RETENTION TIME	FRACTION	RESULTS	
Tentatively Identified Compounds - VOA				
No compounds detected		VOA	10	µg/Kg

NDRC Laboratories, Inc. David R. Godwin, Ph.D.
David R. Godwin, Ph.D.
Chief Executive Officer

16

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 6-DEC-1990

REPORT NUMBER: D90-31112
REPORT DATE: 7-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Cathy Hutchins

SAMPLE MATRIX: SOIL
ID MARKS: T204 0-3914

TEST REQUESTED	DETECTION LIMIT			RESULTS	
Organochlorine Pesticides and PCB's					
Aldrin	27	µg/Kg	<	27	µg/Kg
Alpha-BHC	20	µg/Kg	<	20	µg/Kg
Beta-BHC	40	µg/Kg	<	40	µg/Kg
Delta-BHC	60	µg/Kg	<	60	µg/Kg
Gamma-BHC(Lindane)	26	µg/Kg	<	26	µg/Kg
Chlordane	93	µg/Kg	<	93	µg/Kg
4,4'-DDD	73	µg/Kg	<	73	µg/Kg
4,4'-DDE	26	µg/Kg	<	26	µg/Kg
4,4'-DDT	80	µg/Kg	<	80	µg/Kg
Dieldrin	13	µg/Kg	<	13	µg/Kg
Endosulfan I	93	µg/Kg	<	93	µg/Kg
Endosulfan II	26	µg/Kg	<	26	µg/Kg
Endosulfan Sulfate	442	µg/Kg	<	442	µg/Kg
Endrin	40	µg/Kg	<	40	µg/Kg
Endrin Aldehyde	154	µg/Kg	<	154	µg/Kg
Heptachlor	20	µg/Kg	<	20	µg/Kg
Heptachlor Epoxide	556	µg/Kg	<	556	µg/Kg
Methoxychlor	1210	µg/Kg	<	1210	µg/Kg
Toxaphene	1610	µg/Kg	<	1610	µg/Kg
Arochlor-1016	67	µg/Kg	<	67	µg/Kg
Arochlor-1221	67	µg/Kg	<	67	µg/Kg
Arochlor-1232	67	µg/Kg	<	67	µg/Kg
Arochlor-1242	67	µg/Kg	<	67	µg/Kg
Arochlor-1248	67	µg/Kg	<	67	µg/Kg
Arochlor-1254	67	µg/Kg	<	67	µg/Kg
Arochlor-1260	67	µg/Kg	<	67	µg/Kg

NDRC Laboratories, Inc. David R. Godwin
David R. Godwin, Ph.D.
Chief Executive Officer

294 59

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 6-DEC-1990

REPORT NUMBER: D90-31113
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Cathy Hutchins

SAMPLE MATRIX: SOIL
ID MARKS: T205 0-3915

TEST REQUESTED	DETECTION LIMIT			RESULTS	
TOTAL METALS:					
Silver	1.0	mg/Kg	<	1.0	mg/Kg
Arsenic	0.1	mg/Kg		2.4	mg/Kg
Barium	1.0	mg/Kg		63.9	mg/Kg
Beryllium	1.0	mg/Kg	<	1.0	mg/Kg
Cadmium	1.0	mg/Kg		1.8	mg/Kg
Cobalt	1.0	mg/Kg		3.1	mg/Kg
Chromium	1.0	mg/Kg		5.9	mg/Kg
Copper	1.0	mg/Kg		5.0	mg/Kg
Mercury	0.01	mg/Kg		0.03	mg/Kg
Manganese	1.0	mg/Kg		85.0	mg/Kg
Molybdenum	1.0	mg/Kg		28.0	mg/Kg
Nickel	1.0	mg/Kg		7.9	mg/Kg
Lead	1.0	mg/Kg	<	1.0	mg/Kg
Antimony	1.0	mg/Kg	<	1.0	mg/Kg
Selenium	0.1	mg/Kg	<	0.1	mg/Kg
Thallium	1.0	mg/Kg	<	1.0	mg/Kg
Vanadium	1.0	mg/Kg		12.8	mg/Kg
Zinc	1.0	mg/Kg		14.6	mg/Kg

NDRC Laboratories, Inc. David R. Godwin
David R. Godwin, Ph.D.
Chief Executive Officer

18

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 6-DEC-1990

REPORT NUMBER: D90-31114
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Cathy Hutchins

SAMPLE MATRIX: SOIL
ID MARKS: T206 0-3916

TEST REQUESTED	DETECTION LIMIT			RESULTS	
EPA 8240 Volatile Organics					
Acrolein	10.0	µg/Kg	<	10.0	µg/Kg
Acrylonitrile	10.0	µg/Kg	<	10.0	µg/Kg
Benzene	5.0	µg/Kg	<	5.0	µg/Kg
Bromodichloromethane	5.0	µg/Kg	<	5.0	µg/Kg
Bromoform	5.0	µg/Kg	<	5.0	µg/Kg
Bromomethane	10.0	µg/Kg	<	10.0	µg/Kg
Carbon tetrachloride	5.0	µg/Kg	<	5.0	µg/Kg
Chlorobenzene	5.0	µg/Kg	<	5.0	µg/Kg
Chlorodibromomethane	5.0	µg/Kg	<	5.0	µg/Kg
Chloroethane	10.0	µg/Kg	<	10.0	µg/Kg
2-Chloroethyvinyl ether	10.0	µg/Kg	<	10.0	µg/Kg
Chloroform	5.0	µg/Kg	<	5.0	µg/Kg
Chloromethane	10.0	µg/Kg	<	10.0	µg/Kg
1,2-Dichlorobenzene	5.0	µg/Kg	<	5.0	µg/Kg
1,3-Dichlorobenzene	5.0	µg/Kg	<	5.0	µg/Kg
1,4-Dichlorobenzene	5.0	µg/Kg	<	5.0	µg/Kg
1,1-Dichloroethane	5.0	µg/Kg	<	5.0	µg/Kg
1,2-Dichloroethane	5.0	µg/Kg	<	5.0	µg/Kg
1,1-Dichloroethene	5.0	µg/Kg	<	5.0	µg/Kg
trans-1,2-Dichloroethene	5.0	µg/Kg	<	5.0	µg/Kg
1,2-Dichloropropane	5.0	µg/Kg	<	5.0	µg/Kg
cis-1,3-Dichloropropene	5.0	µg/Kg	<	5.0	µg/Kg
trans-1,3 Dichloropropene	5.0	µg/Kg	<	5.0	µg/Kg
Ethylbenzene	5.0	µg/Kg	<	5.0	µg/Kg
Methylene chloride	10.0	µg/Kg	<	10.0	µg/Kg
1,1,2,2-Tetrachloroethane	5.0	µg/Kg	<	5.0	µg/Kg
Tetrachloroethene	5.0	µg/Kg	<	5.0	µg/Kg
Toluene	5.0	µg/Kg	<	5.0	µg/Kg
1,1,1-Trichloroethane	5.0	µg/Kg	<	5.0	µg/Kg
1,1,2-Trichloroethane	5.0	µg/Kg	<	5.0	µg/Kg

1c

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

REPORT NUMBER: D90-31114

TEST REQUESTED	DETECTION LIMIT			RESULTS	
EPA 8240 (Continued) Volatile Organics					
Trichloroethene	5.0	µg/Kg	<	5.0	µg/Kg
Trichlorofluoromethane	10.0	µg/Kg	<	10.0	µg/Kg
Vinyl chloride	10.0	µg/Kg	<	10.0	µg/Kg
Xylenes	5.0	µg/Kg	<	5.0	µg/Kg

QUALITY CONTROL DATA

SURROGATE COMPOUND	SPIKE LEVEL(µg/Kg)	PERCENT RECOVERED
1,2-Dichloroethane-d4 (SS)	50	100
Toluene-d8 (SS)	50	106
Bromofluorobenzene (SS)	50	85.1

NDRC Laboratories, Inc. David R. Godwin, Ph.D.
David R. Godwin, Ph.D.
Chief Executive Officer

20

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 6-DEC-1990

REPORT NUMBER: D90-31114
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Cathy Hutchins

SAMPLE MATRIX: SOIL
ID MARKS: T206 0-3916

TEST REQUESTED	DETECTION LIMIT			RESULTS	
EPA 8270 Acid Extractable Organics					
4-Chloro-3-methylphenol	660	µg/Kg	<	660	µg/Kg
2-Chlorophenol	660	µg/Kg	<	660	µg/Kg
2,4-Dichlorophenol	660	µg/Kg	<	660	µg/Kg
2,4-Dimethylphenol	660	µg/Kg	<	660	µg/Kg
4,6-Dinitro-2-methylphenol	660	µg/Kg	<	660	µg/Kg
2,4-Dinitrophenol	3300	µg/Kg	<	3300	µg/Kg
2-Methylphenol	660	µg/Kg	<	660	µg/Kg
2-Nitrophenol	660	µg/Kg	<	660	µg/Kg
4-Nitrophenol	3300	µg/Kg	<	3300	µg/Kg
Pentachlorophenol	3300	µg/Kg	<	3300	µg/Kg
Phenol	660	µg/Kg	<	660	µg/Kg
2,4,6-Trichlorophenol	660	µg/Kg	<	660	µg/Kg

QUALITY CONTROL DATA

SURROGATE COMPOUND	SPIKE LEVEL(µg/Kg)	PERCENT RECOVERED
Phenol-d5 (SS)	100	34.4
2-Fluorophenol (SS)	100	50.7
2,4,6-Tribromophenol (SS)	100	40.1

NDRC Laboratories, Inc. David R. Godwin

David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 6-DEC-1990

REPORT NUMBER: D90-31114
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Cathy Hutchins

SAMPLE MATRIX: SOIL
ID MARKS: T206 0-3916

TEST REQUESTED	DETECTION LIMIT			RESULTS	
EPA 8270 Base-Neutral Extractable Organics					
Acenaphthene	660	µg/Kg	<	660	µg/Kg
Acenaphthylene	660	µg/Kg	<	660	µg/Kg
Anthracene	660	µg/Kg	<	660	µg/Kg
Benzidine	660	µg/Kg	<	660	µg/Kg
Benzo(a)anthracene	660	µg/Kg	<	660	µg/Kg
Benzo(b)fluoranthene	660	µg/Kg	<	660	µg/Kg
Benzo(k)fluoranthene	660	µg/Kg	<	660	µg/Kg
Benzo(g,h,i)perylene	660	µg/Kg	<	660	µg/Kg
Benzo(a)pyrene	660	µg/Kg	<	660	µg/Kg
Bis(2-chloroethoxy)methane	660	µg/Kg	<	660	µg/Kg
Bis(2-chloroethyl)ether	660	µg/Kg	<	660	µg/Kg
Bis(2-chloroisopropyl)ether	660	µg/Kg	<	660	µg/Kg
Bis(2-ethylhexyl)phthalate	660	µg/Kg	<	660	µg/Kg
4-Bromophenylphenyl ether	660	µg/Kg	<	660	µg/Kg
Butyl benzyl phthalate	660	µg/Kg	<	660	µg/Kg
2-Chloronaphthalene	660	µg/Kg	<	660	µg/Kg
4-Chlorophenylphenyl ether	660	µg/Kg	<	660	µg/Kg
Chrysene	660	µg/Kg	<	660	µg/Kg
Dibenz(a,h)anthracene	660	µg/Kg	<	660	µg/Kg
Di-n-butylphthalate	660	µg/Kg	<	660	µg/Kg
1,3-Dichlorobenzene	660	µg/Kg	<	660	µg/Kg
1,4-Dichlorobenzene	660	µg/Kg	<	660	µg/Kg
1,2-Dichlorobenzene	660	µg/Kg	<	660	µg/Kg
3,3'-Dichlorobenzidine	1300	µg/Kg	<	1300	µg/Kg
Diethylphthalate	660	µg/Kg	<	660	µg/Kg
Dimethylphthalate	660	µg/Kg	<	660	µg/Kg
2,4-Dinitrotoluene	660	µg/Kg	<	660	µg/Kg
2,6-Dinitrotoluene	660	µg/Kg	<	660	µg/Kg
Di-n-octylphthalate	660	µg/Kg	<	660	µg/Kg
Fluoranthene	660	µg/Kg	<	660	µg/Kg

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

REPORT NUMBER: D90-31114

TEST REQUESTED	DETECTION LIMIT			RESULTS	
EPA 8270 (Continued) Base-Neutral Extractable Organics					
Fluorene	660	µg/Kg	<	660	µg/Kg
Hexachlorobenzene	660	µg/Kg	<	660	µg/Kg
Hexachlorobutadiene	660	µg/Kg	<	660	µg/Kg
Hexachlorocyclobutandiene	660	µg/Kg	<	660	µg/Kg
Hexachloroethane	660	µg/Kg	<	660	µg/Kg
Indeno(1,2,3-cd)pyrene	660	µg/Kg	<	660	µg/Kg
Isophorone	660	µg/Kg	<	660	µg/Kg
Naphthalene	660	µg/Kg	<	660	µg/Kg
Nitrobenzene	660	µg/Kg	<	660	µg/Kg
N-Nitrosodimethylamine	660	µg/Kg	<	660	µg/Kg
N-Nitrosodiphenylamine	660	µg/Kg	<	660	µg/Kg
N-Nitrosodipropylamine	660	µg/Kg	<	660	µg/Kg
Phenanthrene	660	µg/Kg	<	660	µg/Kg
Pyrene	660	µg/Kg	<	660	µg/Kg
1,2,4-Trichlorobenzene	660	µg/Kg	<	660	µg/Kg

QUALITY CONTROL DATA

SURROGATE COMPOUND	SPIKE LEVEL(µg/Kg)	PERCENT RECOVERED
Nitrobenzene-d5 (SS)	50	52.7
2-Fluorobenzene (SS)	50	90.4
Terphenyl-d14 (SS)	50	85.4

NDRC Laboratories, Inc. David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 6-DEC-1990

REPORT NUMBER: D90-31114
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Cathy Hutchins

SAMPLE MATRIX: SOIL
ID MARKS: T206 0-3916

TENTATIVELY IDENTIFIED COMPOUNDS

COMPOUND	RETENTION TIME	FRACTION	RESULTS	
Tentatively Identified Compounds - ABN				
No compounds detected		ABN	660	µg/Kg

NDRC Laboratories, Inc. David R. Godwin, Ph.D.
David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 6-DEC-1990

REPORT NUMBER: D90-31114
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Cathy Hutchins

SAMPLE MATRIX: SOIL
ID MARKS: T206 0-3916

TENTATIVELY IDENTIFIED COMPOUNDS

COMPOUND	RETENTION TIME	FRACTION	RESULTS	
Tentatively Identified Compounds - VOA				
No compounds detected		VOA	10	µg/kg

NDRC Laboratories, Inc. David R. Godwin
David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 6-DEC-1990

REPORT NUMBER: D90-31114
REPORT DATE: 7-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Cathy Hutchins

SAMPLE MATRIX: SOIL
ID MARKS: T206 0-3916

TEST REQUESTED	DETECTION LIMIT			RESULTS	
Organochlorine Pesticides and PCB's					
Aldrin	27	µg/Kg	<	27	µg/Kg
Alpha-BHC	20	µg/Kg	<	20	µg/Kg
Beta-BHC	40	µg/Kg	<	40	µg/Kg
Delta-BHC	60	µg/Kg	<	60	µg/Kg
Gamma-BHC(Lindane)	26	µg/Kg	<	26	µg/Kg
Chlordane	93	µg/Kg	<	93	µg/Kg
4,4'-DDD	73	µg/Kg	<	73	µg/Kg
4,4'-DDE	26	µg/Kg	<	26	µg/Kg
4,4'-DDT	80	µg/Kg	<	80	µg/Kg
Dieldrin	13	µg/Kg	<	13	µg/Kg
Endosulfan I	93	µg/Kg	<	93	µg/Kg
Endosulfan II	26	µg/Kg	<	26	µg/Kg
Endosulfan Sulfate	442	µg/Kg	<	442	µg/Kg
Endrin	40	µg/Kg	<	40	µg/Kg
Endrin Aldehyde	154	µg/Kg	<	154	µg/Kg
Heptachlor	20	µg/Kg	<	20	µg/Kg
Heptachlor Epoxide	556	µg/Kg	<	556	µg/Kg
Methoxychlor	1210	µg/Kg	<	1210	µg/Kg
Toxaphene	1610	µg/Kg	<	1610	µg/Kg
Arochlor-1016	67	µg/Kg	<	67	µg/Kg
Arochlor-1221	67	µg/Kg	<	67	µg/Kg
Arochlor-1232	67	µg/Kg	<	67	µg/Kg
Arochlor-1242	67	µg/Kg	<	67	µg/Kg
Arochlor-1248	67	µg/Kg	<	67	µg/Kg
Arochlor-1254	67	µg/Kg	<	67	µg/Kg
Arochlor-1260	67	µg/Kg	<	67	µg/Kg

NDRC Laboratories, Inc. David R Godwin VP
David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 6-DEC-1990

REPORT NUMBER: D90-31115
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Cathy Hutchins

SAMPLE MATRIX: SOIL
ID MARKS: T207 0-3917

TEST REQUESTED	DETECTION LIMIT		RESULTS		
TOTAL METALS:					
Silver	1.0	mg/Kg	<	1.0	mg/Kg
Arsenic	0.1	mg/Kg		1.7	mg/Kg
Barium	1.0	mg/Kg		121	mg/Kg
Beryllium	1.0	mg/Kg	<	1.0	mg/Kg
Cadmium	1.0	mg/Kg		2.9	mg/Kg
Cobalt	1.0	mg/Kg		3.3	mg/Kg
Chromium	1.0	mg/Kg		9.6	mg/Kg
Copper	1.0	mg/Kg		4.5	mg/Kg
Mercury	0.01	mg/Kg		0.01	mg/Kg
Manganese	1.0	mg/Kg		57.0	mg/Kg
Molybdenum	1.0	mg/Kg		47.8	mg/Kg
Nickel	1.0	mg/Kg		7.1	mg/Kg
Lead	1.0	mg/Kg	<	1.0	mg/Kg
Antimony	1.0	mg/Kg	<	1.0	mg/Kg
Selenium	0.1	mg/Kg		1.6	mg/Kg
Thallium	1.0	mg/Kg	<	1.0	mg/Kg
Vanadium	1.0	mg/Kg		17.7	mg/Kg
Zinc	1.0	mg/Kg		19.6	mg/Kg

NDRC Laboratories, Inc. David R. Godwin
David R. Godwin, Ph.D.
Chief Executive Officer

CANNON AFB
ASBESTOS SAMPLE ANALYSIS
SWDED-GL REPORT NO. 15263

1. REFERENCE: Reference is made to Tulsa Test Request MIL 90-113 requesting testing of possible asbestos samples.

2. SAMPLES: On December 5 and 10, 1990 nine bulk samples were received for analysis by Polarized Light Microscopy.

SWD LAB NO.	FIELD SAMPLE NO.	LOCATION	TOTAL VOLUME (liters)
A-1413	T-101	Rubble Pile - Trench 1	N/A
A-1414	T-301	Rubble Pile - Trench 3	N/A
A-1417	T-201	Rubble Pile - Trench 2	N/A
A-1418	T-401	Rubble Pile - Trench 4	N/A
A-1419	T-501	Rubble Pile - Trench 5	N/A
A-1420	T-501QC	Rubble Pile - Trench 5	N/A
A-1421	T-601	Rubble Pile - Trench 6	N/A
A-1422	T-701	Rubble Pile - Trench 7	N/A
A-1423	T-801	Rubble Pile - Trench 8	N/A

3. RESULTS OF PLM ANALYSIS:

SWD LAB NO.	FIELD SAMPLE NO.	TYPE MATERIAL	ASBESTOS TYPE	PERCENT ASBESTOS
A-1413	T-101	Soil		None Detected
A-1414	T-301	Soil	Actinolite	Trace
A-1417	T-201	Soil		None Detected
A-1418	T-401	Soil		None Detected
A-1419	T-501	Soil		None Detected
A-1420	T-501QC	Soil		None Detected
A-1421	T-601	Soil		None Detected
A-1422	T-701	Soil		None Detected
A-1423	T-801	Soil		None Detected

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 5-DEC-1990

REPORT NUMBER: D90-30985
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Janice Stewart

SAMPLE MATRIX: SOIL
ID MARKS: T-302 0-3894

TEST REQUESTED	DETECTION LIMIT			RESULTS	
PCB by EPA Method 8080					
Arochlor 1016	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1221	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1232	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1242	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1248	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1254	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1260	0.1	mg/Kg	<	0.1	mg/Kg

NDRC Laboratories, Inc. David R. Godwin

David R. Godwin, Ph.D.
Chief Executive Officer

Primavera - 127011 (IA OFF POST WELL LEASES)

File Edit View Project Enterprise Tools Admin Help

Activities

Back Forward Home Dir Help

Projects | Resources | Reports | Tracking | WBS | Activities | Assignments | WPs & Docs | Expenses | Thresholds | Issues | Risks

Layout: *PM Statusing | Filter: All Activities

Activity ID	Activity Name	Activity Type	Activity Status	Percent Complete Type
127011 IA OFF POST WELL LEASES				
127011.07000 Off-Post GW Monitoring Well Leases				
A1000	IAAAP Lease Payments	Task Dependent	In Progress	Physical
A1010	Real Estate Labor	Task Dependent	In Progress	Physical

4, 2006 | Qtr 1, 2007 | Qtr 2, 2007 | Qtr 3, 2007 | Qtr 4, 2007 | Qtr 1, 2008

Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar

Add | Delete | Cut | Copy | Paste | Resources | Rsrc by Role | Roles | Activity Codes | Predecessors | Successors | Steps

Schedule

Project(s) to schedule: 1

Current Data Date: 16-Jul-07

Project Forecast Start Date:

Set Data Date and Planned Start to Project Forecast Start during scheduling

Log to file

M:\Program Files\Primavera Enterprise\Project Manager\S

Cancel | Schedule | View Log | Help | Options...

General | Status | Resources | Relationships | Steps

Activity: A1010 Real Estate Labor | Project: 127011

Resource ID Name	Rate Source	Rate Type	Price / Unit	Start	Finish	Bud Units	Bud Cost	Act Units	Act Cost	Rem Units	Rem Cost	At Compl Cost
G6H4HA0-PROJECT MGMT.G6H	Override		$114.78/h	28-Mar-05 A	01-Oct-08	8.71h	$1,000.00	0.00h	$0.00	4.36h	$500.00	$500.00
G6N0A00-MILITARY BRA.G6N0A	Override		$31.64/h	28-Mar-05 A	01-Oct-08	126.42h	$4,000.00	59.56h	$1,884.54	66.86h	$2,115.46	$4,000.00
G6N0AL0-LEASING & PU.G6N0A	Override		$50.43/h	28-Mar-05 A	01-Oct-08	39.68h	$2,000.00	0.00h	$0.00	0.00h	$0.00	$0.00
G6N0B00-TECHNICAL SE.G6N0E	Override		$84.13/h	28-Mar-05 A	01-Oct-08	11.89h	$1,000.00	2.31h	$194.76	9.57h	$805.24	$1,000.00

Add Resource | Add Role | Assign by Role | Remove

Portfolio: All Projects | User: g6mdxkmh | Data Date: 16-Jul-07 | Access Mode: Shared | Baseline: Current Project

start | Inbox - Microsoft Out... | M:\WINDOWS\syste... | Primavera Project Ma... | USACE PMBP Portal - ... | 4:52 PM

Monday, Jul 16, 2007 04:52 PM

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 5-DEC-1990

REPORT NUMBER: D90-30985
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Janice Stewart

SAMPLE MATRIX: SOIL
ID MARKS: T-302 0-3894

TEST REQUESTED	DETECTION LIMIT			RESULTS	
PCB by EPA Method 8080					
Arochlor 1016	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1221	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1232	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1242	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1248	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1254	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1260	0.1	mg/Kg	<	0.1	mg/Kg

NDRC Laboratories, Inc. David R. Godwin

David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 5-DEC-1990

REPORT NUMBER: D90-30986
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Janice Stewart

SAMPLE MATRIX: SOIL
ID MARKS: T-303 0-3895

TEST REQUESTED	DETECTION LIMIT			RESULTS	
EPA 8270 TCLP - Extractable Organics					
o-Cresol	0.08	mg/L	<	0.08	mg/L
m-Cresol	0.08	mg/L	<	0.08	mg/L
p-Cresol	0.08	mg/L	<	0.08	mg/L
2,4-Dinitrotoluene	0.04	mg/L	<	0.04	mg/L
Hexachlorobenzene	0.04	mg/L	<	0.04	mg/L
Hexachlorobutadiene	0.04	mg/L	<	0.04	mg/L
Hexachloroethane	0.04	mg/L	<	0.04	mg/L
Nitrobenzene	0.04	mg/L	<	0.04	mg/L
Pentachlorophenol	0.20	mg/L	<	0.20	mg/L
Pyridine	0.04	mg/L	<	0.04	mg/L
2,4,5-Trichlorophenol	0.04	mg/L	<	0.04	mg/L
2,4,6-Trichlorophenol	0.04	mg/L	<	0.04	mg/L

QUALITY CONTROL DATA

SURROGATE COMPOUND	SPIKE LEVEL(µg/L)	PERCENT RECOVERED
Nitrobenzene-d5(SS)	50	52.1
2-Fluorobiphenyl(SS)	50	68.9
Terphenyl-d14(SS)	50	82.9
Phenol-d6(SS)	100	23.8
2-Fluorophenol(SS)	100	35.3
2,4,6-Tribromophenol(SS)	100	59.5

NDRC Laboratories, Inc.

David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 5-DEC-1990

REPORT NUMBER: D90-30986
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Janice Stewart

SAMPLE MATRIX: SOIL
ID MARKS: T-303 0-3895

TEST REQUESTED	DETECTION LIMIT			RESULTS	
EPA 8240 TCLP - Volatile Organics					
Benzene	0.01	mg/L	<	0.01	mg/L
Carbon tetrachloride	0.01	mg/L	<	0.01	mg/L
Chlorobenzene	0.01	mg/L	<	0.01	mg/L
Chloroform	0.01	mg/L	<	0.01	mg/L
1,4-Dichlorobenzene	0.01	mg/L	<	0.01	mg/L
1,2-Dichloroethane	0.01	mg/L	<	0.01	mg/L
1,1-Dichloroethene	0.01	mg/L	<	0.01	mg/L
Methyl ethyl ketone	0.05	mg/L	<	0.05	mg/L
Tetrachloroethene	0.01	mg/L	<	0.01	mg/L
Trichloroethene	0.01	mg/L	<	0.01	mg/L
Vinyl chloride	0.02	mg/L	<	0.02	mg/L

QUALITY CONTROL DATA

SURROGATE COMPOUND	SPIKE LEVEL(µg/L)	PERCENT RECOVERED
1,2-Dichloroethane-d4(SS)	50	114
Toluene-d8(SS)	50	98.5
Bromofluorobenzene(SS)	50	91.1

NDRC Laboratories, Inc. David R. Godwin
David R. Godwin, Ph.D.
Chief Executive Officer

32

294 70

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 5-DEC-1990

REPORT NUMBER: D90-30986
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Janice Stewart

SAMPLE MATRIX: SOIL
ID MARKS: T-303 0-3895

TEST REQUESTED	DETECTION LIMIT		RESULTS		
TCLP Herbicides					
2,4-D	5.0	mg/L	<	5.0	mg/L
2,4,5-TP Silvex	0.5	mg/L	<	0.5	mg/L

NDRC Laboratories, Inc.

David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 5-DEC-1990

REPORT NUMBER: D90-30986
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Janice Stewart

SAMPLE MATRIX: SOIL
ID MARKS: T-303 0-3895

TEST REQUESTED	DETECTION LIMIT		RESULTS		
TCLP Pesticides					
Chlordane	0.014	mg/L	<	0.014	mg/L
Heptachlor	0.0030	mg/L	<	0.0030	mg/L
Heptachlor epoxide	0.0830	mg/L	<	0.0830	mg/L
Endrin	0.006	mg/L	<	0.006	mg/L
Lindane	0.004	mg/L	<	0.004	mg/L
Methoxychlor	0.18	mg/L	<	0.18	mg/L
Toxaphene	0.24	mg/L	<	0.24	mg/L

NDRC Laboratories, Inc.

David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 5-DEC-1990

REPORT NUMBER: D90-30986
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Janice Stewart

SAMPLE MATRIX: SOIL
ID MARKS: T-303 0-3895

TEST REQUESTED	DETECTION LIMIT			RESULTS	
TCLP METALS:					
Silver	0.01	mg/L	<	0.01	mg/L
Arsenic	0.05	mg/L	<	0.05	mg/L
Barium	0.1	mg/L		1.3	mg/L
Cadmium	0.01	mg/L		0.01	mg/L
Chromium	0.05	mg/L	<	0.05	mg/L
Mercury	0.001	mg/L	<	0.001	mg/L
Lead	0.02	mg/L	<	0.02	mg/L
Selenium	0.05	mg/L	<	0.05	mg/L

NDRC Laboratories, Inc. David R. Godwin

David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 5-DEC-1990

REPORT NUMBER: D90-30987
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Janice Stewart

SAMPLE MATRIX: SOIL
ID MARKS: T-304 0-3896

TEST REQUESTED	DETECTION LIMIT			RESULTS	
EPA 8240 Volatile Organics					
Acrolein	10.0	µg/Kg	<	10.0	µg/Kg
Acrylonitrile	10.0	µg/Kg	<	10.0	µg/Kg
Benzene	5.0	µg/Kg	<	5.0	µg/Kg
Bromodichloromethane	5.0	µg/Kg	<	5.0	µg/Kg
Bromoform	5.0	µg/Kg	<	5.0	µg/Kg
Bromomethane	10.0	µg/Kg	<	10.0	µg/Kg
Carbon tetrachloride	5.0	µg/Kg	<	5.0	µg/Kg
Chlorobenzene	5.0	µg/Kg	<	5.0	µg/Kg
Chlorodibromomethane	5.0	µg/Kg	<	5.0	µg/Kg
Chloroethane	10.0	µg/Kg	<	10.0	µg/Kg
2-Chloroethyvinyl ether	10.0	µg/Kg	<	10.0	µg/Kg
Chloroform	5.0	µg/Kg	<	5.0	µg/Kg
Chloromethane	10.0	µg/Kg	<	10.0	µg/Kg
1,2-Dichlorobenzene	5.0	µg/Kg	<	5.0	µg/Kg
1,3-Dichlorobenzene	5.0	µg/Kg	<	5.0	µg/Kg
1,4-Dichlorobenzene	5.0	µg/Kg	<	5.0	µg/Kg
1,1-Dichloroethane	5.0	µg/Kg	<	5.0	µg/Kg
1,2-Dichloroethane	5.0	µg/Kg	<	5.0	µg/Kg
1,1-Dichloroethene	5.0	µg/Kg	<	5.0	µg/Kg
trans-1,2-Dichloroethene	5.0	µg/Kg	<	5.0	µg/Kg
1,2-Dichloropropane	5.0	µg/Kg	<	5.0	µg/Kg
cis-1,3-Dichloropropene	5.0	µg/Kg	<	5.0	µg/Kg
trans-1,3 Dichloropropene	5.0	µg/Kg	<	5.0	µg/Kg
Ethylbenzene	5.0	µg/Kg	<	5.0	µg/Kg
Methylene chloride	10.0	µg/Kg	<	10.0	µg/Kg
1,1,2,2-Tetrachloroethane	5.0	µg/Kg	<	5.0	µg/Kg
Tetrachloroethene	5.0	µg/Kg	<	5.0	µg/Kg
Toluene	5.0	µg/Kg	<	5.0	µg/Kg
1,1,1-Trichloroethane	5.0	µg/Kg	<	5.0	µg/Kg
1,1,2-Trichloroethane	5.0	µg/Kg	<	5.0	µg/Kg

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

REPORT NUMBER: D90-30987

TEST REQUESTED	DETECTION LIMIT			RESULTS	
EPA 8240 (Continued) Volatile Organics					
Trichloroethene	5.0	µg/Kg	<	5.0	µg/Kg
Trichlorofluoromethane	10.0	µg/Kg	<	10.0	µg/Kg
Vinyl chloride	10.0	µg/Kg	<	10.0	µg/Kg
Xylenes	5.0	µg/Kg	<	5.0	µg/Kg

QUALITY CONTROL DATA

SURROGATE COMPOUND	SPIKE LEVEL(µg/Kg)	PERCENT RECOVERED
1,2-Dichloroethane-d4 (SS)	50	112
Toluene-d8 (SS)	50	98.6
Bromofluorobenzene (SS)	50	85.2

NDRC Laboratories, Inc. David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 5-DEC-1990

REPORT NUMBER: D90-30987
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Janice Stewart

SAMPLE MATRIX: SOIL
ID MARKS: T-304 0-3896

TEST REQUESTED	DETECTION LIMIT			RESULTS	
EPA 8270 Acid Extractable Organics					
4-Chloro-3-methylphenol	660	µg/Kg	<	660	µg/Kg
2-Chlorophenol	660	µg/Kg	<	660	µg/Kg
2,4-Dichlorophenol	660	µg/Kg	<	660	µg/Kg
2,4-Dimethylphenol	660	µg/Kg	<	660	µg/Kg
4,6-Dinitro-2-methylphenol	660	µg/Kg	<	660	µg/Kg
2,4-Dinitrophenol	3300	µg/Kg	<	3300	µg/Kg
2-Methylphenol	660	µg/Kg	<	660	µg/Kg
2-Nitrophenol	660	µg/Kg	<	660	µg/Kg
4-Nitrophenol	3300	µg/Kg	<	3300	µg/Kg
Pentachlorophenol	3300	µg/Kg	<	3300	µg/Kg
Phenol	660	µg/Kg	<	660	µg/Kg
2,4,6-Trichlorophenol	660	µg/Kg	<	660	µg/Kg

QUALITY CONTROL DATA

SURROGATE COMPOUND	SPIKE LEVEL(µg/Kg)	PERCENT RECOVERED
Phenol-d5 (SS)	100	74.3
2-Fluorophenol (SS)	100	70.2
2,4,6-Tribromophenol (SS)	100	50.3

NDRC Laboratories, Inc.

David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 5-DEC-1990

REPORT NUMBER: D90-30987
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Janice Stewart

SAMPLE MATRIX: SOIL
ID MARKS: T-304 0-3896

TEST REQUESTED	DETECTION LIMIT			RESULTS	
EPA 8270 Base-Neutral Extractable Organics					
Acenaphthene	660	µg/Kg	<	660	µg/Kg
Acenaphthylene	660	µg/Kg	<	660	µg/Kg
Anthracene	660	µg/Kg	<	660	µg/Kg
Benzidine	660	µg/Kg	<	660	µg/Kg
Benzo(a)anthracene	660	µg/Kg	<	660	µg/Kg
Benzo(b)fluoranthene	660	µg/Kg	<	660	µg/Kg
Benzo(k)fluoranthene	660	µg/Kg	<	660	µg/Kg
Benzo(g,h,i)perylene	660	µg/Kg	<	660	µg/Kg
Benzo(a)pyrene	660	µg/Kg	<	660	µg/Kg
Bis(2-chloroethoxy)methane	660	µg/Kg	<	660	µg/Kg
Bis(2-chloroethyl)ether	660	µg/Kg	<	660	µg/Kg
Bis(2-chloroisopropyl)ether	660	µg/Kg	<	660	µg/Kg
Bis(2-ethylhexyl)phthalate	660	µg/Kg	<	660	µg/Kg
4-Bromophenylphenyl ether	660	µg/Kg	<	660	µg/Kg
Butyl benzyl phthalate	660	µg/Kg	<	660	µg/Kg
2-Chloronaphthalene	660	µg/Kg	<	660	µg/Kg
4-Chlorophenylphenyl ether	660	µg/Kg	<	660	µg/Kg
Chrysene	660	µg/Kg	<	660	µg/Kg
Dibenz(a,h)anthracene	660	µg/Kg	<	660	µg/Kg
Di-n-butylphthalate	660	µg/Kg	<	660	µg/Kg
1,3-Dichlorobenzene	660	µg/Kg	<	660	µg/Kg
1,4-Dichlorobenzene	660	µg/Kg	<	660	µg/Kg
1,2-Dichlorobenzene	660	µg/Kg	<	660	µg/Kg
3,3'-Dichlorobenzidine	1300	µg/Kg	<	1300	µg/Kg
Diethylphthalate	660	µg/Kg	<	660	µg/Kg
Dimethylphthalate	660	µg/Kg	<	660	µg/Kg
2,4-Dinitrotoluene	660	µg/Kg	<	660	µg/Kg
2,6-Dinitrotoluene	660	µg/Kg	<	660	µg/Kg
Di-n-octylphthalate	660	µg/Kg	<	660	µg/Kg
Fluoranthene	660	µg/Kg	<	660	µg/Kg

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

REPORT NUMBER: D90-30987

TEST REQUESTED	DETECTION LIMIT			RESULTS	
EPA 8270 (Continued) Base-Neutral Extractable Organics					
Fluorene	660	µg/Kg	<	660	µg/Kg
Hexachlorobenzene	660	µg/Kg	<	660	µg/Kg
Hexachlorobutadiene	660	µg/Kg	<	660	µg/Kg
Hexachlorocyclobutandiene	660	µg/Kg	<	660	µg/Kg
Hexachloroethane	660	µg/Kg	<	660	µg/Kg
Indeno(1,2,3-cd)pyrene	660	µg/Kg	<	660	µg/Kg
Isophorone	660	µg/Kg	<	660	µg/Kg
Naphthalene	660	µg/Kg	<	660	µg/Kg
Nitrobenzene	660	µg/Kg	<	660	µg/Kg
N-Nitrosodimethylamine	660	µg/Kg	<	660	µg/Kg
N-Nitrosodiphenylamine	660	µg/Kg	<	660	µg/Kg
N-Nitrosodipropylamine	660	µg/Kg	<	660	µg/Kg
Phenanthrene	660	µg/Kg	<	660	µg/Kg
Pyrene	660	µg/Kg	<	660	µg/Kg
1,2,4-Trichlorobenzene	660	µg/Kg	<	660	µg/Kg

QUALITY CONTROL DATA

SURROGATE COMPOUND	SPIKE LEVEL(µg/Kg)	PERCENT RECOVERED
Nitrobenzene-d5 (SS)	50	62.3
2-Fluorobenzene (SS)	50	73.2
Terphenyl-d14 (SS)	50	81.9

NDRC Laboratories, Inc. David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 5-DEC-1990

REPORT NUMBER: D90-30987
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Janice Stewart

SAMPLE MATRIX: SOIL
ID MARKS: T-304 0-3896

TENTATIVELY IDENTIFIED COMPOUNDS

COMPOUND	RETENTION TIME	FRACTION	RESULTS	
Tentatively Identified Compounds - ABN				
No compounds detected		ABN	660	µg/Kg

NDRC Laboratories, Inc.

David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 5-DEC-1990

REPORT NUMBER: D90-30987
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Janice Stewart

SAMPLE MATRIX: SOIL
ID MARKS: T-304 0-3896

TENTATIVELY IDENTIFIED COMPOUNDS

COMPOUND	RETENTION TIME	FRACTION	RESULTS	
Tentatively Identified Compounds - VOA				
No compounds detected		VOA	10	µg/Kg

NDRC Laboratories, Inc. David R. Godwin

David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 5-DEC-1990

REPORT NUMBER: D90-30987
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Janice Stewart

SAMPLE MATRIX: SOIL
ID MARKS: T-304 0-3896

TEST REQUESTED	DETECTION LIMIT			RESULTS	
Organochlorine Pesticides and PCB's					
Aldrin	2.7	µg/Kg	<	2.7	µg/Kg
Alpha-BHC	2.0	µg/Kg	<	2.0	µg/Kg
Beta-BHC	4.0	µg/Kg	<	4.0	µg/Kg
Delta-BHC	6.0	µg/Kg	<	6.0	µg/Kg
Gamma-BHC(Lindane)	2.6	µg/Kg	<	2.6	µg/Kg
Chlordane	9.3	µg/Kg	<	9.3	µg/Kg
4,4'-DDD	7.3	µg/Kg	<	7.3	µg/Kg
4,4'-DDE	2.6	µg/Kg	<	2.6	µg/Kg
4,4'-DDT	8.0	µg/Kg	<	8.0	µg/Kg
Dieldrin	1.3	µg/Kg	<	1.3	µg/Kg
Endosulfan I	9.3	µg/Kg	<	9.3	µg/Kg
Endosulfan II	2.6	µg/Kg	<	2.6	µg/Kg
Endosulfan Sulfate	44.2	µg/Kg	<	44.2	µg/Kg
Endrin	4.0	µg/Kg	<	4.0	µg/Kg
Endrin Aldehyde	15.4	µg/Kg	<	15.4	µg/Kg
Heptachlor	2.0	µg/Kg	<	2.0	µg/Kg
Heptachlor Epoxide	55.6	µg/Kg	<	55.6	µg/Kg
Methoxychlor	121	µg/Kg	<	121	µg/Kg
Toxaphene	161	µg/Kg	<	161	µg/Kg
Arochlor-1016	6	µg/Kg	<	6	µg/Kg
Arochlor-1221	6	µg/Kg	<	6	µg/Kg
Arochlor-1232	6	µg/Kg	<	6	µg/Kg
Arochlor-1242	6	µg/Kg	<	6	µg/Kg
Arochlor-1248	6	µg/Kg	<	6	µg/Kg
Arochlor-1254	6	µg/Kg	<	6	µg/Kg
Arochlor-1260	6	µg/Kg	<	6	µg/Kg

NDRC Laboratories, Inc. David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 5-DEC-1990

REPORT NUMBER: D90-30988
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Janice Stewart

SAMPLE MATRIX: SOIL
ID MARKS: T-305 0-3897

TEST REQUESTED	DETECTION LIMIT			RESULTS	
TOTAL METALS:					
Silver	1.0	mg/Kg	<	1.0	mg/Kg
Arsenic	0.1	mg/Kg		1.7	mg/Kg
Barium	1.0	mg/Kg		82.1	mg/Kg
Cadmium	1.0	mg/Kg		8.5	mg/Kg
Chromium	1.0	mg/Kg		10.3	mg/Kg
Mercury	0.01	mg/Kg		0.02	mg/Kg
Lead	1.0	mg/Kg	<	1.0	mg/Kg
Selenium	0.1	mg/Kg		0.6	mg/Kg

NDRC Laboratories, Inc.

David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 5-DEC-1990

REPORT NUMBER: D90-30989
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Janice Stewart

SAMPLE MATRIX: SOIL
ID MARKS: T-306 0-3898

TEST REQUESTED	DETECTION LIMIT			RESULTS	
EPA 8240 Volatile Organics					
Acrolein	10.0	µg/Kg	<	10.0	µg/Kg
Acrylonitrile	10.0	µg/Kg	<	10.0	µg/Kg
Benzene	5.0	µg/Kg	<	5.0	µg/Kg
Bromodichloromethane	5.0	µg/Kg	<	5.0	µg/Kg
Bromoform	5.0	µg/Kg	<	5.0	µg/Kg
Bromomethane	10.0	µg/Kg	<	10.0	µg/Kg
Carbon tetrachloride	5.0	µg/Kg	<	5.0	µg/Kg
Chlorobenzene	5.0	µg/Kg	<	5.0	µg/Kg
Chlorodibromomethane	5.0	µg/Kg	<	5.0	µg/Kg
Chloroethane	10.0	µg/Kg	<	10.0	µg/Kg
2-Chloroethyvinyl ether	10.0	µg/Kg	<	10.0	µg/Kg
Chloroform	5.0	µg/Kg	<	5.0	µg/Kg
Chloromethane	10.0	µg/Kg	<	10.0	µg/Kg
1,2-Dichlorobenzene	5.0	µg/Kg	<	5.0	µg/Kg
1,3-Dichlorobenzene	5.0	µg/Kg	<	5.0	µg/Kg
1,4-Dichlorobenzene	5.0	µg/Kg	<	5.0	µg/Kg
1,1-Dichloroethane	5.0	µg/Kg	<	5.0	µg/Kg
1,2-Dichloroethane	5.0	µg/Kg	<	5.0	µg/Kg
1,1-Dichloroethene	5.0	µg/Kg	<	5.0	µg/Kg
trans-1,2-Dichloroethene	5.0	µg/Kg	<	5.0	µg/Kg
1,2-Dichloropropane	5.0	µg/Kg	<	5.0	µg/Kg
cis-1,3-Dichloropropene	5.0	µg/Kg	<	5.0	µg/Kg
trans-1,3 Dichloropropene	5.0	µg/Kg	<	5.0	µg/Kg
Ethylbenzene	5.0	µg/Kg	<	5.0	µg/Kg
Methylene chloride	10.0	µg/Kg	<	10.0	µg/Kg
1,1,2,2-Tetrachloroethane	5.0	µg/Kg	<	5.0	µg/Kg
Tetrachloroethene	5.0	µg/Kg	<	5.0	µg/Kg
Toluene	5.0	µg/Kg	<	5.0	µg/Kg
1,1,1-Trichloroethane	5.0	µg/Kg	<	5.0	µg/Kg
1,1,2-Trichloroethane	5.0	µg/Kg	<	5.0	µg/Kg

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

REPORT NUMBER: D90-30989

TEST REQUESTED	DETECTION LIMIT			RESULTS	
EPA 8240 (Continued) Volatile Organics					
Trichloroethene	5.0	µg/Kg	<	5.0	µg/Kg
Trichlorofluoromethane	10.0	µg/Kg	<	10.0	µg/Kg
Vinyl chloride	10.0	µg/Kg	<	10.0	µg/Kg
Xylenes	5.0	µg/Kg	<	5.0	µg/Kg

QUALITY CONTROL DATA

SURROGATE COMPOUND	SPIKE LEVEL(µg/Kg)	PERCENT RECOVERED
1,2-Dichloroethane-d4 (SS)	50	114
Toluene-d8 (SS)	50	99.2
Bromofluorobenzene (SS)	50	78.2

NDRC Laboratories, Inc. David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 5-DEC-1990

REPORT NUMBER: D90-30989
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Janice Stewart

SAMPLE MATRIX: SOIL
ID MARKS: T-306 0-3898

TEST REQUESTED	DETECTION LIMIT			RESULTS	
EPA 8270 Acid Extractable Organics					
4-Chloro-3-methylphenol	660	µg/Kg	<	660	µg/Kg
2-Chlorophenol	660	µg/Kg	<	660	µg/Kg
2,4-Dichlorophenol	660	µg/Kg	<	660	µg/Kg
2,4-Dimethylphenol	660	µg/Kg	<	660	µg/Kg
4,6-Dinitro-2-methylphenol	660	µg/Kg	<	660	µg/Kg
2,4-Dinitrophenol	3300	µg/Kg	<	3300	µg/Kg
2-Methylphenol	660	µg/Kg	<	660	µg/Kg
2-Nitrophenol	660	µg/Kg	<	660	µg/Kg
4-Nitrophenol	3300	µg/Kg	<	3300	µg/Kg
Pentachlorophenol	3300	µg/Kg	<	3300	µg/Kg
Phenol	660	µg/Kg	<	660	µg/Kg
2,4,6-Trichlorophenol	660	µg/Kg	<	660	µg/Kg

QUALITY CONTROL DATA

SURROGATE COMPOUND	SPIKE LEVEL(µg/Kg)	PERCENT RECOVERED
Phenol-d5 (SS)	100	67.8
2-Fluorophenol (SS)	100	60.6
2,4,6-Tribromophenol (SS)	100	42.6

NDRC Laboratories, Inc.

David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 5-DEC-1990

REPORT NUMBER: D90-30989
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Janice Stewart

SAMPLE MATRIX: SOIL
ID MARKS: T-306 0-3898

TEST REQUESTED	DETECTION LIMIT			RESULTS	
EPA 8270 Base-Neutral Extractable Organics					
Acenaphthene	660	µg/Kg	<	660	µg/Kg
Acenaphthylene	660	µg/Kg	<	660	µg/Kg
Anthracene	660	µg/Kg	<	660	µg/Kg
Benzidine	660	µg/Kg		2000	µg/Kg
Benzo(a)anthracene	660	µg/Kg	<	660	µg/Kg
Benzo(b)fluoranthene	660	µg/Kg	<	660	µg/Kg
Benzo(k)fluoranthene	660	µg/Kg	<	660	µg/Kg
Benzo(g,h,i)perylene	660	µg/Kg	<	660	µg/Kg
Benzo(a)pyrene	660	µg/Kg	<	660	µg/Kg
Bis(2-chloroethoxy)methane	660	µg/Kg	<	660	µg/Kg
Bis(2-chloroethyl)ether	660	µg/Kg	<	660	µg/Kg
Bis(2-chloroisopropyl)ether	660	µg/Kg	<	660	µg/Kg
Bis(2-ethylhexyl)phthalate	660	µg/Kg	<	660	µg/Kg
4-Bromophenylphenyl ether	660	µg/Kg	<	660	µg/Kg
Butyl benzyl phthalate	660	µg/Kg	<	660	µg/Kg
2-Chloronaphthalene	660	µg/Kg	<	660	µg/Kg
4-Chlorophenylphenyl ether	660	µg/Kg	<	660	µg/Kg
Chrysene	660	µg/Kg	<	660	µg/Kg
Dibenz(a,h)anthracene	660	µg/Kg	<	660	µg/Kg
Di-n-butylphthalate	660	µg/Kg	<	660	µg/Kg
1,3-Dichlorobenzene	660	µg/Kg	<	660	µg/Kg
1,4-Dichlorobenzene	660	µg/Kg	<	660	µg/Kg
1,2-Dichlorobenzene	660	µg/Kg	<	660	µg/Kg
3,3'-Dichlorobenzidine	1300	µg/Kg	<	1300	µg/Kg
Diethylphthalate	660	µg/Kg	<	660	µg/Kg
Dimethylphthalate	660	µg/Kg	<	660	µg/Kg
2,4-Dinitrotoluene	660	µg/Kg	<	660	µg/Kg
2,6-Dinitrotoluene	660	µg/Kg	<	660	µg/Kg
Di-n-octylphthalate	660	µg/Kg	<	660	µg/Kg
Fluoranthene	660	µg/Kg	<	660	µg/Kg

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

REPORT NUMBER: D90-30989

TEST REQUESTED	DETECTION LIMIT			RESULTS	
EPA 8270 (Continued) Base-Neutral Extractable Organics					
Fluorene	660	µg/Kg	<	660	µg/Kg
Hexachlorobenzene	660	µg/Kg	<	660	µg/Kg
Hexachlorobutadiene	660	µg/Kg	<	660	µg/Kg
Hexachlorocyclobutandiene	660	µg/Kg	<	660	µg/Kg
Hexachloroethane	660	µg/Kg	<	660	µg/Kg
Indeno(1,2,3-cd)pyrene	660	µg/Kg	<	660	µg/Kg
Isophorone	660	µg/Kg	<	660	µg/Kg
Naphthalene	660	µg/Kg	<	660	µg/Kg
Nitrobenzene	660	µg/Kg	<	660	µg/Kg
N-Nitrosodimethylamine	660	µg/Kg	<	660	µg/Kg
N-Nitrosodiphenylamine	660	µg/Kg	<	660	µg/Kg
N-Nitrosodipropylamine	660	µg/Kg	<	660	µg/Kg
Phenanthrene	660	µg/Kg	<	660	µg/Kg
Pyrene	660	µg/Kg	<	660	µg/Kg
1,2,4-Trichlorobenzene	660	µg/Kg	<	660	µg/Kg

QUALITY CONTROL DATA

SURROGATE COMPOUND	SPIKE LEVEL(µg/Kg)	PERCENT RECOVERED
Nitrobenzene-d5 (SS)	50	61.2
2-Fluorobenzene (SS)	50	63.6
Terphenyl-d14 (SS)	50	71.2

NDRC Laboratories, Inc.

David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 5-DEC-1990

REPORT NUMBER: D90-30989
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Janice Stewart

SAMPLE MATRIX: SOIL
ID MARKS: T-306 0-3898

TENTATIVELY IDENTIFIED COMPOUNDS

COMPOUND	RETENTION TIME	FRACTION	RESULTS	
Tentatively Identified Compounds - ABN				
Phenol, 2,6-bis(1,1-dimethylethyl)	22.28	ABN	13000	µg/Kg
2-Methyl-6-propyldodecane	23.48	ABN	2000	µg/Kg
3-Methylhexadecane	25.00	ABN	1100	µg/Kg
7-Hexyltridecane	27.82	ABN	1600	µg/Kg
Eicosane	29.16	ABN	1900	µg/Kg
10-Methyleicosane	30.39	ABN	2600	µg/Kg
Tricosane	32.70	ABN	2100	µg/Kg
Tetracosane	33.78	ABN	1800	µg/Kg
Hexacosane	35.89	ABN	1400	µg/Kg
Octacosane	38.49	ABN	2900	µg/Kg
Unidentified aromatic hydrocarbon	38.60	ABN	5300	µg/Kg
Nonacosane	40.13	ABN	1700	µg/Kg
Unidentified cyclic hydrocarbon	46.64	ABN	3400	µg/Kg
Sitosterol	52.44	ABN	1900	µg/Kg

NDRC Laboratories, Inc.

David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 5-DEC-1990

REPORT NUMBER: D90-30989
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Janice Stewart

SAMPLE MATRIX: SOIL
ID MARKS: T-306 0-3898

TENTATIVELY IDENTIFIED COMPOUNDS

COMPOUND	RETENTION TIME	FRACTION	RESULTS	
Tentatively Identified Compounds - VOA				
No compounds detected		VOA	10	µg/Kg

NDRC Laboratories, Inc.

David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 5-DEC-1990

REPORT NUMBER: D90-30989
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Janice Stewart

SAMPLE MATRIX: SOIL
ID MARKS: T-306 0-3898

TEST REQUESTED	DETECTION LIMIT			RESULTS	
Organochlorine Pesticides and PCB's					
Aldrin	27	µg/Kg	<	27	µg/Kg
Alpha-BHC	20	µg/Kg	<	20	µg/Kg
Beta-BHC	40	µg/Kg	<	40	µg/Kg
Delta-BHC	60	µg/Kg	<	60	µg/Kg
Gamma-BHC(Lindane)	26	µg/Kg	<	26	µg/Kg
Chlordane	93	µg/Kg	<	93	µg/Kg
4,4'-DDD	73	µg/Kg	<	73	µg/Kg
4,4'-DDE	26	µg/Kg	<	26	µg/Kg
4,4'-DDT	80	µg/Kg	<	80	µg/Kg
Dieldrin	13	µg/Kg	<	13	µg/Kg
Endosulfan I	93	µg/Kg	<	93	µg/Kg
Endosulfan II	26	µg/Kg	<	26	µg/Kg
Endosulfan Sulfate	442	µg/Kg	<	442	µg/Kg
Endrin	40	µg/Kg	<	40	µg/Kg
Endrin Aldehyde	154	µg/Kg	<	154	µg/Kg
Heptachlor	20	µg/Kg	<	20	µg/Kg
Heptachlor Epoxide	556	µg/Kg	<	556	µg/Kg
Methoxychlor	1210	µg/Kg	<	1210	µg/Kg
Toxaphene	1610	µg/Kg	<	1610	µg/Kg
Arochlor-1016	67	µg/Kg	<	67	µg/Kg
Arochlor-1221	67	µg/Kg	<	67	µg/Kg
Arochlor-1232	67	µg/Kg	<	67	µg/Kg
Arochlor-1242	67	µg/Kg	<	67	µg/Kg
Arochlor-1248	67	µg/Kg	<	67	µg/Kg
Arochlor-1254	67	µg/Kg	<	67	µg/Kg
Arochlor-1260	67	µg/Kg	<	67	µg/Kg

NDRC Laboratories, Inc.

David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 5-DEC-1990

REPORT NUMBER: D90-30990
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Janice Stewart

SAMPLE MATRIX: SOIL
ID MARKS: T-307 0-3899

TEST REQUESTED	DETECTION LIMIT			RESULTS	
TOTAL METALS:					
Silver	1.0	mg/Kg	<	1.0	mg/Kg
Arsenic	0.1	mg/Kg		3.0	mg/Kg
Barium	1.0	mg/Kg		705	mg/Kg
Cadmium	1.0	mg/Kg		33.3	mg/Kg
Chromium	1.0	mg/Kg		9.4	mg/Kg
Mercury	0.01	mg/Kg		0.02	mg/Kg
Lead	1.0	mg/Kg	<	1.0	mg/Kg
Selenium	0.1	mg/Kg		1.5	mg/Kg

NDRC Laboratories, Inc.

David R. Godwin, Ph.D.
Chief Executive Officer

CANNON AFB
ASBESTOS SAMPLE ANALYSIS
SWDED-GL REPORT NO. 15263

1. REFERENCE: Reference is made to Tulsa Test Request MIL 90-113 requesting testing of possible asbestos samples.

2. SAMPLES: On December 5 and 10, 1990 nine bulk samples were received for analysis by Polarized Light Microscopy.

SWD LAB NO.	FIELD SAMPLE NO.	LOCATION	TOTAL VOLUME (liters)
A-1413	T-101	Rubble Pile - Trench 1	N/A
A-1414	T-301	Rubble Pile - Trench 3	N/A
A-1417	T-201	Rubble Pile - Trench 2	N/A
A-1418	T-401	Rubble Pile - Trench 4	N/A
A-1419	T-501	Rubble Pile - Trench 5	N/A
A-1420	T-501QC	Rubble Pile - Trench 5	N/A
A-1421	T-601	Rubble Pile - Trench 6	N/A
A-1422	T-701	Rubble Pile - Trench 7	N/A
A-1423	T-801	Rubble Pile - Trench 8	N/A

3. RESULTS OF PLM ANALYSIS:

SWD LAB NO.	FIELD SAMPLE NO.	TYPE MATERIAL	ASBESTOS TYPE	PERCENT ASBESTOS
A-1413	T-101	Soil	Actinolite	Trace
A-1414	T-301	Soil	None	Detected
A-1417	T-201	Soil	None	Detected
A-1418	T-401	Soil	None	Detected
A-1419	T-501	Soil	None	Detected
A-1420	T-501QC	Soil	None	Detected
A-1421	T-601	Soil	None	Detected
A-1422	T-701	Soil	None	Detected
A-1423	T-801	Soil	None	Detected

294 92

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 6-DEC-1990

REPORT NUMBER: D90-31116
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Cathy Hutchins

SAMPLE MATRIX: SOIL
ID MARKS: T402 0-3919

TEST REQUESTED	DETECTION LIMIT		RESULTS		
PCB by EPA Method 8080					
Arochlor 1016	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1221	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1232	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1242	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1248	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1254	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1260	0.1	mg/Kg	<	0.1	mg/Kg

NDRC Laboratories, Inc. David R. Godwin
David R. Godwin, Ph.D.
Chief Executive Officer

CANNON AFB
ASBESTOS SAMPLE ANALYSIS
SWDED-GL REPORT NO. 15263

1. REFERENCE: Reference is made to Tulsa Test Request MIL 90-113 requesting testing of possible asbestos samples.

2. SAMPLES: On December 5 and 10, 1990 nine bulk samples were received for analysis by Polarized Light Microscopy.

SWD LAB NO.	FIELD SAMPLE NO.	LOCATION	TOTAL VOLUME (liters)
A-1413	T-101	Rubble Pile - Trench 1	N/A
A-1414	T-301	Rubble Pile - Trench 3	N/A
A-1417	T-201	Rubble Pile - Trench 2	N/A
A-1418	T-401	Rubble Pile - Trench 4	N/A
A-1419	T-501	Rubble Pile - Trench 5	N/A
A-1420	T-501QC	Rubble Pile - Trench 5	N/A
A-1421	T-601	Rubble Pile - Trench 6	N/A
A-1422	T-701	Rubble Pile - Trench 7	N/A
A-1423	T-801	Rubble Pile - Trench 8	N/A

3. RESULTS OF PLM ANALYSIS:

SWD LAB NO.	FIELD SAMPLE NO.	TYPE MATERIAL	ASBESTOS TYPE	PERCENT ASBESTOS
A-1413	T-101	Soil	Actinolite	Trace
A-1414	T-301	Soil	None	Detected
A-1417	T-201	Soil	None	Detected
A-1418	T-401	Soil	None	Detected
A-1419	T-501	Soil	None	Detected
A-1420	T-501QC	Soil	None	Detected
A-1421	T-601	Soil	None	Detected
A-1422	T-701	Soil	None	Detected
A-1423	T-801	Soil	None	Detected

294 91

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 6-DEC-1990

REPORT NUMBER: D90-31117
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Cathy Hutchins

SAMPLE MATRIX: SOIL
ID MARKS: T502 0-3921

TEST REQUESTED	DETECTION LIMIT		RESULTS		
PCB by EPA Method 8080					
Arochlor 1016	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1221	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1232	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1242	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1248	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1254	0.1	mg/Kg	<	0.1	mg/Kg
Arochlor 1260	0.1	mg/Kg	<	0.1	mg/Kg

NDRC Laboratories, Inc. David R. Godwin

David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 6-DEC-1990

REPORT NUMBER: D90-31118
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Cathy Hutchins

SAMPLE MATRIX: SOIL
ID MARKS: T503 0-3922

TEST REQUESTED	DETECTION LIMIT			RESULTS	
EPA 8270 TCLP - Extractable Organics					
o-Cresol	0.04	mg/L	<	0.04	mg/L
m-Cresol	0.04	mg/L	<	0.04	mg/L
p-Cresol	0.04	mg/L	<	0.04	mg/L
2,4-Dinitrotoluene	0.02	mg/L	<	0.02	mg/L
Hexachlorobenzene	0.02	mg/L	<	0.02	mg/L
Hexachlorobutadiene	0.02	mg/L	<	0.02	mg/L
Hexachloroethane	0.02	mg/L	<	0.02	mg/L
Nitrobenzene	0.02	mg/L	<	0.02	mg/L
Pentachlorophenol	0.10	mg/L	<	0.10	mg/L
Pyridine	0.02	mg/L	<	0.02	mg/L
2,4,5-Trichlorophenol	0.02	mg/L	<	0.02	mg/L
2,4,6-Trichlorophenol	0.02	mg/L	<	0.02	mg/L

QUALITY CONTROL DATA

SURROGATE COMPOUND	SPIKE LEVEL(µg/L)	PERCENT RECOVERED
Nitrobenzene-d5(SS)	50	68.5
2-Fluorobiphenyl(SS)	50	67.4
Terphenyl-d14(SS)	50	74.6
Phenol-d6(SS)	100	66.8
2-Fluorophenol(SS)	100	65.9
2,4,6-Tribromophenol(SS)	100	52.1

NDRC Laboratories, Inc.

David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 6-DEC-1990

REPORT NUMBER: D90-31118
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Cathy Hutchins

SAMPLE MATRIX: SOIL
ID MARKS: T503 0-3922

TEST REQUESTED	DETECTION LIMIT			RESULTS	
EPA 8240 TCLP - Volatile Organics					
Benzene	0.01	mg/L	<	0.01	mg/L
Carbon tetrachloride	0.01	mg/L	<	0.01	mg/L
Chlorobenzene	0.01	mg/L	<	0.01	mg/L
Chloroform	0.01	mg/L	<	0.01	mg/L
1,4-Dichlorobenzene	0.01	mg/L	<	0.01	mg/L
1,2-Dichloroethane	0.01	mg/L	<	0.01	mg/L
1,1-Dichloroethene	0.01	mg/L	<	0.01	mg/L
Methyl ethyl ketone	0.05	mg/L	<	0.05	mg/L
Tetrachloroethene	0.01	mg/L	<	0.01	mg/L
Trichloroethene	0.01	mg/L	<	0.01	mg/L
Vinyl chloride	0.02	mg/L	<	0.02	mg/L

QUALITY CONTROL DATA

SURROGATE COMPOUND	SPIKE LEVEL(µg/L)	PERCENT RECOVERED
1,2-Dichloroethane-d4(SS)	50	98.6
Toluene-d8(SS)	50	88.1
Bromofluorobenzene(SS)	50	88.4

NDRC Laboratories, Inc. David R. Godwin
David R. Godwin, Ph.D.
Chief Executive Officer

60

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 6-DEC-1990

REPORT NUMBER: D90-31118
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Cathy Hutchins

SAMPLE MATRIX: SOIL
ID MARKS: T503 0-3922

TEST REQUESTED	DETECTION LIMIT		RESULTS		
TCLP Herbicides					
2,4-D	5.0	mg/L	<	5.0	mg/L
2,4,5-TP Silvex	0.5	mg/L	<	0.5	mg/L

NDRC Laboratories, Inc. David R. Godwin, Ph.D.
David R. Godwin, Ph.D.
Chief Executive Officer

NDRC LABORATORIES, INC.

Dallas - 1101 Commerce Drive, Richardson, Texas 75081 • (214) 238-5591 • FAX (214) 238-5592
Houston - 11155 South Main, Houston, Texas 77025 • (713) 661-8150 • FAX (713) 661-2661

DATE RECEIVED: 6-DEC-1990

REPORT NUMBER: D90-31118
REPORT DATE: 3-JAN-1991

SAMPLE SUBMITTED BY: US Army Corp of Engineers
ADDRESS: 4815 Cass St.
Dallas, Texas 75235
ATTENTION: Ms. Cathy Hutchins

SAMPLE MATRIX: SOIL
ID MARKS: T503 0-3922

TEST REQUESTED	DETECTION LIMIT		RESULTS		
TCLP Pesticides					
Chlordane	0.014	mg/L	<	0.014	mg/L
Heptachlor	0.0010	mg/L	<	0.0010	mg/L
Heptachlor epoxide	0.0010	mg/L	<	0.0010	mg/L
Endrin	0.006	mg/L	<	0.006	mg/L
Lindane	0.004	mg/L	<	0.004	mg/L
Methoxychlor	0.18	mg/L	<	0.18	mg/L
Toxaphene	0.24	mg/L	<	0.24	mg/L

NDRC Laboratories, Inc. David R. Godwin VP
David R. Godwin, Ph.D.
Chief Executive Officer

62

APPENDIX H

RCRA FACILITY INVESTIGATION (RFI) REPORT

FINAL REPORT

SWMU NO. 97

LANDFILL NO. 25

IRP SITE LF-25

AIR FORCE PROJECT NO. CZQZ 92 7005

CANNON AIR FORCE BASE, NEW MEXICO

Prepared for:

U.S. Army Corps of Engineers

Omaha District

Prepared by:

Radian Corporation

10675 Richmond Avenue, Suite 190

Houston, Texas 77042

June 1994

Enclosure 2

EXECUTIVE SUMMARY

As part of the Installation Restoration Program (IRP) and Resource Conservation and Recovery Act (RCRA) requirements, Radian Corporation (Radian) was requested by the U.S. Army Corps of Engineers (USACE), Omaha District, to perform a RCRA Facility Investigation (RFI) and Risk Assessment on a former landfill site on Cannon Air Force Base (CAFB), near Clovis, New Mexico. The site is known as Landfill No. 25. This document contains the RFI and risk assessment for Landfill No. 25.

Landfill No. 25, Solid Waste Management Unit No. 97 (SWMU 97), is an elongated trapezoidal-shaped area covering approximately 32 acres. It is located in the northeastern portion of CAFB, just west of the ordinance area and east of the sewage lagoons and Perimeter Road (Figure 1).

The site is covered by rubble piles consisting of large chunks of concrete mixed with asbestos siding tiles, metal and asbestos/cement pipe, asphalt mixed with soil, and small amounts of wood. The heights of the rubble piles vary across the site and reach a maximum at the north end where the rubble is mounded to 15 feet above natural ground. Over most of the site, however, the rubble is only 3 to 4 feet deep. The rubble consists of the remains of demolished World War II temporary buildings and runways. The oldest piles of rubble located on the north and west sides of the site are overgrown with weeds, shrubs, and trees. The debris dumped later appears as individual piles over the site.

In 1991, the USACE, Tulsa District, performed an environmental assessment of the northern half of Landfill No. 25. The assessment consisted of trenching at 9 locations and collecting both rubble and native soil samples for laboratory analyses. The results showed elevated levels of metals and semivolatile organics.

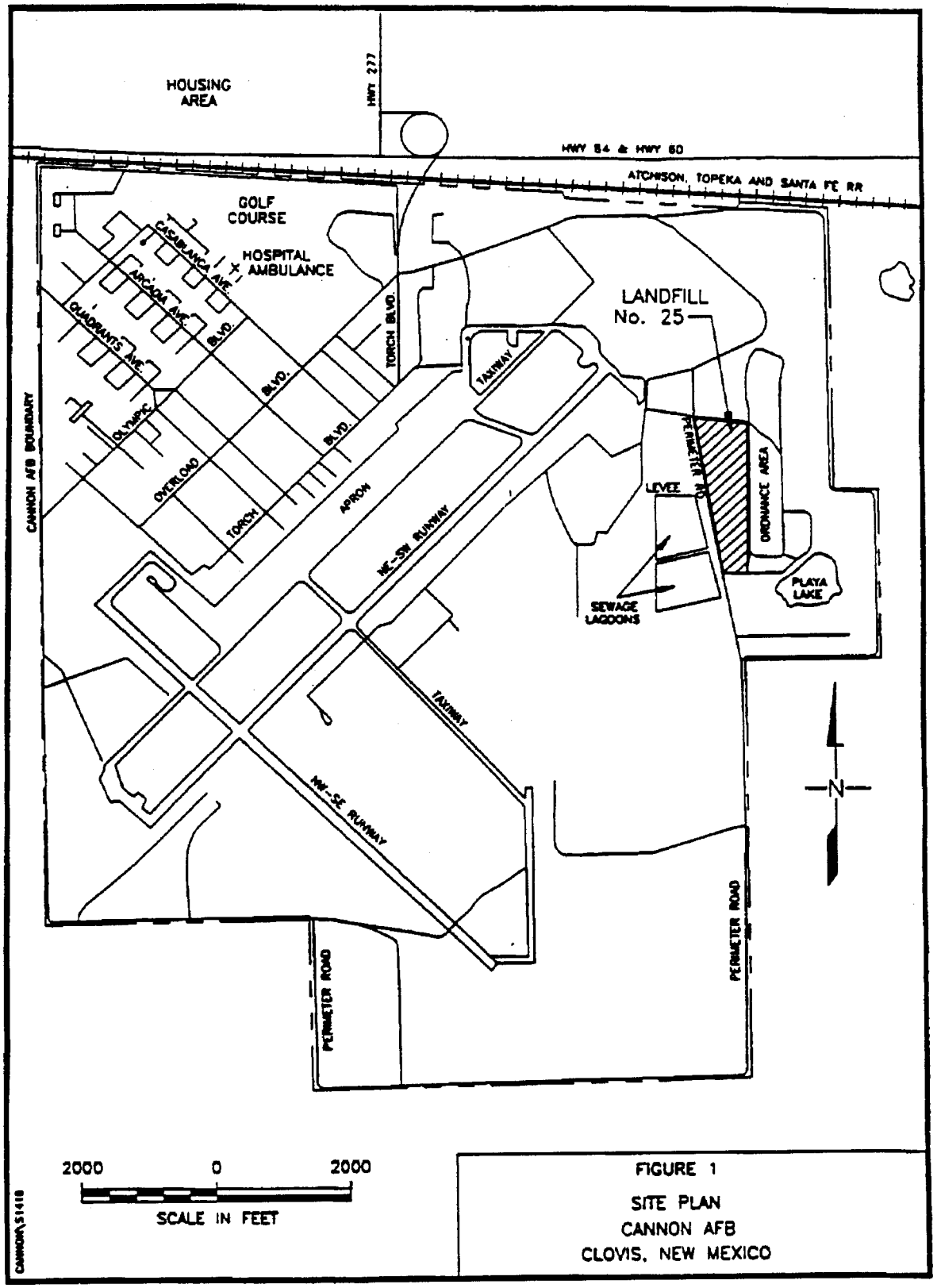


FIGURE 1

SITE PLAN
CANNON AFB
CLOVIS, NEW MEXICO

Consequently, the USACE recommended completion of a Remedial Investigation (USACE, 1991).

Based on the environmental assessment results, the USACE, Omaha District, prepared a Scope of Services designed to complete the RFI. The purpose of this investigation, as stated in the Scope of Services and modified as a result of a site visit, was to determine if contamination associated with landfill waste has migrated into native soils underlying it. Specific objectives include:

- Drilling and sampling of soil borings in the vicinity of the former trench locations where evidence of contamination had been detected. Analyses of these samples provides data on contaminant concentrations below source areas.
- Excavating and sampling of trenches in the previously uninvestigated south half of the landfill. This investigation provides information on contaminants in native soils throughout the remainder of the known landfill area.
- Drilling and sampling of deep (60-foot) soil borings throughout much of the landfill to determine the presence or absence of landfill related contamination at depth.
- Evaluation of the risks to human health and the environment associated with site contaminants in the underlying soils (surface and subsurface) and their potential mobilization.

A total of 139 soil samples, plus 14 Quality Control (QC) duplicates, and 14 Quality Assurance (QA) splits were collected and analyzed for the following:

- Volatile Organic Compounds (SW-846:8240);
- Semi-volatile Organic Compounds (SW-846:8270);
- Total Metals (SW-846:6010 and AA);
- Total Recoverable Petroleum Hydrocarbons (EPA Method 418.1);

- Pesticides/PCBs (SW-846:3520/8080); and
- pH (SW-846:9045).

Thirty-five soil samples, excluding QA and QC samples, were analyzed for Total Petroleum Hydrocarbons (SW-846:8015M) and Herbicides (SW-846:8150), and 46 samples were analyzed for grain size.

Metals, organochlorine pesticides, SVOCs, TRPH, TPH, chlorinated herbicides, and VOCs were all detected at levels above the analytical method reporting limit. Overall, the majority of the contamination was in the near surface soils, and as a general rule, decreased with depth.

One surface sample exceeded the noncarcinogenic RCRA Proposed Subpart S Media Action Level for lead (Figure 2). All other target metals and organics, were less than the proposed noncarcinogenic action levels.

Beryllium was the only metal detected above the RCRA Proposed Subpart S carcinogenic soil action level. However, beryllium in some background samples also exceeded the proposed action level, suggesting that this level is not appropriate for this site. One surface sample exceeded the proposed carcinogenic soil action levels for benzo(a)pyrene and benzo(b)fluoranthene (Figure 3). No other compounds were detected at levels exceeding the proposed carcinogenic soil action levels.

The risk assessment presents an assessment of the risks to human health and the environment associated with current and potential future activities at Landfill No. 25. The objectives of the risk assessment were to determine the average and reasonable maximum carcinogenic and noncarcinogenic risks associated with the landfill soil. To ensure adequate characterization of risk that shall be incurred at or near Landfill No. 25 presently or in the future, the baseline risk assessment considers several

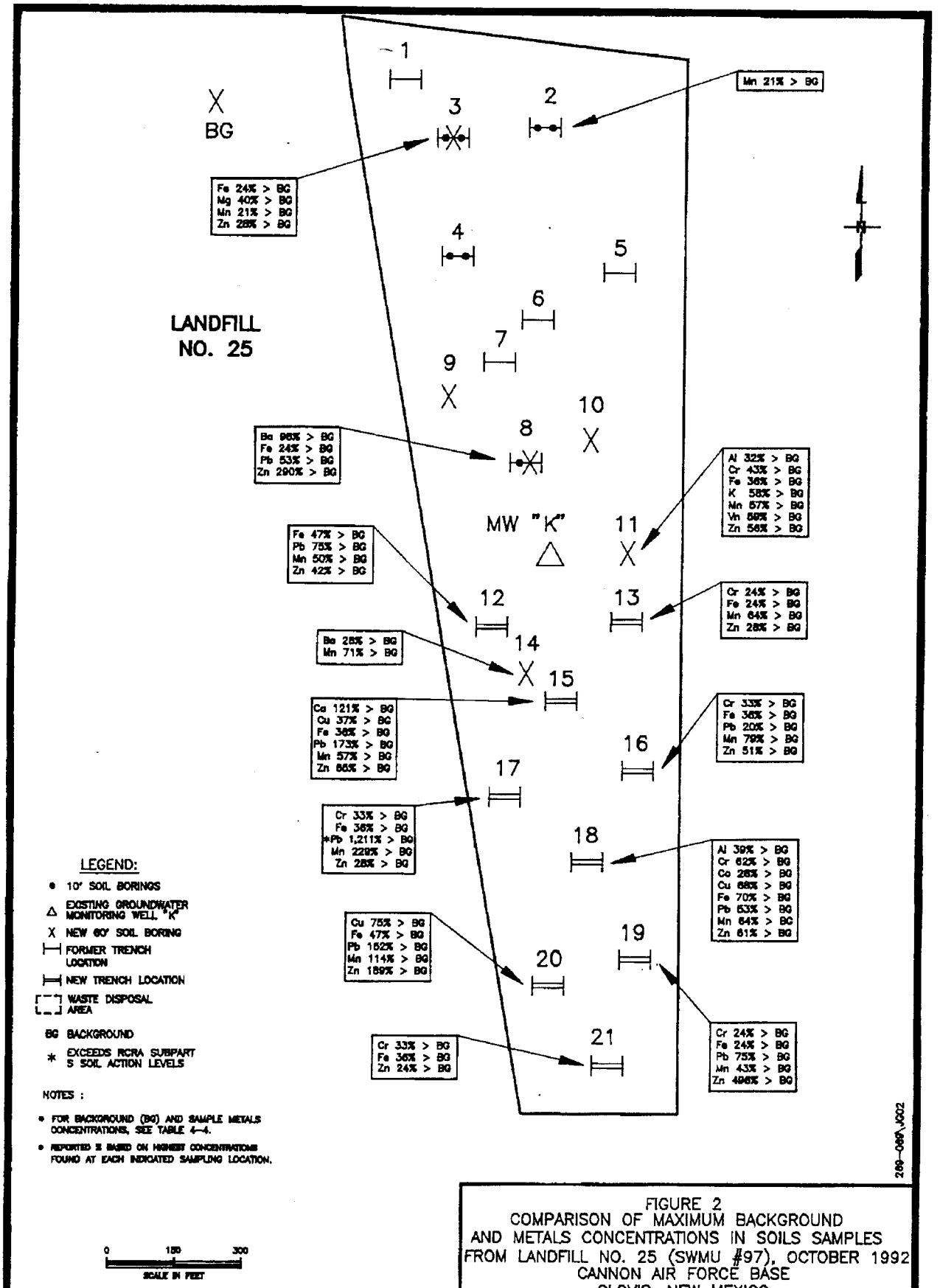


FIGURE 2
COMPARISON OF MAXIMUM BACKGROUND AND METALS CONCENTRATIONS IN SOILS SAMPLES FROM LANDFILL NO. 25 (SWMU #97), OCTOBER 1992
CANNON AIR FORCE BASE
CLOVIS, NEW MEXICO

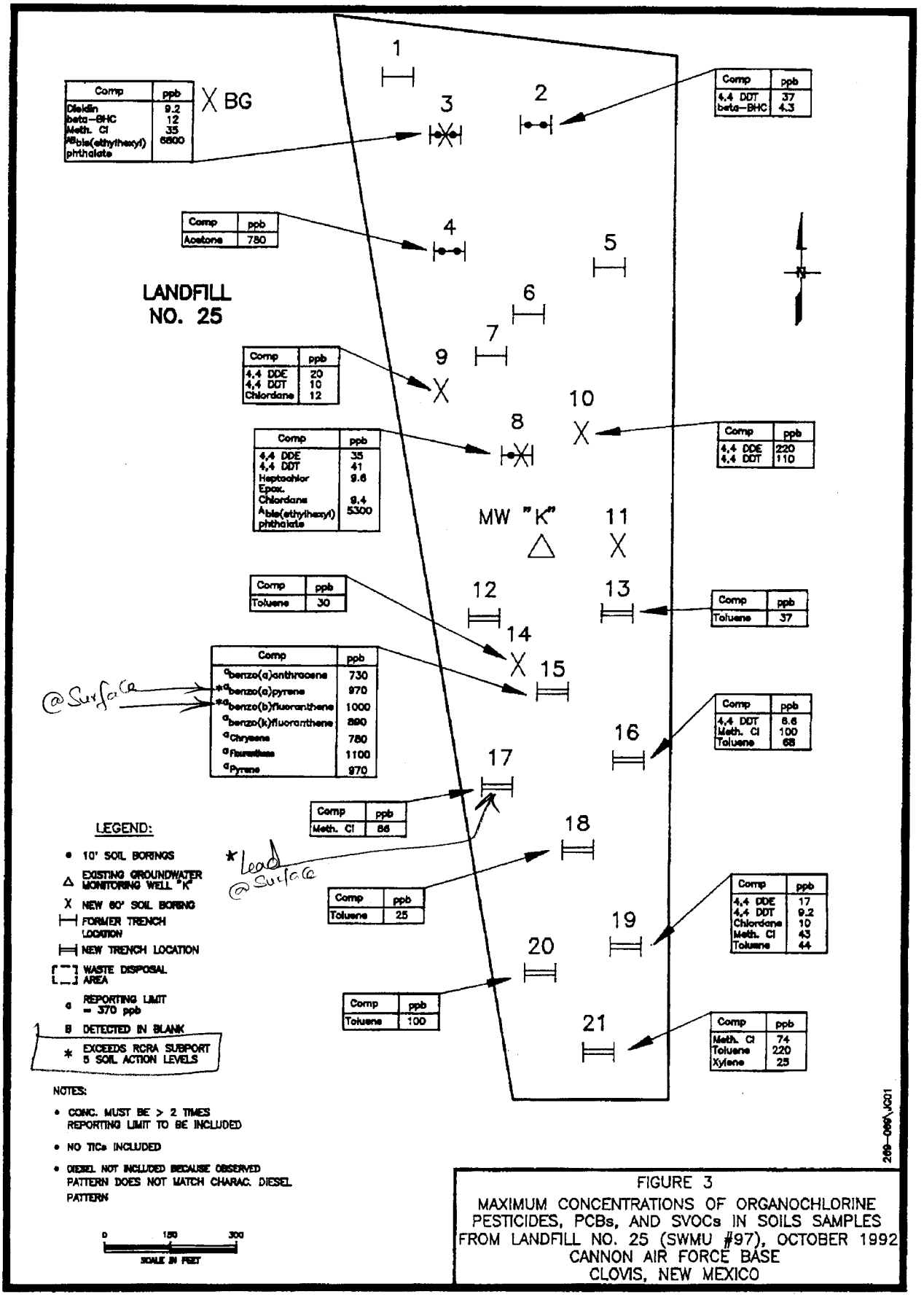


FIGURE 3
MAXIMUM CONCENTRATIONS OF ORGANOCHLORINE PESTICIDES, PCBs, AND SVOCs IN SOILS SAMPLES FROM LANDFILL NO. 25 (SWMU #97), OCTOBER 1992
CANNON AIR FORCE BASE
CLOVIS, NEW MEXICO

populations in eight exposure scenarios, including three chronic scenarios and two subchronic scenarios. The chronic scenarios include present and future off-site residents in areas downwind and hydraulically downgradient from Landfill No. 25 and present on-site workers. The subchronic scenarios include present on-site workers and future on-site construction workers.

Current human exposure to contaminants originating at Landfill No. 25 may occur in areas close to and downwind of the landfill and at the landfill itself (occupational) via inhalation of the ambient air. Use of water from Playa Lake to irrigate commercially produced agricultural crops and/or feed crops consumed by beef or dairy cows in the area may also indirectly result in human exposure to contaminants from the site.

Probable future land uses in the vicinity of CAFB will not significantly alter these exposure points and exposure routes although the size of the potentially exposed population could change. However, this investigation was conducted partially in response to a proposed expansion of the current munitions facility onto the northern portion of Landfill No. 25. Therefore, land use at the Base itself may change in the future, thus altering on-Base exposure patterns. Changes in exposure which could occur in the future include: 1) an increase or decrease in the number of people potentially exposed to site-related contaminants; 2) potential exposure of on-Base personnel and off-Base residents to site-related contaminants resulting from potential future groundwater contamination and subsequent use of the groundwater for domestic purposes (drinking, showering, etc.); and 3) an increase in exposure of on-site workers involved in future construction activities proposed for Landfill No. 25 (incidental ingestion of and/or dermal contact with soil).

The USEPA Superfund site remediation goal set forth in the National Contingency Plan (NCP) allows a cancer risk range of 1E-4 (1 in 10,000) to 1E-6 (1 in 1,000,000). This range is designed to be protective of human health and a cancer risk of

1 in 10,000 marks the point of departure. None of the estimated cancer risks exceed the Superfund site remediation cancer risk goal of 1 in 1,000,000 (1E-6), considered to be the de minimis value used in making risk management decisions. In addition, all of the estimated noncarcinogenic hazard indices are below the Superfund Site remediation goal of 1 for noncarcinogenic effects. These results suggest that, based on currently available information and the assumptions used in this risk assessment, Landfill No. 25 poses no notable human health risks to potentially exposed populations currently, or in the future. It should be noted, however, that this risk assessment was based on subsurface contamination below the rubble pile and not on contaminants, or their respective concentrations, within the rubble pile itself.

Results of the qualitative environmental evaluation indicate the level of exposure of wildlife known to inhabit the landfill and surrounding areas to contaminants present at the site is likely to be low. Therefore, potential adverse impacts of contamination from Landfill No. 25 on critical habitats and endangered species in the area is judged to be insignificant.

Only 2 of the 139 samples exceeded proposed RCRA Subpart S Soil Action Levels. Sample CAN97-17-S exceeded the proposed noncarcinogenic soil action level for lead. Sample CAN97-15-S exceeded the proposed soil action level for benzo(a)pyrene and benzo(b)fluoranthene. The above two samples are surface samples and do not represent significant contamination. The remaining 137 samples were all within the proposed soil action levels. In addition, the results of the quantitative risk assessment indicate that, based on currently available information and the assumptions used in the risk assessment, the native soil below the rubble at Landfill No. 25 poses no notable human health risks to potentially exposed populations.

The results of this investigation suggest that the native soil below the rubble at Landfill No. 25 is not contaminated. No further action is recommended for the native soil.

1.0 INTRODUCTION

As part of the Installation Restoration Program (IRP) and Resource Conservation and Recovery Act (RCRA) requirements, Radian Corporation (Radian) was requested by the U.S. Army Corps of Engineers (USACE), Omaha District, to perform an RCRA Facility Investigation (RFI) and Risk Assessment on a former landfill site on Cannon Air Force Base (CAFB), near Clovis, New Mexico. The site is known as Landfill No. 25. This document contains the RFI and risk assessment for Landfill No. 25.

1.1 Regulatory Overview

Because of the complicated nature of the regulations governing Department of Defense (DOD) facilities, this section is included, as requested in the scope of services, to explain the overlaps and differences of the various programs.

1.1.1 IRP and CERCLA

Because of the aircraft maintenance activities associated with its primary mission, the USAF has long been engaged in operations in which toxic and hazardous materials are used and industrial wastes are generated. There are a number of federal and state regulatory programs designed to ensure that routinely generated wastes are properly characterized and managed and that past disposal sites are identified and remediated, as necessary, to eliminate hazards to human health or the environment. One such program is the IRP.

The IRP began in 1975 as a pilot program conducted by the U.S. Army to investigate past hazardous waste disposal sites at DOD installations. Initial guidelines for conducting the IRP were provided to the armed services in a 23 July 1976 directive from the Assistant Secretary of Defense for Installations and Logistics. In these early stages of the program, DOD installations were required to identify their inactive hazardous waste disposal

sites and establish a prioritization program for conducting records searches. Subsequent legislative enactments have resulted in changes to the scope and procedures of the IRP.

In 1980, the U.S. Congress enacted the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 *United States Code* Section 9601 *et seq.*, as amended, which is primarily known for establishing the federal Superfund program and is administered by the U.S. Environmental Protection Agency (EPA). Under the Superfund program, inactive or abandoned waste disposal sites are investigated and remediated by the potentially responsible private or public parties (PRPs). If no PRPs are identified at a site, the EPA can undertake the investigation and cleanup with monies from the Superfund. The regulations that implement this program are referred to as the National Contingency Plan (NCP), found in 40 *Code of Federal Regulations* (CFR) Part 300. The NCP details the requirements for Remedial Investigations and Feasibility Studies.

In 1986, statutory amendments were made to CERCLA through the Superfund Amendments and Reauthorization Act (SARA). SARA specifies that remedial actions must achieve a degree of cleanup that meets legally applicable or relevant and appropriate requirements (ARARs) in light of the hazardous substances that are present. Basically, ARARs are quantitative standards, standards of control, and other substantive criteria or limitations promulgated by federal or state agencies. This includes "to be considered" (TBC) standards, which are non-promulgated federal and state guidelines, proposed rules, criteria, and advisories that may be useful to apply to the particular substances or units at a Superfund site. Early identification of ARARs (including TBC standards) is required, and potential remediation alternatives should be considered at the initiation of an RI/FS. SARA also provides for greater interaction with the public and state agencies, and extends EPA's role in evaluating the health risks associated with the contamination.

Section 9620 of SARA stipulates that CERCLA regulate the IRP. In November 1986, in response to this, the USAF modified the IRP to follow CERCLA guidance as related to the RI/FS process. The IRP is now oriented to include ARAR

determinations, the identification and screening of technologies, and the development of remedial alternatives.

1.1.2 RCRA

The Resource Conservation and Recovery Act (RCRA), 42 *United States Code* Section 6901 *et seq.*, was enacted in 1976. This law required the U.S. Environmental Protection Agency (EPA) to adopt regulations governing the current generation; transportation; and treatment, storage, or disposal of hazardous wastes. Subsequent amendments to the act required EPA to develop a "corrective action" program which, like the IRP, focuses on past waste management practices. These amendments, called the Hazardous and Solid Waste Amendments (HSWA) of 1984, require facilities that seek a RCRA operating permit to investigate and remediate the release of any hazardous wastes or constituents from active and inactive solid waste management units (SWMUs) under the corrective action program.

Section 6961 of RCRA, as amended, applies to federal, as well as private, facilities. Since CAFB stores hazardous wastes and is a federal facility, it is subject to RCRA as well as CERCLA.

1.1.3 Integration of IRP and RCRA Corrective Action Program

Both the IRP and RCRA corrective action programs are intended to ensure remediation of contaminated sites that pose an actual or potential threat to human health or the environment. Both programs are implemented through phased approaches to identify, investigate, and remediate these sites. However, there are differences between the two programs. First, the IRP is solely a federal facility program while RCRA corrective action also applies to private facilities. Second, the IRP does not contain substantive cleanup standards. For the IRP, federal and state laws serve as the basis for identifying cleanup standards through the ARAR process, while the proposed RCRA corrective action rules (*55*

Federal Register, 27 July 1990) contain ranges of media-specific cleanup standards. Finally, the terminology and scope of the two programs' phases are somewhat different.

Figure 1-1 presents a side-by-side comparison of the basic phases of implementation of the IRP and RCRA corrective action processes. The general scope of each of these phases is described below:

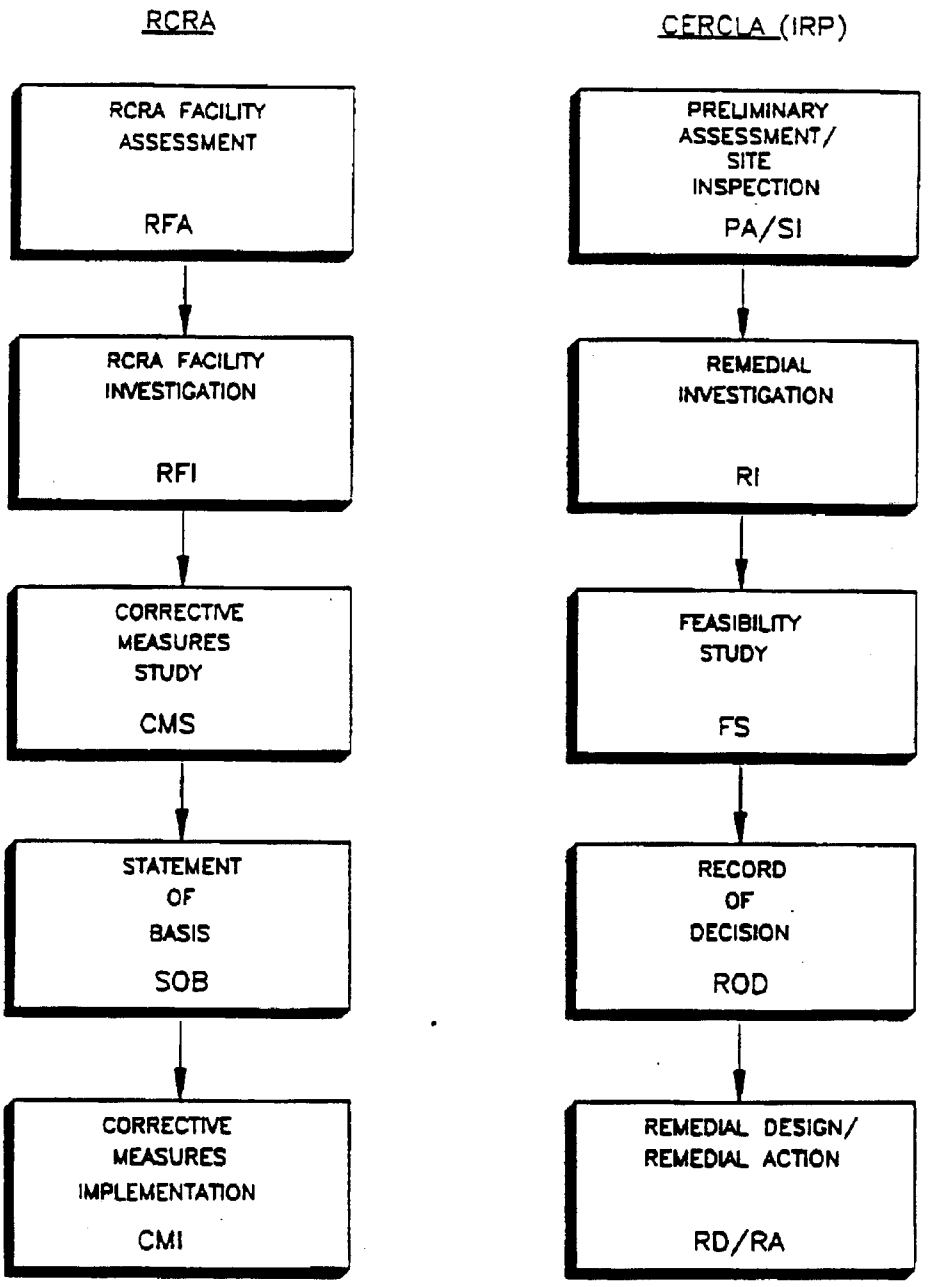
- RCRA Facility Assessment (RFA) and CERCLA Preliminary Assessment/Site Inspection (PA/SI)--the first steps in the process to screen and identify what specific sites at the installation need further investigation. The screening is usually based on a visual site inspection and records review at the installation.

- RCRA Facility Investigation (RFI) and CERCLA Remedial Investigation (RI)--the stages during which data about site and waste characteristics, their hazards, and routes of exposure are collected and analyzed, and the need for further action developed.

- RCRA Corrective Measures Study (CMS) and CERCLA Feasibility Study (FS)--the stages during which a number of potential remedial action alternatives are developed and screened.

- Statement of Basis and Record of Decision (ROD)--the document in which the a remedy is selected and documented. It also describes the technical parameters of the remedy and provides the public with a consolidated source of information about the site, the chosen remedy, and the rationale behind the selection.

- RCRA Corrective Measures Implementation (CMI) and CERCLA Remedial Design (RD)/Remedial Action (RA)--the stages during which the chosen remedy is designed and implemented.



CANNON\N1546

FIGURE 1-1
COMPARISON OF RCRA
CORRECTIVE ACTION AND IRP PHASES
CANNON AIR FORCE BASE
CLOVIS, NEW MEXICO

The EPA, in the preamble to the proposed RCRA corrective action rules, confirmed that, because the IRP and RCRA corrective action programs are independent environmental requirements, federal facilities must comply with the requirements of both programs (*55 Federal Register* 30798, 30858). The agency further states that, to the extent possible, it will try to ensure the coordination of activities required under the programs to minimize duplication of information and work effort.

1.1.4 Integration of IRP and RCRA Corrective Action Program at CAFB

Since CAFB is part of the Department of Defense IRP, it is regulated by CERCLA. Additionally, because CAFB applied for a RCRA hazardous waste management permit to authorize the operation of an on-site storage facility for currently generated hazardous wastes, the facility is subject to the RCRA corrective action program.

HSWA was enacted into law on 8 November 1984 and required corrective action for releases of hazardous wastes or constituents from solid waste management units (SWMUs) at hazardous waste treatment, storage, and disposal facilities. Section 3004(u) of HSWA states that any facility applying for a RCRA hazardous waste management facility permit will be subject to an RFA. The RFA is conducted by the regulatory agency granting the permit and is designed to identify SWMUs that are suspected to be the source of releases to the environment. If any such SWMUs are identified during the RFA, the owner/operator of the facility will be directed to perform an RFI to assess the nature and extent of the release.

CAFB initiated the RCRA corrective action process by conducting an RFA in 1987 in conjunction with their ongoing IRP. A.T. Kearney, Inc. of Chicago performed the RFA of CAFB Landfill No. 25 under contract to EPA Region VI. Kearney evaluated past operational activities and waste management practices at CAFB and, in a 1987 report, identified 76 SWMUs that could have adverse impacts on the environment (Kearney, 1987). Landfill No. 25 was designated as SWMU 97 in the Kearney report.

EPA Region VI issued CAFB the HSWA component of its RCRA operating permit, effective 16 October 1989. The HSWA portions of the permit require CAFB to investigate some of the SWMUs identified in the RFA. EPA selected the SWMUs for investigation based on the results of the RFA, and Landfill No. 25 was among those SWMUs chosen for investigation.

1.2 Report Organization

This is the RFI Report for Landfill No. 25 at CAFB. It is also intended to address all of the elements required under the IRP for Landfill No. 25. Landfill No. 25 is designated by IRP as LF-25 and by RCRA as SWMU 97.

CAFB will meet the requirements of both CERCLA and the RCRA corrective action program without expending resources on duplication of effort. This report is presented in the CERCLA RI format but includes a reference table that outlines applicable RCRA corrective action RFI requirements and indicates where they are addressed within this report (Table 1-1).

Following this introduction, the RFI report contains eight sections. Section 2, Background and Scope, presents information concerning the site history, the previous investigation of Landfill No. 25, and this Remedial Investigation. Section 3, Field Investigation Program, summarizes the methods and procedures used to collect data for this RFI. Section 4 contains the geologic and analytical results from the Landfill No. 25 investigation. Topics covered in Section 4 include geologic interpretation, data validation, statistical analyses for background determination, and presentation of risk based action levels. A discussion of the findings can be found in Section 5. Section 6 contains the Risk Assessment. The Section 7 Conclusions and Recommendations are based on the Section 6 Risk Assessment and guidelines from the CERCLA and RCRA corrective action programs.

Table 1-1

Location of Responses to HSWA Permit Requirements in this RFI Report

Section	HSWA Permit Requirement	Location in RFI Report
A. ENVIRONMENTAL SETTING		
1. Hydrogeology		
a.	Regional and SWMU-specific geologic and hydrogeologic conditions affecting groundwater flow	Sections 1.3.1 and 1.3.2 Figures 1-4, 1-9, and 1-10
b.	Topographic features influencing groundwater flow	Sections 1.3.1 and 1.3.2 Figure 1-5
c.	Hydrogeologic units in migration pathways	Sections 1.3.1 and 1.3.2
d.	Extent and characteristics of hydrogeologic units in migration pathways	Sections 1.3.1 and 1.3.2
e.	Water level monitoring	Sections 1.3.1 and 1.3.2
f.	Man-made influences on hydrogeology	Sections 1.3.1 and 1.3.2 Figure 1-10
2. Soils		
a.	Surface soil distribution	Sections 1.3.1, 1.3.2 Figure 1-8
b.	Soil profile and classification	Sections 1.3.1, 1.3.2 Figure 1-8
c.	Soil stratigraphy	Sections 1.3.1, 1.3.2
d.	Saturated hydraulic conductivity	Sections 1.3.1, 1.232 Appendix K
e.	Porosity	Appendix K
f.	Cation exchange capacity	————
g.	Soil pH	Appendix K
h.	Particle size distribution	Section 4.2, Appendix E
i.	Depth to water table	Sections 1.3.1 and 1.3.2 Figure 1-9
j.	Moisture	Appendix L
k.	Effect of stratigraphy on unsaturated flow	Section 4.2, 5.1 Appendix K
l.	Infiltration	Section 4.2, 5.1 Appendix K
m.	Evapotranspiration	Sections 1.3.1 and 1.3.2 Table 1-2
n.	Contaminant concentrations in soils	Section 4.0
o.	Metals concentrations in soils	Section 4.3

Table 1-1

(Continued)

Section	HSWA Permit Requirement	Location in RFI Report
B. SOURCE CHARACTERIZATION		
1. Unit/Disposal Area Characteristics		
a.	Location	Sections 1.3.2, 6.1
b.	Type	Section 1.3.2
c.	Design features	Section 1.3.2
d.	Operating practices	Section 1.3.2
e.	Period of operation	Section 1.3.2
f.	Age	Section 1.3.2
g.	Physical conditions	Section 1.3.2, 4.2
h.	Closure method	Section 1.3.2
2. Waste Characteristics		
a.	Type	Sections 2.2 and 4.0
b.	Physical and chemical characteristics	Sections 4.0, 5.0
c.	Migration and dispersal characteristics	Section 5.0
C. CONTAMINATION CHARACTERISTICS		
1. Groundwater Contamination		
a.	Horizontal and vertical extent of contamination	Section 5.0
b.	Horizontal and vertical direction of movement	Section 5.0 Appendices J, K, and L
c.	Velocity	Appendices J, K, and L
d.	Horizontal and vertical concentration profiles of any Appendix IX or radiochemical constituents	Sections 4.0, 5.0 Appendices J, K, and L
e.	Factors influencing plume movement	Appendices J, K, and L
f.	Extrapolation of future movement	Section 6.0 Appendices J, K, and L
2. Soil Contamination		
a.	Vertical and horizontal extent	Sections 4.0, 5.0
b.	Contaminant and soil chemical properties	Section 4.0 Appendices B and E
c.	Contaminant concentrations	Section 4.0 Appendix B
d.	Velocity and direction of contaminant movement	Appendices J, K, and L

Table 1-1

(Continued)

Section	HSWA Permit Requirement	Location in RFI Report
e.	Extrapolation of future contaminant movement	Section 6.0 Appendices J, K, and L
3. Surface Water Contamination		
a.	Horizontal and vertical extent of any immiscible or dissolved plumes originating from the facility, and the extent of contamination in the underlying sediments	Section 4.0 Appendices B, J, K, and L
b.	Horizontal and vertical direction and velocity of contaminant movement	Appendix K
c.	Physical, biological, chemical, and radiochemical factors influencing contaminant movement	Appendix K
d.	Extrapolation of future contaminant movement	Appendix K
e.	Chemistry and radiochemistry of contaminated surface waters and sediments	Appendix K
4. Air Contamination		
a.	Horizontal and vertical direction and velocity	Appendix J
b.	Rate and amount of release	Appendix J
c.	Chemical, radiochemical, and physical composition of contaminants, including horizontal and vertical concentration profiles	Appendix J
D. POTENTIAL RECEPTORS		Section 6

1.3 Project Setting

CAFB is located about seven miles west of Clovis (Curry County), New Mexico. Clovis is in eastern New Mexico, approximately five miles west of the Texas/New Mexico state line (Figure 1-2).

1.3.1 Region Description

Physiography

Eastern New Mexico and western Texas are part of the Southern High Plains physiographic province. The Southern High Plains province is part of the Great Plains province, which extends from Montana and South Dakota to New Mexico and Texas. (See Figure 1-3).

The Southern High Plains is an isolated plateau within the Great Plains province that covers much of eastern New Mexico and western Texas. The northern boundary of the Southern High Plains is the Canadian River, which lies 60 miles to the north of Clovis. The eastern and western sides of the plateau are bounded by sandstone escarpments that rise as high as 300 feet above the surrounding area (NMGS, 1972). The elevation of the plateau is typically 4,500 feet above mean sea level (MSL).

Much of the province has a broad, relatively flat, gently sloping surface. The Rocky Mountain orogeny (uplift) created an eastward dip that ranges from 5 to 30 feet per mile. Small temporary lake basins known as playas are the dominant surface feature. These circular, concave depressions extend to a depth of more than 20 feet in the vicinity of CAFB. In several cases they exceed 50 acres in size (NMGS, 1972).

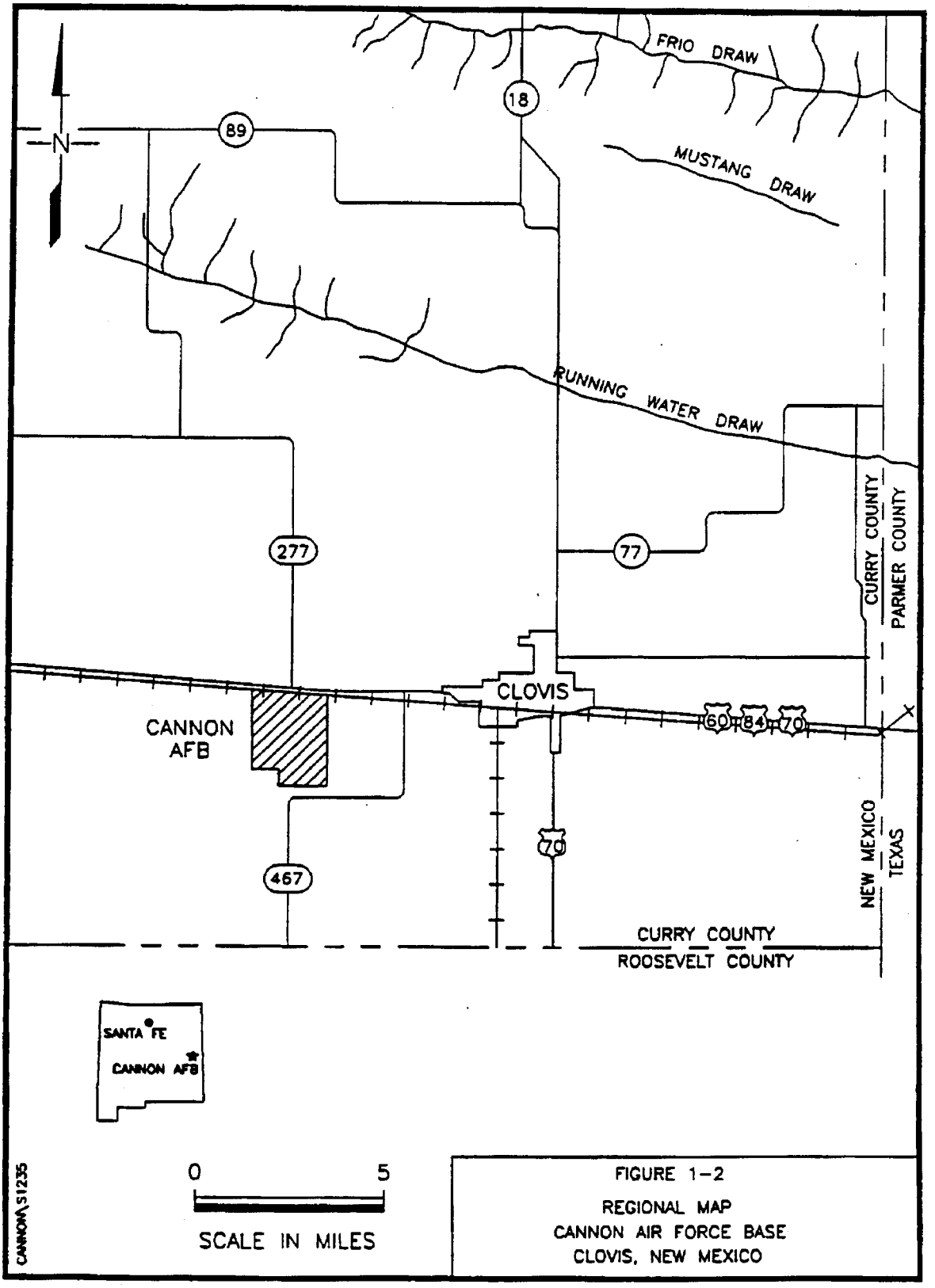


FIGURE 1-2
REGIONAL MAP
CANNON AIR FORCE BASE
CLOVIS, NEW MEXICO

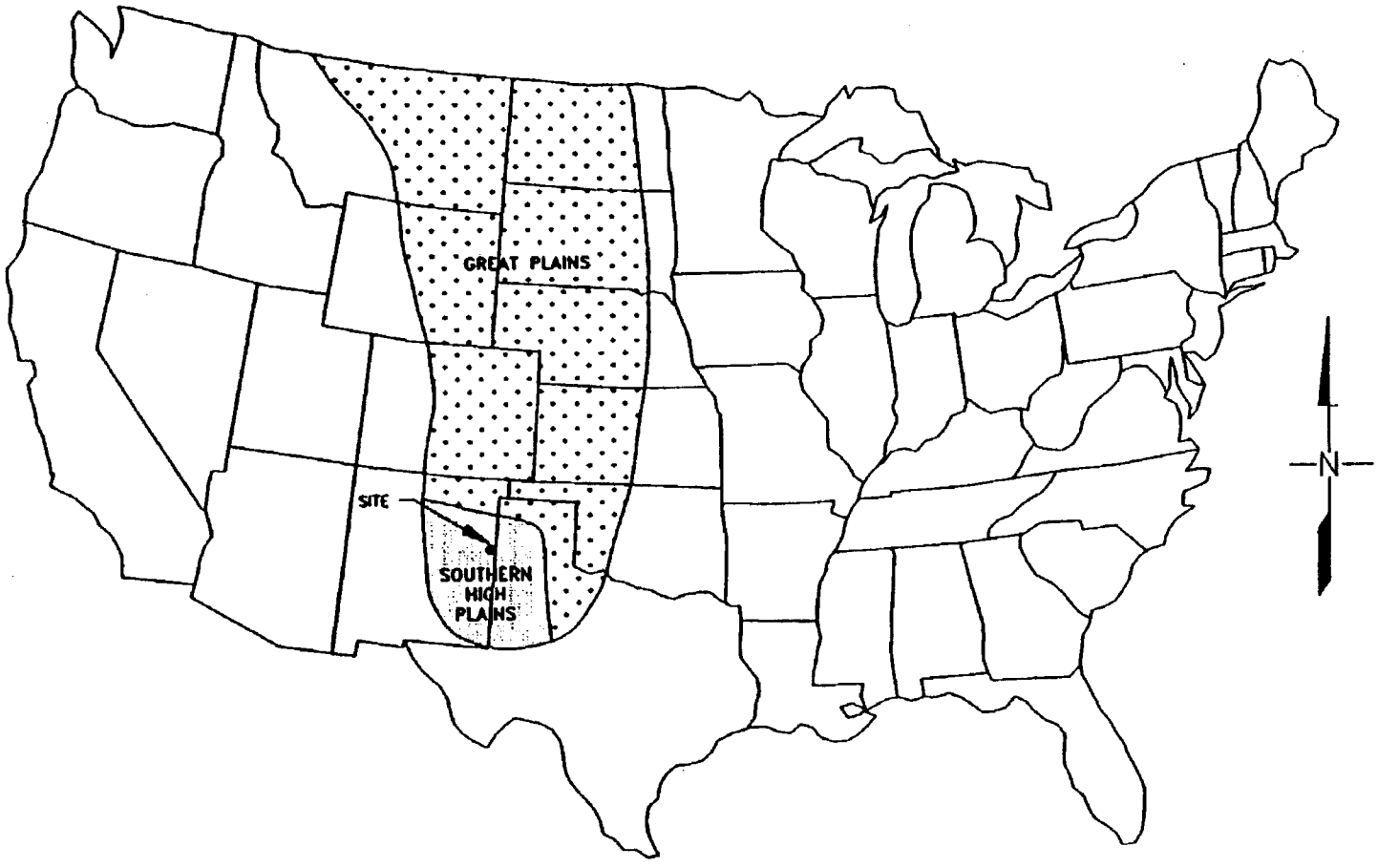


FIGURE 1-3

GREAT PLAINS AND
SOUTHERN HIGH PLAINS PROVINCES
CLOVIS, NEW MEXICO

Climate

The weather in the Southern High Plains is some of the most variable in the country. There are no high hills or mountains to break the flow, so air masses cross the region relatively unimpeded. Even with the potential of icy winters, scorching summers, extreme winds, and sudden storms, the regional average is more than 300 sunny days per year.

The local climate is controlled by the interactions of three extensive air masses (Anderson, 1975). The Canadian air mass from the north is generally dry and cool. The tropical air mass from the south is usually moist and warm. The Pacific air mass that must first cross the Rockies can be warm or cold and either moist or dry. Storms result when any of these air masses meet. Counter-clockwise rotation around low pressure systems spins moisture up from the gulf. The moisture cools by contact with polar air or by adiabatic cooling as it rises over the polar air mass, resulting in violent thunderstorms. Pacific storms from the northwest bring some moisture, but most is lost over the Rockies. The stable, clear weather is the result of a high pressure system that is situated near the Four Corners region for much of the fall and winter. All of these large-scale interactions provide the Southern High Plains with a relatively constant wind.

The climate of east-central New Mexico is classified as semi-arid. Average monthly temperatures range from a winter low of 39°F in January to a summer high of 78°F in July (Curry County, 1988). Mean annual precipitation is approximately 18 inches. The mean annual evapotranspiration rate is 71 in/yr, which represents a net loss of 53 in/yr (See Table 1-2). Prevailing winds are from the west at an average of 8 mph during fall, winter, and spring months. During the summer, winds are from the south at an average of 6 mph.

Table 1-2

Precipitation Data Based on Average Monthly Values For Clovis, New Mexico [a]

Month	Average Precipitation (in.)	Pan Evaporation (in.)	Net Precipitation (in.)
January	0.40	0.40	0.00
February	0.40	3.40	-3.00
March	0.60	5.00	-4.40
April	1.30	7.40	-6.10
May	2.35	8.50	-6.15
June	2.55	9.30	-6.75
July	2.50	11.80	-9.30
August	2.90	9.10	-6.20
September	2.25	5.50	-3.25
October	1.85	5.00	-3.15
November	0.50	3.50	-3.00
December	0.60	2.20	-1.60
Total	18.20	71.10	-52.90

[a] From Pan Evaporation Data collected by the Agricultural Science Station north of Clovis, New Mexico.

Because of the consistent winds and the patchy vegetative cover, the Texas Panhandle-eastern New Mexico area has the most windblown dust in the United States. Dust storms usually occur in March and April and can seriously limit visibility.

Soils

The soil profile for Curry County is classified as an aridisol using the Soil Conservation Service (SCS) Comprehensive Soil Classification System. Such soils form in relatively dry environments where the moisture balance is strongly negative for a significant portion of the year (See Table 1-2). Consequently, native vegetation is sparse, and little leaching occurs within the soil column. The primary soil-forming regime is calcification. Aridisols have essentially no organic layer (O-horizon) and often have a salt-enriched layer (i.e. caliche) at the surface or at depth. The local texture of an aridisol depends on surface processes such as wind and runoff. With the aid of irrigation, the agricultural potential of aridisols is good, but excessive evaporation can create alkaline conditions.

The dominant soil within the county is developed in sandy calcareous material that has been reworked by wind and runoff. Typically, the soil has a well developed surface layer (A-horizon) about 6" thick consisting of brown, friable, noncalcareous loam. The subsoil (B-horizon) is approximately 40" of red-brown, friable to well-cemented, calcareous, sandy-clay loam. The substratum (C-horizon) is white to pink, chalky, calcareous sandy loam with hard white to brown caliche nodules.

The soil is alkaline because of the high calcium carbonate concentration. A wide variety of metals is naturally occurring in the soils. Table 1-3 compares typical soil metals concentrations in the Clovis region to the rest of the United States.

Table 1-3

Elemental Concentrations[1] in Soils and Other Surficial Materials in the Conterminous United States[2]

Element	Arithmetic Mean		Typical Levels in Clovis, NM Region
	Conterminous United States	Western United States	
Aluminum	72,000	74,000	50,000
Antimony	0.67	0.62	<1
Arsenic	7.2	7.0	6.5
Barium	589	670	500
Beryllium	0.92	0.97	1 - 2
Cadmium	---	---	---
Calcium	24,000	36,000	7,500 - 18,000
Chromium	54	56	30
Cobalt	9.1	9.0	3 - 7
Copper	25	27	20
Iron	26,000	26,000	100 - 15,000
Lead	19	20	15
Magnesium	9,800	10,000	2,000 - 5,000
Manganese	550	480	500
Mercury	0.0??	0.065	0.032 - 0.052
Nickel	19	19	15
Potassium	15,000	18,000	16,000
Selenium	0.34	0.34	0.15 - 0.30
Silver	---	---	---
Sodium	12,000	12,000	7,000
Thallium	---	---	---
Vanadium	80	83	30 - 70
Zinc	60	65	45

[1] All concentrations are in milligrams per kilogram (mg/kg).
[2] Source: Sheckloette and Boerngea 1964

Vegetation

The entire region of eastern New Mexico lies within the Pinyon-Juniper Belt. It is characterized by widely-spaced, open, mixed stands of pinyon pines and junipers. This belt is also referred to as the Upper Sonoran Zone, the Plains Zone, and the Woodlands Zone (Elmore, 1976). The Pinyon-Juniper Belt ranges from high plateaus and foothills to low plains and canyons. Elevations generally range from 4,000 to 6,500 feet above MSL. The terrain is usually dry, rocky, and gravelly, and is characterized by limited moisture. Other than in riparian zones, the plants are drought-resistant species.

Other than pinyons and junipers, shrubs such as shadscale, saltbrush, and greasewood are often intermixed, especially where the soil is alkaline. Cacti and yucca creep up from the desert and Ponderosa pine and Gambles oak creep down from the foothills. Sagebrush often makes up stands of more than an acre uninterrupted by a single tree. In riparian zones, cottonwoods, walnuts, and sycamores are present, and dryer locations yield shrubs such as rabbitbrush, fernbush, cliffrose, and scrub oak.

Land Use

Of the 897,000 acres that comprise Curry County, 222,080 acres are irrigated cropland, 422,000 acres are dry cropland, and 235,000 acres are range. County revenues are approximately $44 million for crops and $88 million for livestock. The major crops grown in the county are wheat (170,600 acres), sorghum (20,500 acres), corn (17,000 acres), hay (14,500 acres), vegetables (4,530 acres), potatoes (3,000 acres), cotton (2,600 acres), and peanuts (1,600 acres). There is an estimated total of 130,250 head of cattle (Curry County, 1990). CAFB occupies about 4,320 acres and is a major source of revenue for Clovis. The base employs approximately 12,340 people. The total population of Clovis is 33,000 people.

Geology

The near-surface geology of the region consists of two sedimentary units (NMGS, 1972). The oldest is the Dockum Group of Triassic age (Figure 1-4). This is overlain by the Miocene-Pliocene age Ogallala Formation. Both units dip gently east-southeast away from the Rocky Mountain uplift.

The Dockum Group is made up of the Santa Rosa Sandstone, the Chinle Formation, and the Redonda Formation. Deep wells in the vicinity of Clovis have determined that the top several hundred feet of the unit consists of red-brown siltstone and claystone with interbedded fine to very fine sands. Prior to deposition of the Ogallala Formation, the Dockum Group was eroded by a series of deep east-west trending streams creating an uneven contact surface.

Overlying the Dockum Group is the Ogallala Formation. The Ogallala Formation is an alluvial fan deposit comprised of eroded sediments from the eastern margin of the ancestral Rocky Mountains. It consists of lenticular beds of silt, sand, and sand-gravel mixtures. Caliche, often an almost pure calcium carbonate, is found in the upper 100 feet of the formation (NMGS, 1972). The sediments exhibit varying degrees of carbonate cementation, but most of the formation is poorly-cemented, light-tan-to-red, fine-to-medium-grained sand. The base of the formation is marked by 15 to 40 feet of gravels. This basal gravel is the primary aquifer for the region. Drillers' logs from CAFB and nearby Radian investigations indicate that the Ogallala varies from 360 to 415 feet thick in the Clovis area. This fluctuation is the result of the uneven contact with the underlying Dockum Group.

Surface Water and Topography

The topography in the vicinity of CAFB is characterized by broad gentle slopes with localized depressions (Figure 1-5). The topographic gradient is approximately 17

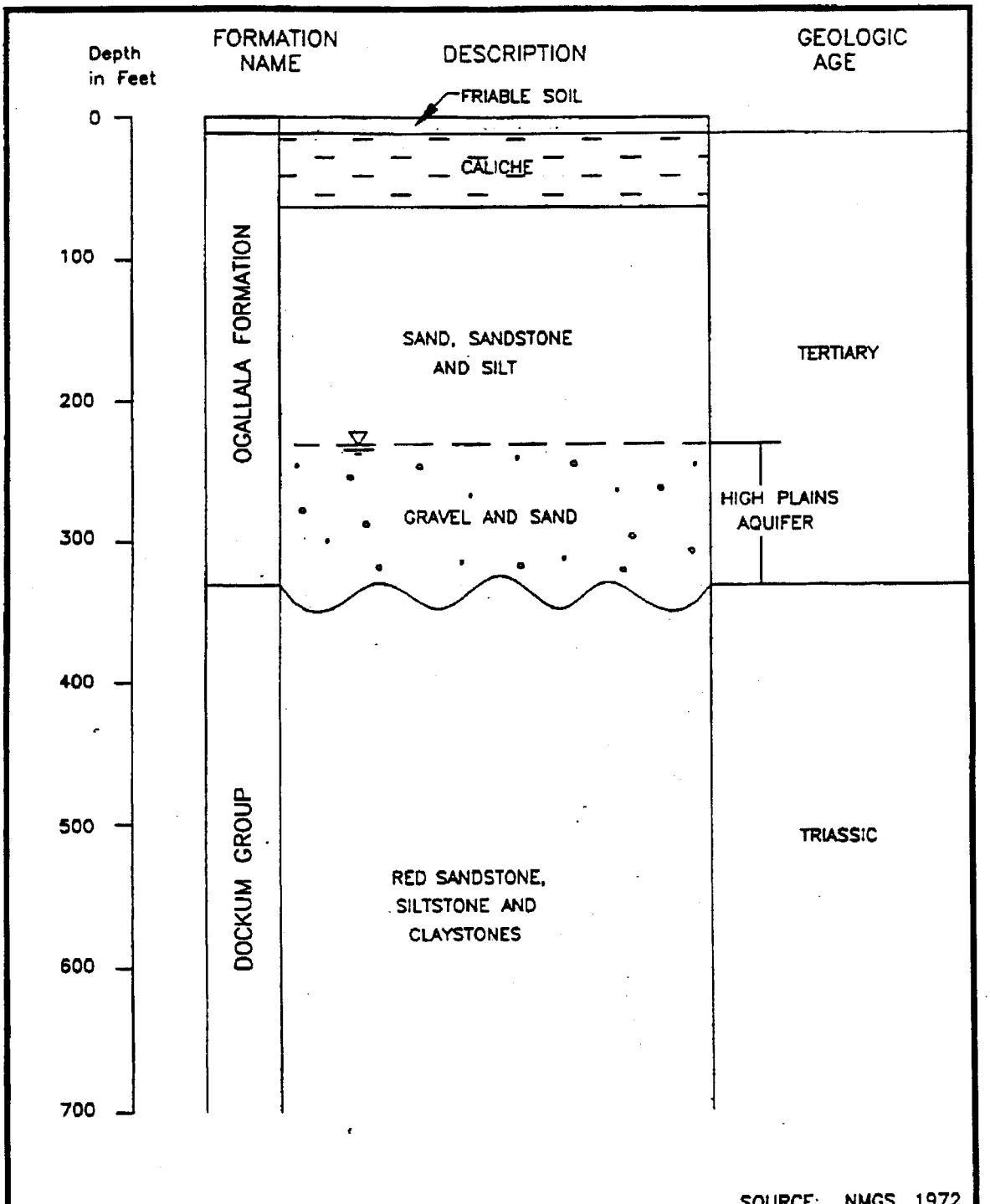
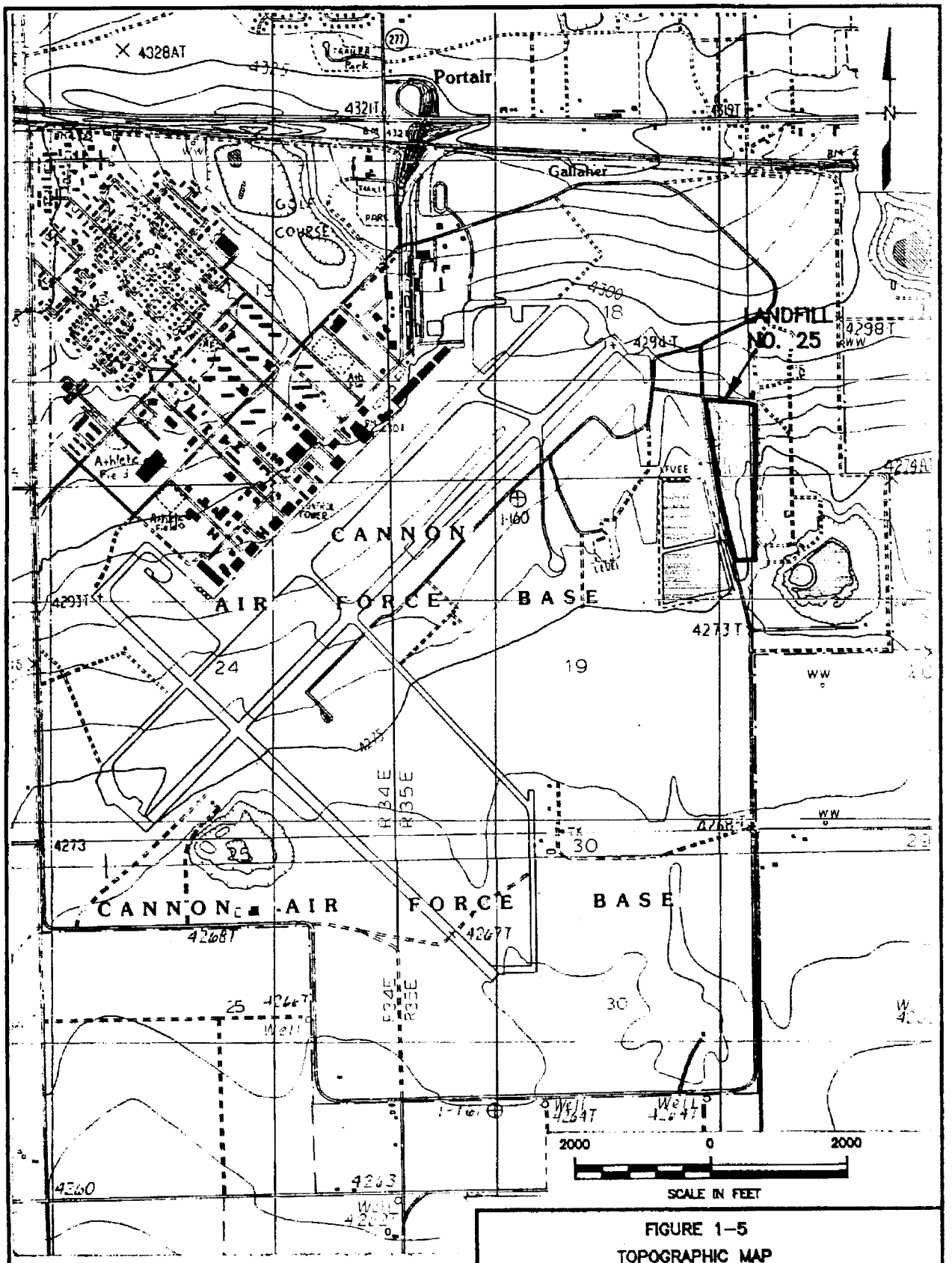


FIGURE 1-4

GEOLOGIC COLUMN
AT CANNON AIR FORCE BASE
CLOVIS, NEW MEXICO



REFERENCE:
USGS QUAD SHEETS "PORTAIR, NEW MEXICO"
AND "OASIS STATE PARK, NEW MEXICO"

FIGURE 1-5
TOPOGRAPHIC MAP
CANNON AIR FORCE BASE
CLOVIS, NEW MEXICO

feet per mile southeast and the depressions are 10 feet to 20 feet deep covering up to 50 acres.

Regional drainage in Curry County is predominantly to the east-southeast. Stream drainage is poorly developed and intermittent because of the low annual precipitation and the minimal relief. The drainages that are developed are long shallow valleys and draws that extend from the western margin of the Southern High Plains to eastern boundary of the province. Running Water Draw and Patrick Draw, located 10 and 20 miles, respectively, north of CAFB, are the nearest drainages (Figure 1-2). Both of these drainages trend to the southeast, interrupted periodically by short second-order streams. Eventually, the draws run into either the Red River, the Brazos River, or the Colorado River. Because of the semi-arid climate, the negative water balance, and the intermittent nature of these drainages, they rarely contribute to the annual flow of these major rivers. In the areas not drained by the draws (i.e. most of the county), surface runoff collects in playa lakes. The playas have no surface outlet, and consequently, all of the water that collects in the lakes is eventually lost to evapotranspiration and infiltration.

Groundwater

Water used for municipal and industrial purposes is derived from wells screened in the coarse-grained material at the base of the Ogallala Formation. The Ogallala aquifer is part of the High Plains aquifer that extends continuously from Wyoming and South Dakota into New Mexico and Texas. In eastern New Mexico, contact with the Dockum Group serves as the basal aquitard. The Ogallala is a water table, or unconfined, aquifer (Weeks and Gutentag, 1981; Berkstresser and Mourant, 1966). Previous Radian work indicates that the depth to water in the Clovis area is approximately 300 feet below land surface (BLS). The water table has a southeasterly gradient of 13 feet per mile. Kearney (1987) indicates a regional flow velocity of about 1.0×10^{-1} cm/sec. Well yields vary from less than 1 gpm in fine silt and clays, to 1600 gpm in coarse sands and gravels (Berkstresser and Mourant, 1966). Other than having a hardness of 185 mg/L as $CaCO_3$, and containing

an average of 2.2 mg/L fluoride, the water from the Ogallala aquifer is considered to be of good chemical quality (NMGS, 1972).

Groundwater recharge to the Ogallala aquifer is primarily through precipitation at a rate of 1.0 in/yr (Kearney, 1987). Because of the negative water balance of 53.4 inches per year, recharge only occurs during heavy precipitation events when the initial abstraction capacity of the soil is exceeded and runoff occurs, or during cool months when evapotranspiration is exceeded by precipitation. Discharge from the aquifer occurs primarily through well pumping and secondarily through springs along the eroded margins. The rate of pumping vastly exceeds recharge, and consequently, water levels have steadily declined at a rate of more than 2 feet per year in the Clovis area (NMGS, 1972).

Groundwater in the Dockum group is scarce and of poor chemical quality. Consequently, the base of the Ogallala Formation is considered to be the practical lower limit from which useful volumes of potable water can be derived.

1.3.2 Site Description

At various times in CAFB's history, demolished buildings, runways, and subgrade material was deposited on a site now known as Landfill No. 25.

Location

Landfill No. 25 (SWMU 97) is an elongated trapezoidal-shaped area covering approximately 32 acres. It is located in the northeastern portion of CAFB, just west of the ordnance area and east of the sewage lagoons and Perimeter Road (Figure 1-6). The exact landfill boundaries are poorly defined.

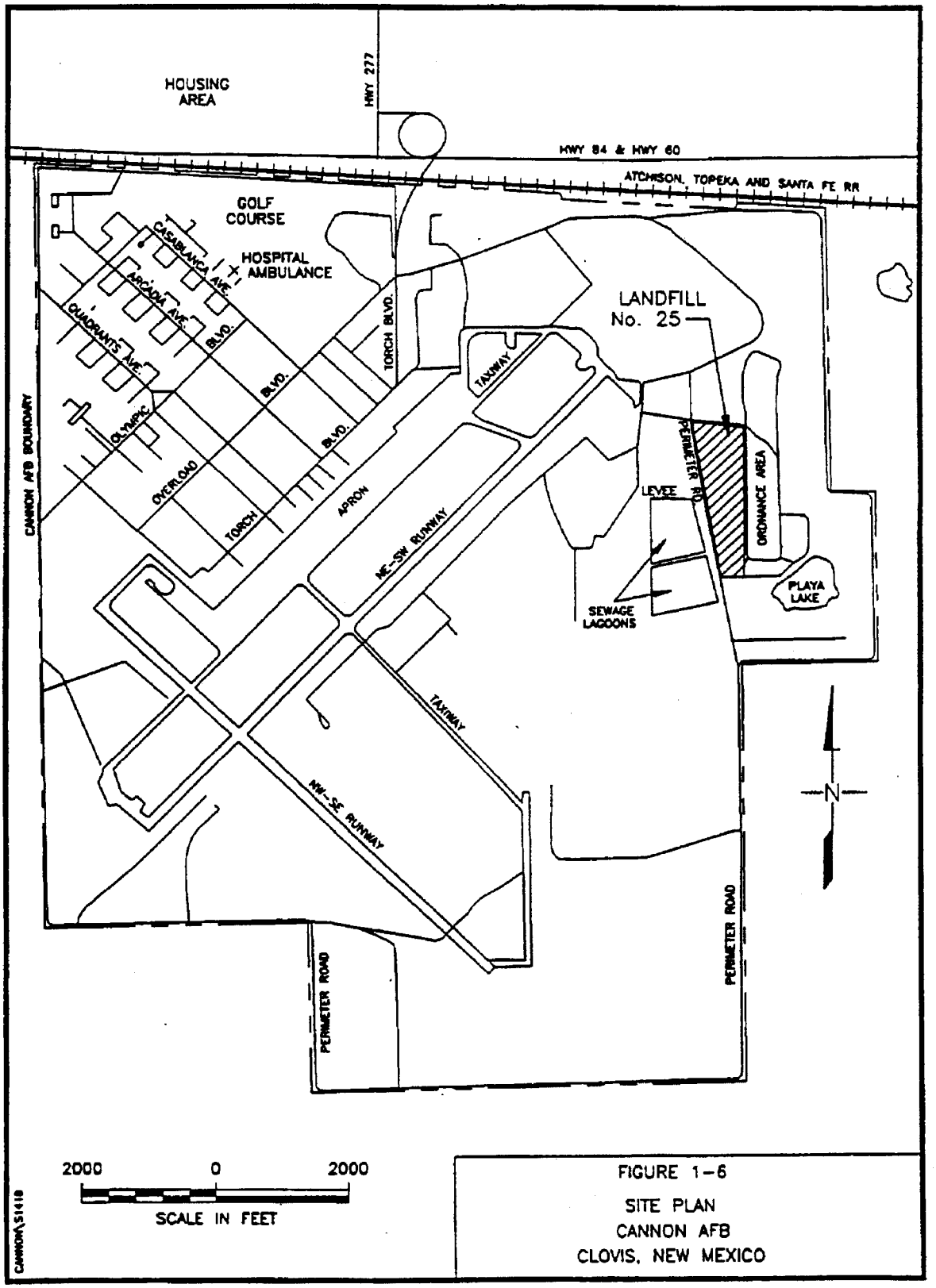


FIGURE 1-6
SITE PLAN
CANNON AFB
CLOVIS, NEW MEXICO

The site is covered by rubble piles consisting of large chunks of concrete mixed with asbestos siding tiles, metal and asbestos/cement pipe, asphalt mixed with soil, and small amounts of wood. The heights of the rubble piles vary across the site and reach a maximum at the north end where the rubble is mounded to 15 feet above natural ground. Over most of the site, however, the rubble is only 3 to 4 feet deep. Figure 1-7 is a conceptual cross-section of Landfill No. 25. The rubble consists of the remains of demolished World War II temporary buildings and runways. The oldest piles of rubble located on the north and west sides of the site are overgrown with weeds, shrubs, and trees. The debris dumped later appears as individual conical piles over the site.

Soils

Soils in the vicinity of CAFB are classified as silty sands, sand silt mixtures (SM) to clayey sands, sand-clay mixtures (SC) using the Unified Classification systems and as aridisols using the SCS classification system. The following description is based on the Soil Conservation Service Curry County Soil Survey (1953). Three soil types are present in the vicinity of Landfill No. 25 (Figure 1-8). These are the Amarillo Fine Sandy Loam (Ab and Ac), the Mansker Fine Sandy Loam (Mb), and the Potter Fine Sandy Loam (Pa). Amarillo fine sandy loam is the most common. It consists of a thin sandy A-horizon (top soil), a well-developed clayey or calcic B-horizon (zone of accumulation), and a C-horizon made of broken down Ogallala formation. The Amarillo soil is derived from stream erosion coupled with extensive reworking of the sediments by the wind. The Mansker soils occupy the slopes, draws and playas. Mansker soils are strongly calcareous and are simply Amarillo soils where the top layers are eroded off, exposing the strongly calcareous zone of accumulation. The Potter soils are found at the base of playas. They are shallow extremely calcareous pan layers that are the first step in caliche formation.

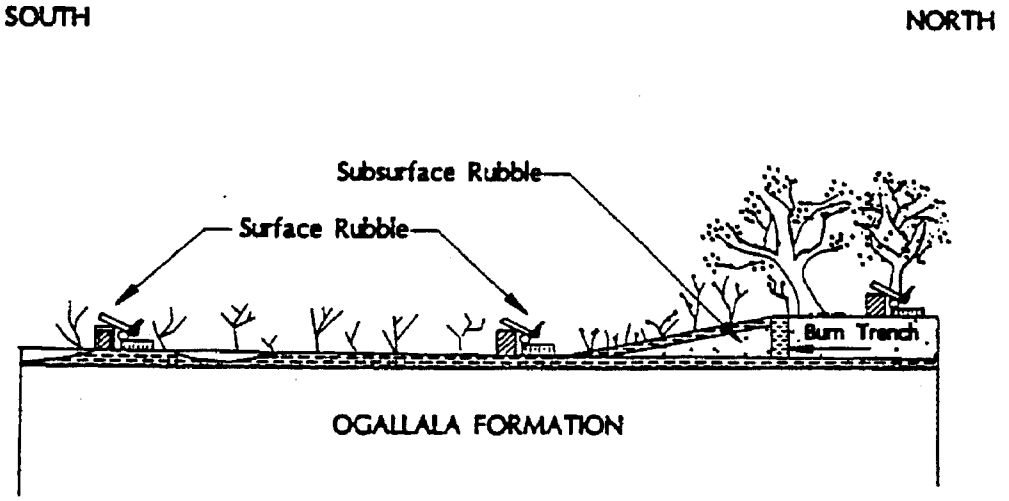


FIGURE 1-7

GENERALIZED CROSS-SECTION
OF LANDFILL NO. 25

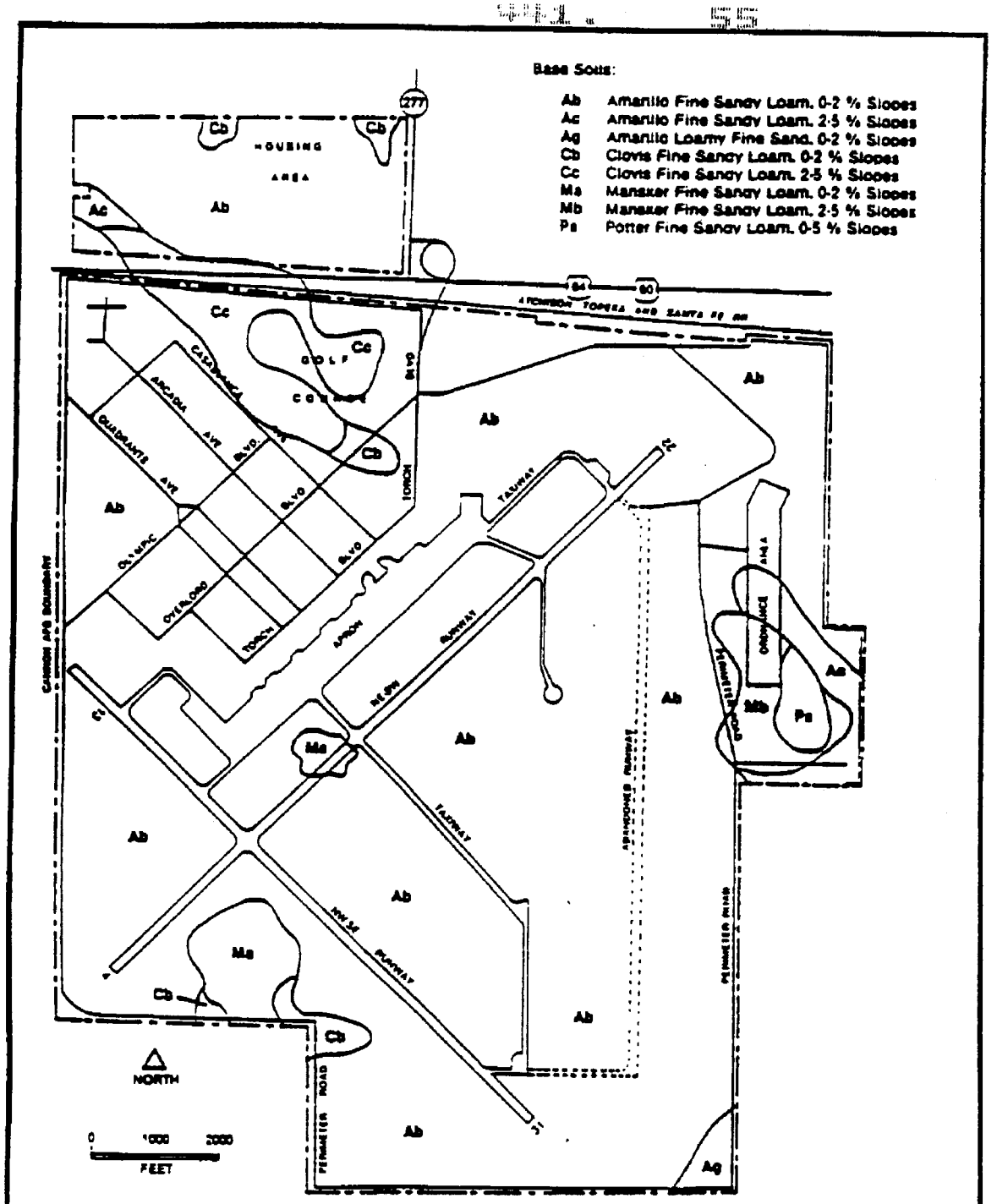


FIGURE 1-8

DISTRIBUTION OF SOILS, BY TYPE
CANNON AFB
CLOVIS, NEW MEXICO

Vegetation

A visual survey of the vegetative cover was completed during the field investigation phase of the project. The unconsolidated landfill debris above the firmer Ogallala sediments has a different vegetative cover than adjacent parts of the base. Chinese elms along with various other deciduous trees are found on the northern half of the landfill. Yucca is present over its entirety. Sage and rabbitbrush are the most common shrubs. Indian rice grass, foxtail barley, and blue gramma are the most common grasses.

Surface Water

Landfill No. 25 slopes from north to south (Figure 1-5). Runoff from the site goes to Playa Lake. Playa Lake is located 500 feet southeast of Landfill No. 25.

Groundwater

Based on the survey elevations shown on Plate 1 and the estimated groundwater elevations shown on Figure 1-9, the depth to groundwater on the site is approximately 270 feet. At CAFB, the Ogallala aquifer has a thickness ranging from 93 to 143 feet (1960 data) (Kearney, 1987). The exact thickness and flow direction is influenced by the uneven erosional surface at the top of the Dockum Group. The local groundwater gradient is southeasterly at 7.5 feet per mile. Figure 1-9 shows the water table elevation contours for 1984 (Radian 1986).

Figure 1-10 shows the approximate location of water wells on and in the vicinity of CAFB. Off-base well locations are based on 1990 Lee Wan and Associates Work Plans (Lee Wan, 1990). The ten wells located on the base were located with the help of CAFB water plant personnel. Water well 5 is closest to Landfill No. 25 and is immediately to the north of it.

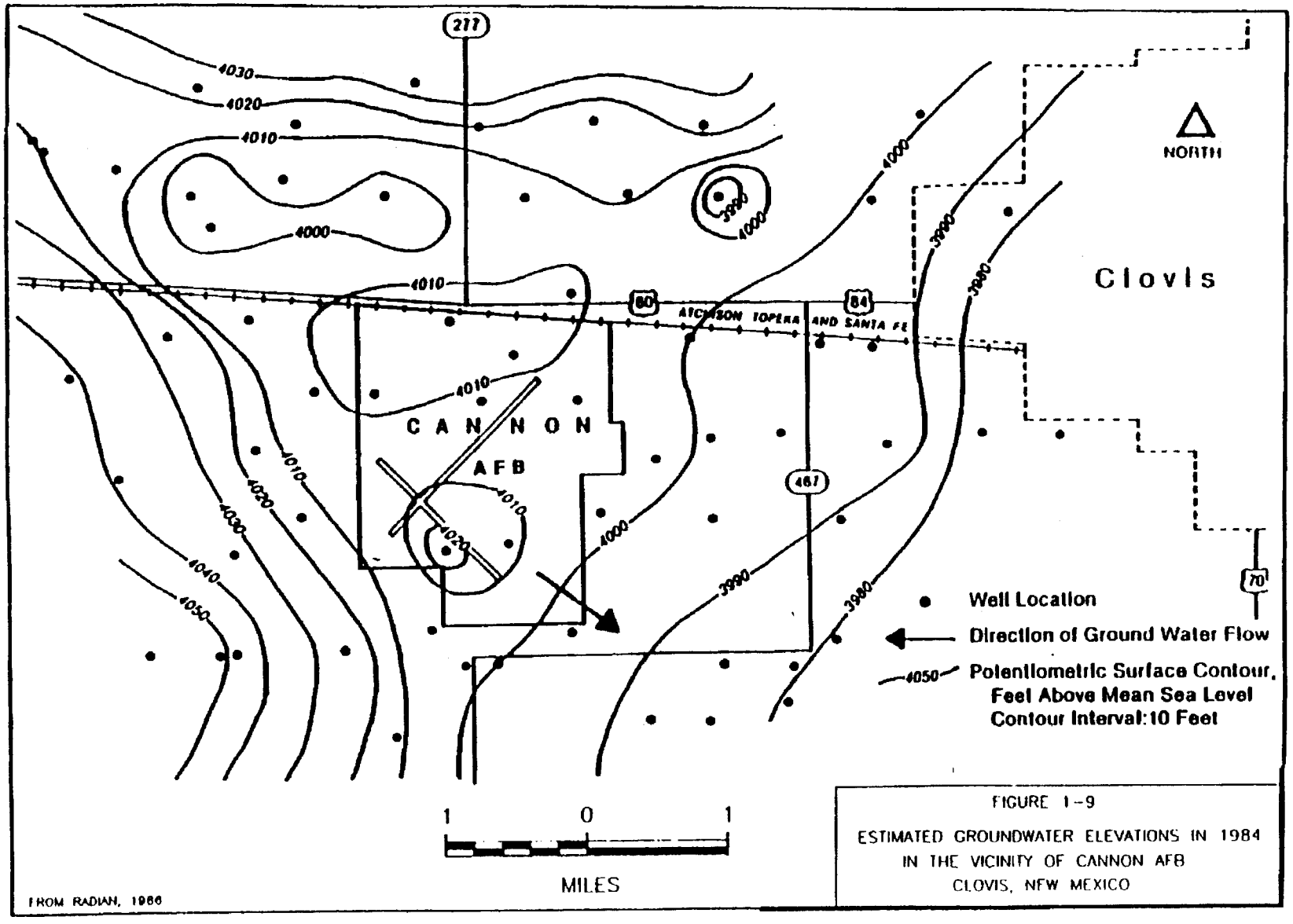


FIGURE 1-9

ESTIMATED GROUNDWATER ELEVATIONS IN 1984 IN THE VICINITY OF CANNON AFB CLOVIS, NEW MEXICO

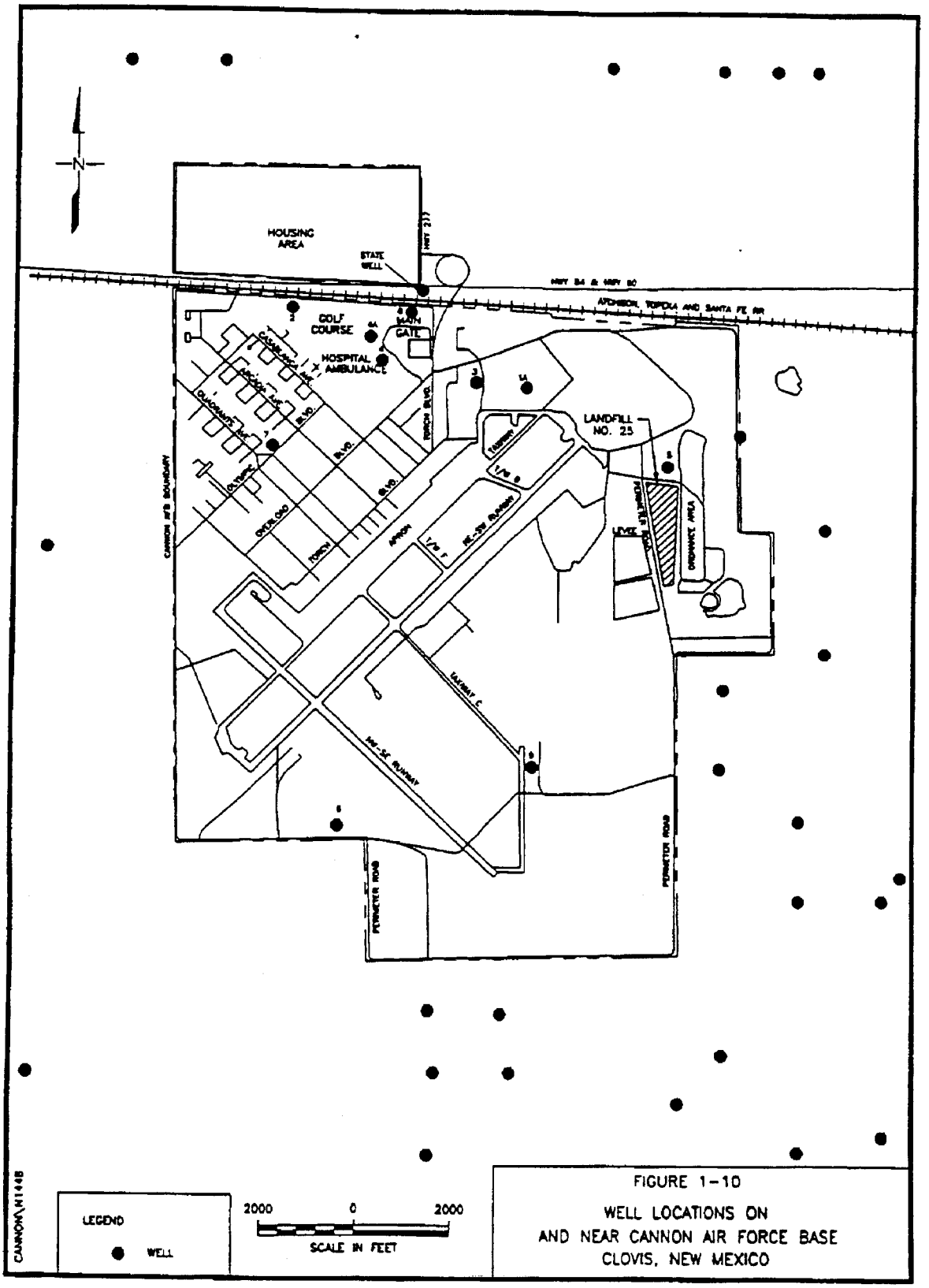


FIGURE 1-10

WELL LOCATIONS ON AND NEAR CANNON AIR FORCE BASE CLOVIS, NEW MEXICO

Estimates of hydraulic conductivity were calculated from pump tests in water wells 5 and 9 (Lee Wan, 1990). An estimate of hydraulic conductivity for well 8 was made from water level recovery data (i.e. slug test). Hydraulic conductivity was found to be approximately 2.0×10^{-3} cm/sec in wells 5 and 9 and 2.0×10^{-2} cm/sec in well 8. These values are lower than published values for pure sand-gravel aquifers, suggesting there may be some interstitial clays present in the aquifer in the vicinity of CAFB. Boring logs from CAFB IRP projects and published reports (Frye, et. al. 1974; Glass, et. al. 1973) support this suggestion.

2.0 BACKGROUND AND SCOPE

Landfill No. 25 is one of several landfill sites that have been used for disposal of a variety of waste materials during the active life of Cannon Air Force Base (CAFB). To place current activities in a proper context, a discussion of the history of CAFB and of Landfill No. 25 is presented in this section. This section includes a summary of previous site investigation activities performed at Landfill No. 25 and defines objectives of this RFI effort. Finally, a discussion of the scope of current RFI activities and how these activities are intended to address stated objectives is provided.

2.1 Site History

CAFB is one of 25 U.S. Air Combat Command bases. The history of CAFB dates to 1929, when Portair Field was established on the site. Portair Field was a civilian passenger terminal for early commercial transcontinental flights. In 1942 the Army Air Corps took control of the civilian airfield and it became known as the Clovis Army Air Base. During World War II, temporary buildings and runways were constructed, and the base was used to teach flying, bombing, and gunnery classes. After World War II, the base was renamed Clovis Army Air Field, and flying activities at the base decreased until the base was deactivated in May 1947. The base was reassigned to the Tactical Air Command in July 1951 and formally reactivated in November 1951 as Clovis Air Force Base. In 1957, the base was renamed Cannon Air Force Base.

The World War II temporary buildings and runways were demolished and disposed of at Landfill No. 25. The first piles of building and runway rubble, now overgrown with weeds, shrubs, and trees, were dumped on the north and west sides of the site. Later dumping occurred as individual conical piles over the site. According to base personnel, waste disposal at Landfill No. 25 is believed to have begun around 1945. The date when dumping ceased at the site is unknown.

2.2 Previous Investigation

Investigation of landfills at CAFB began with a RCRA Facility Assessment (RFA) in 1987 (Kearney, 1987). A total of 76 SWMUs was described in the RFA, including Landfill No. 25, which was identified as SWMU 97. The HSWA portions of the CAFB RCRA operating permit require investigation of each of these SWMUs. Recognizing the impracticality of trying to complete all SWMU investigations in a set time period, CAFB is permitted to set priorities and perform investigations on a smaller subset of SWMUs so long as reasonable progress is demonstrated.

A Phase IV investigation of an Old Entomology Rinse Area (SWMU 96), located about 200 feet west of Landfill No. 25 and just north of the sewage lagoons, was completed in 1987. The investigation was conducted by Walk, Haydle & Associates (WHA) [Woodward-Clyde Consultants (WCC) 1992] and involved minimal sampling on Landfill No. 25. Samples taken included those from two soil borings located just east of Perimeter Road in the northern part of Landfill No. 25 and from Monitoring Well K in the center of Landfill No. 25. Low concentrations of pesticides were found in one of the borings at the 0.5-foot sample depth (See Table 2-1). A monitoring well sample was analyzed for metals, PCBs, and pesticides. Only metals below MCLs (as of July 30, 1992) were detected (WCC 1992) (See Table 2-1).

CAFB was interested in using part of the Landfill No. 25 area for construction of additional base operation facilities. As a result, CAFB decided to proceed directly with investigation of Landfill No. 25 to accommodate these construction plans. CAFB requested that USACE perform an environmental assessment to determine if wastes in Landfill No. 25 presented any potential threat to human health and the environment. CAFB was also interested in knowing if construction plans could proceed on schedule.

Table 2-1

Results of SMWU 96 Samples Taken on Landfill No. 25

Soil Boring at 0.5 feet (WHA 1987)	
Pesticide	**Concentration (mg/kg)**
4,4-DDD	ND[a]
4,4-DDE	0.5
4,4-DDT	2.0
Chlordane	0.1
Monitoring Well K	
Metal	**Concentration (mg/L)**
Antimony	ND
Arsenic	BDL[b]
Barium	0.66
Beryllium	ND
Cadmium	ND
Chromium	ND
Cobalt	ND
Copper	0.15
Lead	BDL
Mercury	ND
Nickel	BDL
Selenium	ND
Silver	ND
Thallium	ND
Tin	ND
Vanadium	0.035
Zinc	0.049

[a] ND = Not Detected
[b] BDL = Below Detection Limit

USACE prepared a Sampling and Analysis Plan (USACE, 1990), and performed the environmental assessment of Landfill No. 25 in December 1990 (USACE, 1991). The assessment consisted of trenching at nine locations and collecting both waste and native soil samples for laboratory analysis. Approximate locations of these trenches are shown in Figure 2-1.

Trenches 1, 4, 6, and 8 were excavated only through the rubble. Trenches 2, 3, 5, and 7 were excavated through the rubble and 5 feet into the undisturbed soil below. A background trench (BG) was excavated north of the landfill (Figure 2-1). Excavation of the trenches revealed that the majority of the material in the rubble pile was airfield paving and sub-grade material. The second most prevalent waste was building demolition rubble. The third type of waste encountered was glass, metal, cinders, ash, and other burned material in what appeared to be burn trenches. The burn material was not previously known to exist on the site (USACE, 1991).

Rubble samples from each trench were analyzed for asbestos, PCBs, and TCLP metals. Only minor amounts of metals (Barium, Mercury, and Cadmium) were detected. The results are shown in Table 2-2. Soil samples in trenches 2, 3, 5, and BG were collected from 0 to 1 foot and 4 to 5 feet below the native soil surface. The samples were analyzed for volatiles, semivolatiles, PCBs, and metals. These results are presented in Table 2-3. Soil from trench 3 showed elevated concentrations of metals (barium and cadmium) and semivolatiles (benzidine). Consequently, USACE recommended delaying construction on the site until completion of an RFI (USACE, 1991).

2.3 Remedial Investigation

Based on environmental assessment results, USACE prepared a Scope of Services designed to complete the RFI. The Scope of Services specified the number and location of soil borings and trenches, depth and sampling frequency of soil borings, and

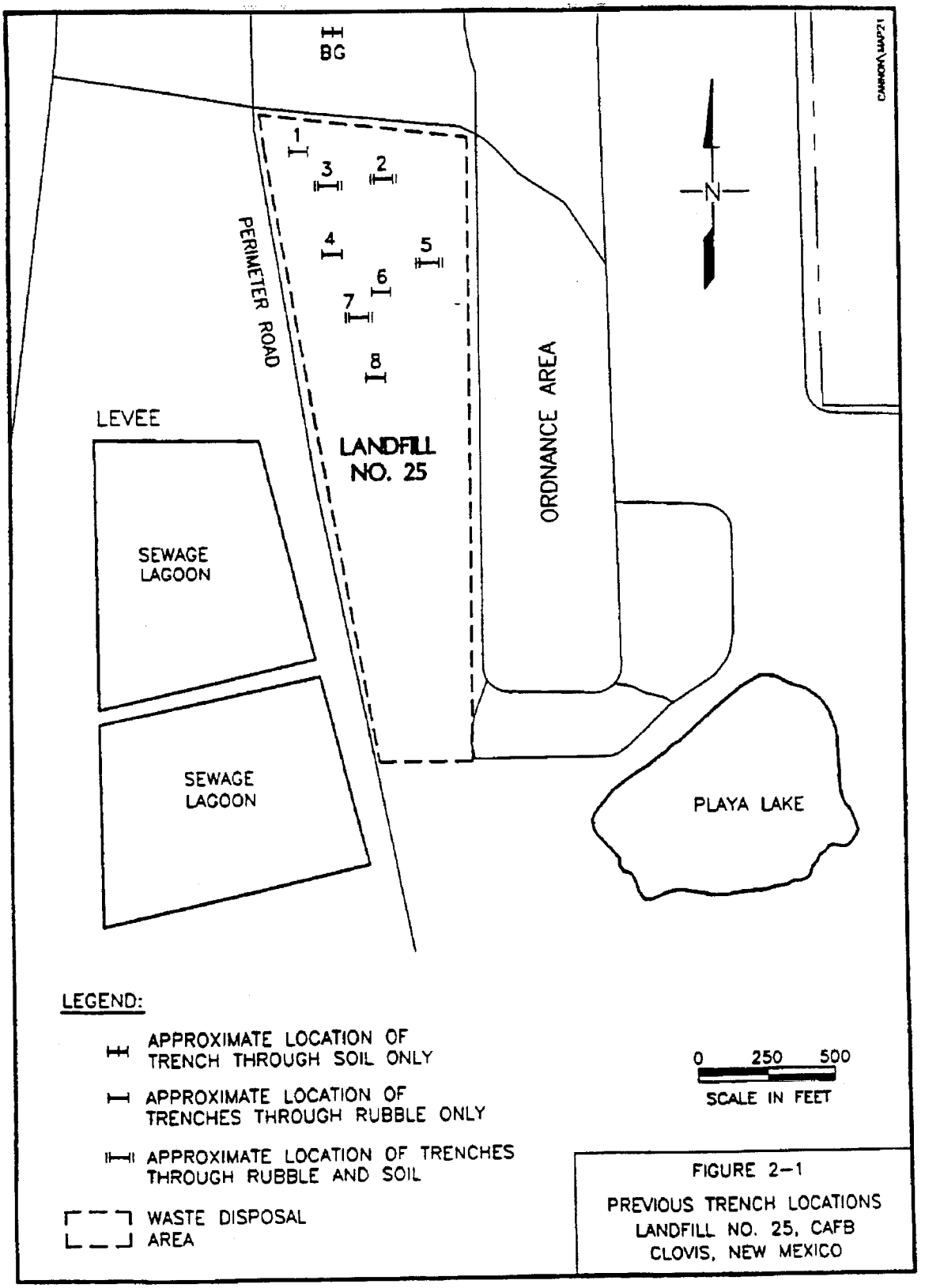


FIGURE 2-1
PREVIOUS TRENCH LOCATIONS
LANDFILL NO. 25, CAFB
CLOVIS, NEW MEXICO

Table 2-2

Summary of Analytical Results of Rubble (From 1990 Environmental Assessment)

Trench	Asbestos	PCBs	TCLP				
			Extractable Organics	Volatile Organics	Herbicides	Pesticides	Metals
	percent	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
1	< 0.25*	ND					
2	ND	ND	ND	ND	ND	ND	Ba- 0.8 Hg- 0.002
3	ND	ND	ND	ND	ND	ND	Ba- 1.3 Cd- 0.01
4	ND	ND					
5	ND	ND	ND	ND	ND	ND	Ba- 0.8
6	ND	ND					
7	ND	ND					
8	ND	ND	ND	ND	ND	ND	Ba- 0.2

* < 0.25 percent actinolite asbestos

Table 2-3

Summary of Analytical Results of Soils (From 1990 Environmental Assessment)

Trench	0 to 1 Foot Below Natural Ground				4 to 5 Feet Below Natural Ground				Notes
	VOA	SVOA	Pest/ PCBs	Metals	VOA	SVOA	Pest/ PCBs	Metals	
	µg/kg	µg/kg	µg/kg	mg/kg	µg/kg	µg/kg	µg/kg	mg/kg	
2	ND	Bis- 3400	ND	As- 2.4 Ba- 63.9 Cd- 1.8 Co- 3.1 Cr- 5.9 Cu- 5.0 Hg- 0.03 Mn- 85.0 Mo- 28.0 Ni- 7.9 V- 12.8 Zn- 14.6	ND	ND	ND	As- 1.7 Ba- 121 Cd- 2.9 Co- 3.3 Cr- 9.6 Cu- 4.5 Hg- 0.01 Mn- 57.0 Mo- 47.8 Ni- 7.1 Se- 1.6 V- 17.7 Zn- 19.6	Bis=Bis(2-ethyl-hexyl)phthalate
3	ND	ND	ND	As- 1.7 Ba- 82.1 Cd- 8.5 Co- 3.8 Cr- 10.3 Cu- 20.2 Hg- 0.02 Mn- 138 Ni- 7.8 Se- 0.6 V- 17.8 Zn- 31.6	ND	Ben- 2000	ND	As- 3.0 Ba- 705 Cd- 33.3 Co- 5.2 Cr- 9.4 Cu- 2.3 Hg- 0.02 Mn- 68.2 Mo- 9.2 Ni- 1.5 V- 27.0 Zn- 23.1	Ben=Benzidine 14 SVOA Tentatively identified compounds were also detected in the 4- to 5-foot sample
5	ND	ND	ND	As- 2.9 Ba- 108 Cd- 4.7 Co- 6.7 Cr- 15.4 Cu- 8.3 Hg- 0.65 Mn- 198 Mo- 106 Ni- 13.1 V- 27.9 Zn- 36.9	ND	ND	ND	As- 2.9 Ba- 537 Cd- 3.2 Co- 5.3 Cr- 8.0 Cu- 4.5 Hg- 78.7 Mn- 57.9 Mo- 9.6 Ni- 1.8 V- 21.7 Zn- 18.9	

Table 2-3

(Continued)

Trench	0 to 1 Foot Below Natural Ground				4 to 5 Feet Below Natural Ground				Notes
	VOA	SVOA	Pest/ PCBs	Metals	VOA	SVOA	Pest/ PCBs	Metals	
	µg/kg	µg/kg	µg/kg	mg/kg	µg/kg	µg/kg	µg/kg	mg/kg	
5 (QC Sample)	ND	ND	ND	As- 2.4 Mn- 175 Ba- 85.9 Mo- 32.7 Cd- 1.8 Ni- 11.8 Co- 3.8 Se- 0.3 Cr- 9.1 V- 19.2 Cu- 6.6 Zn- 23.5 Hg- 0.03					
7	ND	ND	ND	As- 2.2 Mn- 89.6 Ba- 408 Mo- 47.0 Cd- 3.0 Ni- 9.7 Co- 4.3 Se- 1.0 Cr- 9.3 V- 16.4 Cu- 8.8 Zn- 24.6 Hg- 0.07	ND	ND	ND	As- 2.7 Mn- 155 Ba- 199 Mo- 69.0 Cd- 45.5 Ni- 11.1 Co- 5.4 Se- 2.7 Cr- 12.3 V- 20.8 Cu- 6.1 Zn- 30.1 Hg- 0.02	
Back-ground	ND	ND	ND	As- 2.8 Mn- 176 Ba- 94.7 Mo- 83.2 Cd- 4.6 Ni- 11.7 Co- 5.9 Se- 1.9 Cr- 11.6 V- 22.3 Cu- 6.5 Zn- 30.7 Hg- 0.07	ND	ND	ND	As- 2.3 Mn- 48.8 Ba- 106 Mo- 46.9 Cd- 2.8 Ni- 8.3 Co- 3.2 Se- 1.9 Cr- 7.8 V- 15.4 Cu- 4.1 Zn- 18.1 Hg- 0.03	1 SVOA Tentatively identified compound was also detected in the 0- to 1- foot sample

specific analyses required. A Field Sampling Plan (FSP) was prepared using the specific investigation provided in the Scope of Services. The FSP was prepared and approved by USACE in 1992 (Radian, 1992).

The original site-specific objectives in the Scope of Services were to further define and confirm subsurface contamination and to delineate the extent of two burnpit areas located during the Environmental Assessment. Between receipt of the Scope of Services and FSP preparation, a site visit of Landfill No. 25 was conducted. During this site visit, it became apparent that, due to the absence of surveyed locations and the lack of surface evidence, the former trenching locations could not be located accurately. The delineation of the two burnpits within a larger landfill would not provide additional information as to the overall extent of contamination. Consequently, the USACE determined that delineation of the burn pit areas would not be included in this RFI effort.

2.3.1 Purpose and Objectives

The purpose of this investigation, as stated in the Scope of Services and modified as a result of the site visit, is to determine if contamination associated with landfill waste has migrated into native soils underlying it. Specific objectives include the following:

- Soil borings will be drilled and sampled in the vicinity of the former trench locations where evidence of contamination had been detected. Analysis of these samples will provide data on contaminant concentrations below source areas.
- Trenches will be excavated and sampled in the previously uninvestigated south half of the landfill. This investigation will provide information on contaminants in native soils throughout the remainder of the known landfill area.

- Deep (60-foot) soil borings will be drilled and sampled throughout much of the landfill to determine the presence or absence of landfill related contamination at depth.
- Risks to human health and the environment associated with site contaminants and their potential mobilization will be evaluated.

2.3.2 Scope and Rationale of the Field Investigation Program

The scope of the field investigation was to make basic field observations and collect a series of soil samples from soil borings and trenches. The specific sampling locations were designated in the Scope of Services (USACE, 1992). The following is a description of the sampling locations and a discussion of the rationale for the various samples. Table 2-4 summarizes the boring and trench depths and the sample intervals.

Borings near previous trench locations

Nine borings were completed in the approximate locations of former trenches 2, 3, 4, and 8. Two borings were completed in each of former trench locations 2, 4, and 8; three borings were completed in former trench location 3 (Figure 2-2).

Two 10-foot BNS (Below Native Soil) borings were completed in each of former trench locations 2 and 4. A 10-foot BNS boring and a 60-foot BNS boring were completed in former trench location 8. Two 10-foot BNS borings and a 60-foot BNS boring were completed in former trench location 3. Samples were collected at the native soil surface and every 5 feet for the entire depth of boring.

The rationale for the 10-foot BNS borings in the former trench locations was to determine if contamination migrated from the rubble into the native soil. The 60-foot BNS borings were intended to determine the presence of contamination at depth.

Table 2-4
Landfill No. 25 Soil Sampling

Location #	Trench	Boring	Total Depth	Sample Intervals
BG		x	60 ft.	S, every 5 ft.
1	o			
2a		x	10 ft.	S, 4-6 ft., 8-10 ft.
2b		x	10 ft.	S, 4-6 ft., 8-10 ft.
3a		x	10 ft.	S, 4-6 ft., 8-10 ft.
3b		x	10 ft.	S, 4-6 ft., 8-10 ft.
3c		x	60 ft.	S, every 5 ft.
4a		x	10 ft.	S, 4-6 ft., 8-10 ft.
4b		x	10 ft.	S, 4-6 ft., 8-10 ft.
5	o			
6	o			
7	o			
8a		x	10 ft.	S, 4-6 ft., 8-10 ft.
8b		x	60 ft.	S, every 5 ft.
9		x	60 ft.	S, every 5 ft.
10		x	60 ft.	S, every 5 ft.
11		x	60 ft.	S, every 5 ft.
12	x		8 ft.	S, I, 6-8 ft.
13	x		8 ft.	S, I, 6-8 ft.
14		x	60 ft.	S, every 5 ft.
15	x		8 ft.	S, I, 6-8 ft.
16	x		8 ft.	S, I, 6-8 ft.
17	x		8 ft.	S, I, 6-8 ft.
18	x		8 ft.	S, I, 6-8 ft.
19	x		8 ft.	S, I, 6-8 ft.
20	x		8 ft.	S, I, 6-8 ft.
21	x		8 ft.	S, I, 6-8 ft.

o = From Environmental Assessment. Not resampled in RFI.
S = Surface sample
I = Rubble/soil interface

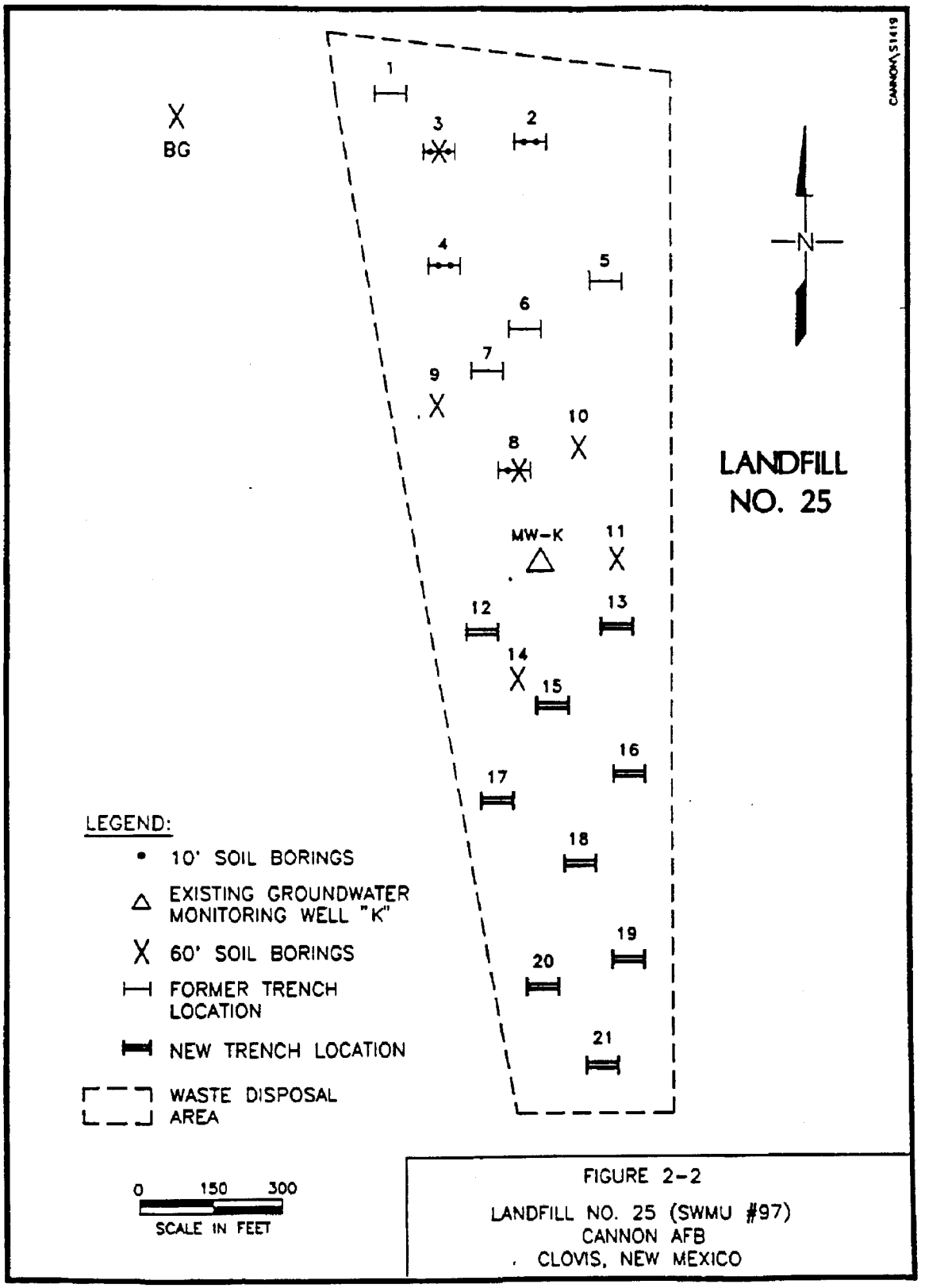


FIGURE 2-2

LANDFILL NO. 25 (SWMU #97)
CANNON AFB
CLOVIS, NEW MEXICO

New 60-foot BNS borings

A total of five 60-foot BNS borings was completed at previously unsampled locations. A background boring (BG) was drilled west of Perimeter Road and north of the sewage lagoons. The other four borings (9, 10, 11, and 14) were drilled near the middle of the site (Figure 2-2). Soil samples were collected at the native soil surface and every 5 feet for the entire depth of boring.

The rationale for these borings was to sample at locations down-gradient, both hydrologically and topographically, from the previously discovered area of contamination.

Trenches

Nine trenches were excavated in the southern half of the site. The trenches are labeled 12, 13, and 15 through 21 on Figure 2-2. The trenches were excavated through the rubble and 8 feet into the native soil. Samples were collected at land surface, at the interface between the rubble and the native soil, and from 6 to 8 feet BNS.

Since the Environmental Assessment trenches were all completed in only the northern portion of the site, this additional trenching was necessary to fully characterize the entire site.

2.3.3 Laboratory Samples and Analysis

A total of 139 soil samples, plus 14 Quality Control (QC) duplicates, and 14 Quality Assurance (QA) splits were collected (Table 2-5) and analyzed for the following:

Table 2-5

Frequency of Field Samples Per Sampling Locations (Exclusive of Duplicates, QA/QC Samples)

Borehole/Trench Number	Analytes							
	VOC (8240)	SVOC (8270)	Herbicides (8150)	Pest/PCB (8080)	TPH (8015M)	TRPH (418.1)	Metals	Geotech
BG	13	13	3	13	3	13	13	2
2a	3	3	1	3	1	3	3	2
2b	3	3	1	3	1	3	3	2
3a	3	3	1	3	1	3	3	2
3b	3	3	1	3	1	3	3	2
3c	13	13	3	13	3	13	13	2
4a	3	3	1	3	1	3	3	2
4b	3	3	1	3	1	3	3	2
8a	3	3	1	3	1	3	3	2
8b	13	13	2	13	2	13	13	2
9	13	13	3	13	3	13	13	2
10	13	13	3	13	3	13	13	2
11	13	13	3	13	3	13	13	2
12	3	3	1	3	1	3	3	2
13	3	3	1	3	1	3	3	2
14	13	13	2	13	2	13	13	2
15	3	3	1	3	1	3	3	2
16	3	3	1	3	1	3	3	2
17	3	3	1	3	1	3	3	2
18	3	3	1	3	1	3	3	2
19	3	3	1	3	1	3	3	2
20	3	3	1	3	1	3	3	2
21	3	3	1	3	1	3	3	2

- Volatile Organic Compounds (SW-846:8240);
- Semi-volatile Organic Compounds (SW-846:8270);
- Total Metals (SW-846:6010 and AA);
- Total Recoverable Petroleum Hydrocarbons (EPA Method 418.1);
- Pesticides/PCBs (SW-846:3520/8080); and,
- pH (SW-846:9045).

Thirty-five soil samples, excluding QA and QC samples, were analyzed for Total Petroleum Hydrocarbons (SW-846:8015M) and Herbicides (SW-846:8150). In order to have a representative population, one soil sample for each 10-foot soil boring or trench excavation and two or three soil samples for each 60-foot soil boring were collected and analyzed for Total Petroleum Hydrocarbons and Herbicides (See Table 2-5).

Forty-six samples were collected for geotechnical analysis. Two samples from each boring were collected at the discretion of the on-site geologist to typify the subsurface geology of the site.

3.0 FIELD ACTIVITIES

Field work was completed according to the following schedule:

28 September - 29 September, 1992:	Site survey, clear access paths.
30 September - 13 October, 1992:	Soil boring and sampling.
13 October - 16 October, 1992:	Trenching and sampling.
18 October, 1992:	Survey

The following list names the subcontractors hired for this Remedial Investigation and the work they performed:

- Lydick Engineers and Surveyors, Inc. of Clovis, New Mexico completed the sieve analysis of the geotechnical samples and completed both site surveys.
- Southwest Engineering, Inc. of Las Cruces, New Mexico was subcontracted to provide all drilling services.
- Radian Analytical Services of Austin, Texas was subcontracted to provide all analytical services.

3.1 Sample Collection Procedures

Following is a brief description of the methodology used to collect samples from soil borings and trench excavations. A more detailed description can be found in Section 3.0 of the Field Sampling Plan.

Soil Boring Samples

Soil samples were collected from the borings using a CME-55 drill rig and a 3-inch diameter 2-foot long stainless steel split-spoon soil sampler. The split-spoon sampler

was driven through 6 ⅝-inch OD hollow stem augers according to ASTM Methods D-1586-84 and D-3550. Standard Penetration Test (SPT) methodology was followed. The split-spoon sampler was attached to a sampling rod and lowered into the hollow-stem continuous-flight auger. A 140-lb. hammer and anvil were attached to the top of the sampling rods. The sampler was seated into place with a single hammer blow. By successively raising and dropping the weight, the sampler was driven into the soil.

Immediately after opening the split-spoon sampler, organic vapor was monitored with an HNu field screening device. The soil necessary for volatile organics and purgeable TPH analyses was collected and placed in 60-mL short, wide-mouth glass jars. The site geologist recorded the physical characteristics of the soil following the guidelines of Section 16.5 of the Scope of Services (USACE, 1992). The description of the soil physical characteristics is recorded on the boring logs (Appendix C). The soil remaining in the split-spoon sampler was packed into three 250-mL (8-ounce) wide-mouth clear glass sample jars leaving some headspace. If the volume of soil recovered in the split-spoon sampler was inadequate to fill the jars, the driller augured out the interval just sampled and pushed the sampler to collect more soil. The recovered soil was composited with the previously recovered soil and packed into the three 250-mL jars, and the sampling interval was recorded in the field log book.

Trench Excavation Samples

Rubble was cleared from the trench locations with a bulldozer prior to sampling. For each trench location, a soil sample was collected from the ground surface before the trench was excavated. As with the split-spoon soil samples, HNu readings were taken on the excavated soil that was sampled. The volatile organics and purgeable TPH samples were collected first and packed without headspace into 60-mL short, wide-mouth glass jars. Enough soil to fill three 250-mL jars was then collected and composited in a stainless steel pan.

A soil sample was then collected from immediately below the interface between the native soil and the rubble. The volatile organics and purgeable TPH samples were collected first, and the samples for remaining analytes were collected and composited as described above. A third sample was collected during trench excavation from between 6 and 8 feet BNS.

When a trench was excavated to 6 feet BNS, the trackhoe bucket was washed with a low phosphate detergent and potable water followed by a de-ionized water rinse. The next bucket of soil excavated from the trench was sampled by collecting soil from the center of the bucket. The volatile organics and purgeable TPH samples were collected first and packed into 60-mL jars without leaving any headspace. Soil for the remaining samples was collected and composited in a stainless steel pan.

Geotechnical Samples

Two geotechnical samples per boring and trench were collected by the site geologist and put into heavy-duty Ziploc® freezer bags. The bags were marked with indelible ink showing the boring number, the depth from which the sample was collected, and the date and time of sample collection. The geotechnical samples were stored in a sealed drum on site until the laboratory results indicated which samples were contaminated. RCRA Subpart S Soil Action Levels were used as the basis of determination. All geotechnical samples were submitted for analysis.

3.2 Sample Identification

A sample identification procedure was developed by the USACE to ensure uniformity of sample labels. All sample names took the form of CAN97-XXx-NN, where "CAN" indicates the samples were taken from Cannon AFB and "97" is the SWMU designation for LF No. 25. Next, XXx indicates the field identifier of the soil boring or trench excavation. Finally, NN is either a two-digit number ranging from 01 to 13 or the

letter "S" or "I". The numbers and letters represent different depths for the soil borings and trench excavations. For the 60-foot soil borings, 01 indicates native soil surface sample (as opposed to the surface sample), 02 indicates the 5-foot BNS sample, and so on, in 5-foot increments until 13 indicates the 60-foot BNS sample. For the 10-foot soil borings, "S" indicates the native soil surface sample, "I" indicates the 5-foot BNS sample, and 06 indicates the 10-foot BNS sample. Finally, for the trench excavations, "S" indicates the surface sample (even if the surface consists of rubble detritus), "I" indicates the sample taken just below the interface between the rubble and the native soil, and "06" indicates the sample taken from 6 to 8 feet BNS (See Table 3-1).

3.3 Sample Handling

All samples were kept cool after collection and during shipment. The samples were placed in coolers. Ice was placed in Ziploc bags above and around the top of the sample contaminers. The remaining space was filled with additional packing material. The chain-of-custody form was completed and sealed in a plastic Ziploc bag and attached to the inside top lid of the cooler. The cooler was completely wrapped with strapping tape around both ends. The cooler was labeled "This Side Up" on each side. Custody seals were placed across the opening to indicate if tampering had occurred. More details on sampling packing can be found in Appendix A of the Field Sampling Plan.

3.4 Field Quality Assurance/Quality Control Program

The following paragraphs discuss the field QA/QC program. A more comprehensive description of the QA/QC program is provided in the QAPP.

Table 3-1

Explanation of Depth Field in Sample Identification System

Boring or Trench	60-foot Borings	10-foot Borings	Trench Excavations
Rubble Surface			S
Native Soil Surface	01	S	
Just Below Rubble/Native Soil Interface			I
5 feet BNS	02	I	
6-8 feet BNS			06
10 feet BNS	03	06	
15 feet BNS	04		
20 feet BNS	05		
25 feet BNS	06		
30 feet BNS	07		
35 feet BNS	08		
40 feet BNS	09		
45 feet BNS	10		
50 feet BNS	11		
55 feet BNS	12		
60 feet BNS	13		

3.4.1 Decontamination of Sampling Equipment

To ensure that soil sampling equipment was not contaminated or cross-contaminated by materials and equipment used in the course of the investigation, *Standard Operating Procedure 15* (Appendix A of FSP) was followed. The following procedures were used to decontaminate all sampling equipment:

- Wash with LIQUINOX detergent;
- Rinse with potable water;
- Rinse with reagent-grade isopropanol;
- Rinse twice with laboratory reagent-grade water;
- Allow to air dry protected from wind and dust; and
- Wrap in foil or visqueen if equipment not used immediately.

The drilling augers and spilt-spoon samplers were decontaminated with a high-pressure, high-temperature steam cleaner between each boring. The trackhoe bucket was washed according to the above procedure, but without the isopropanol wash, between each trench. The back end of the drill rig was decontaminated with the steam cleaner between each borehole. Rinse water was contained in pump sprayers to prevent used rinse water from contaminating subsequent samples. Wash and rinse water used during all decontamination activities was containerized in 55-gallon drums for subsequent analysis and disposal.

3.4.2 QA/QC Samples

The total number of QA/QC samples collected is listed in Table 3-2, and the collection frequency of QA/QC samples per location is listed in Table 3-3.

Table 3-2

Analytical Sample Counts - Landfill No. 25

Chemical Analyses (Method [a] No.)	Base Samples	Field Dups	Equip Rinse	Trip Blank [b]	Amb Blank	MS/MSD	Analyt Dups	Radian Sample Count [c]	QA Splits	QA Rinse	QA Trip Blanks	Total QA Sample Count [d]	Total Sample Count [e]
Matrix	Soil	Soil	Water	Water	Water	Soil	Soil	--	Soil	Water	Water	--	--
Volatile Organics (8240)	139	14	0	14	0	14	0	167	14	0	14	28	195
Top 10 TIC's	139	14	0	14	0	0	0	167	0	0	0	0	167
SVOC's - soils - (8270)	139	14	7	0	0	14	0	160	14	7	0	22	181
SVOC Top 20 TIC's	139	14	7	0	0	0	0	160	0	0	0	0	160
Herbicides (8150)	35	4	2	0	0	4	0	41	14	7	0	22	62
Pesticides and PCBs - soils-(8080)	139	14	7	0	0	14	0	160	14	7	0	22	181
TPH by modified 8015	35	4	2	0	0	4	0	41	14	7	0	22	62
TRPH (EPA 418.1)	139	14	7	0	0	14	0	160	14	7	0	22	181
Metals [e] (6010, 7060, 7421, 7471, 7740)	139	14	7	0	0	14	0	160	14	7	0	22	181
% Moisture (SW-846) for corr. to dry weight	139	14	0	0	0	0	0	153	0	0	0	0	153
pH (9045)	139	14	0	0	0	0	0	153	0	0	0	0	153

TIC - Tentatively Identified Compounds.
SVOC - Semi-volatile Organic Compounds.
PCB - Polychlorinated Biphenols.
TPH - Total Petroleum Hydrocarbons.
TRPH - Total Recoverable Petroleum Hydrocarbons.
ICPES - Inductively Coupled Plasma Emission Spectroscopy.

[a] Reference Methods from SW-846 Test Methods For Evaluating Solid Wastes. Physical/Chemical Methods. November 1986, third edition.
[b] One trip blank per cooler containing volatile organics or TPH (purgeables) samples.
[c] Sample count does not include MS/MSD.
[d] All QA samples will be submitted to USACE Missouri River Division (MRD) Laboratory for analysis.
[e] ICPES metals: aluminum, antimony, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, iron, magnesium, manganese, nickel, potassium, silver, sodium, thallium, tin, vanadium and zinc. Other metals: arsenic, lead, selenium and mercury.

Table 3-3

Frequency of QA/QC Samples Per Sampling Locations

Borehole/ Trench Number	Type - T, 10, 60 [a]	Short List Duplicate [a]	Full List Duplicate [a]	Full List MRD Split [a]	Short List MS/MSD [a]	Full List MS/MSD [a]	Short List QC (Radian) Rinse [a]	Full List QC (Radian) Rinse [a]	Full List QA (MRD) Rinse	CLP Data Valid. Sample [b]
BG	60		1	1		1		1	1 [c]	30 feet
2a	10			1						0 feet
2b	10	1								0 feet
3a	10			1			1		1	8 feet
3b	10									--
3c	60		1	1	1					--
4a	10	1								4 feet
4b	10			1			1		1	0 feet
8a	10									4 feet
8b	60	1		1		1				45 feet
9	60	1		1	1		1		1	25 feet
10	60	1		1						--
11	60		1	1	1					15 feet
12	T			1			1		1	6 feet
13	T	1			1					--
14	60		1	1						40 feet
15	T			1						1
16	T	1					1		1	--
17	T	1			1					--

Table 3-3

(Continued)

Borehole/ Trench Number	Type - T, 10, 60 [a]	Short List Duplicate [b]	Full List Duplicate [c]	Full List MRD Split [d]	Short List MS/MSD [e]	Full List MS/MSD [f]	Short List QC (Radian) Rinse [g]	Full List QC (Radian) Rinse [h]	Full List QA (MRD) Rinse	CLP Data Valid. Sample [j]
18	T			1						--
19	T	1								1
20	T			1				1	1	--
21	T	1								--

[a] T = 8-foot trench, 10 = 10-foot boring, and 60 = 60-foot boring.

[b] Short list duplicate to be duplicate of short list field sample. Short list duplicate includes VOCs (8240), Metals, TRPH (418.1), SVOCs (8270), and Pesticides/PCBs (8080). See Table 3-4.

[c] Full list duplicate to be duplicate of full list field sample. Short list duplicate includes VOCs (8240), purgeable TPH (8015M), Metals, TRPH (418.1), SVOCs (8270), extractable TPH (8015M), Pesticides/PCBs (8080), and Herbicides (8150). See Table 3-4.

[d] All QA (MRD) splits will be full list splits of full list field samples.

[e] Short list MS/MSD samples include those analyses listed in note b. MS/MSD samples not separate field samples -- taken by laboratory personnel from designated field samples.

[f] Full list MS/MSD samples include those analyses listed in note c. MS/MSD samples not separate field samples -- taken by laboratory personnel from designated field samples.

[g] Short list QC rinse samples collected in 1-liter bottles, one each for Metals (6010, 7060, 7421, 7471, 7740), TRPH (418.1), SVOC (8270), Pesticides/PCBs (8080). See Table 3-7. Send to Radian Laboratory.

[h] Full list QC rinse samples same as note g, except also collect Herbicides (8150) and extractable TPH (8015M) samples.

[i] All QA rinse samples are full list and will be collected in 1-Liter bottles, two bottles each for Metals (6010, 7060, 7421, 7471, 7740), TRPH (418.1), SVOC (8270), Pesticides/PCBs (8080), Herbicides (8150), and extractable TPH.

[j] CLP data validation samples are not collected as separate samples. The designated CLP samples are indicated on the chain-of-custody by marking "CLP" in the remarks column or in the left margin.

QA and QC Split Samples

Ten percent of samples were collected for QA and QC split samples, respectively. The soil was homogenized and divided equally among all containers for both standard and duplicate samples, with the exception of samples collected for volatile organics or purgeable (light) TPH analyses. To minimize volatilization, samples collected for either volatile organics or purgeable-TPH analyses were split but not homogenized. The QA split samples were sent to Missouri River Division (MRD) Laboratory as described in Section 4.0 of the FSP. The QC samples were analyzed by Radian Analytical Services.

Matrix Spike and Matrix Spike Duplicate (MS/MSD) Samples

Matrix spike and matrix spike duplicate (MS/MSD) samples were collected at a rate of 5% for each chemical analyte. For all analyses except volatile organics and purgeable TPH, the soil was homogenized. The MS/MSD samples were not collected as separate samples in the field. Instead, the field personnel marked the labels of the samples chosen to be MS/MSDs with the letters "MS/MSD" in indelible ink and marked the chain-of-custody in the left margin adjacent to the Sample ID. A note was made in the remarks section of the chain-of-custody designating all MS/MSD samples included. Table 3-3 shows that, for all analyses except herbicides and TPH, 14 MS/MSD analyses were performed by the Radian laboratory, seven of which were MS samples, and seven of which were MSD samples. The seven MS/MSD samples were chosen to include the full diversity of soil types found at the site.

Trip Blanks

Trip blanks consisted of 40-mL VOA vials filled by the laboratory with organic-free water. Trip blanks accompanied all ice chests that contained volatile organic or purgeable-TPH samples during both the sampling activities and the shipping procedures. The

trip blanks were then analyzed for volatile organics and purgeable TPH to show that no contamination occurred during sampling and shipping.

Equipment Rinse Samples

Equipment blanks were collected by pouring reagent-grade deionized water over decontaminated split-spoon sampling tubes and some handling equipment, and catching the rinsate in 1-liter bottles. The equipment from which the rinsate blank was collected was noted in the field log book. Each metals rinsate sample was collected in polyethylene 1-liter bottles. Rinsate samples were sent to both the MRD Laboratory and the Radian Laboratory. The rinsate locations and analyses are summarized in Table 3-3.

3.4.3 Sample Handling

All field samples were kept in a locked trailer prior to shipment. The coolers were taped shut, and a tamper-evident seal was placed across the lid. Upon arrival at the laboratory, the coolers were checked for tampering, and the samples were logged in and checked for quality control parameters (i.e., temperature, breakage, and leaking).

3.5 Site Management

3.5.1 Utility Clearance

Digging permits were required for all soil boring and trenching activities. A permit was obtained from the Base Civil Engineering Division. A scaled map with the proposed sample locations was circulated with the permit application to the Base utility groups. U.S. West conducted a field check and marked buried communication cables on the site. A 3-inch water line was the only subsurface structure of concern at Landfill No. 25. Base Safety, Fire, Security, and Environmental Divisions checked and signed the permit. Copies of the permit were kept on site for the duration of the field activities.

3.5.2 Handling of Drill Cuttings and Decontamination Water

Drill cuttings and decontamination water were drummed and clearly labeled with the following information:

- Type of material contained;
- Site number and location;
- Telephone number of the Base Environmental Coordinator (Extension 4639);
- Boring number and depth interval; and
- Date of sampling activity.

An indelible-paint pen was used to mark this information on the sides of the drums.

Water collected from decontamination activities was considered potentially contaminated and was captured in a large trough. The water was pumped from the trough into drums using a small submersible pump. The drums were labeled, placed on wooden pallets, and stored with the cuttings. At the conclusion of the drilling activities, all drums were transported to Landfill No. 5 for temporary storage.

3.5.3 Sampling Site Preparation

Before sampling began, paths through the rubble were cleared with a bulldozer to enable the drill rig to reach the sampling locations. Since no survey had been made of the trench locations during the December 1990 investigation (USACE, 1990), only approximate locations were known. For this RFI, surveyors marked the approximate locations for the former trenches based on field observations. New trenches and boring locations were marked and cleared.

3.5.4 Site Restoration

All borings were backfilled with a cement/bentonite slurry according to Appendix A of the Field Sampling Plan. The trenches were backfilled with the excavated soil/rubble. Debris was moved by trackhoe to block access road entrances. Due to the access path construction, the site was not restored to its exact original state. The site was left neat and orderly, and the restoration efforts met the approval of the CAFB Base Environmental Coordinator's office.

3.5.5 Field Documentation

A field log book was used to document all field activities. All important observations made during on-site work were recorded in the field log book. The book is bound, with sequentially numbered pages; only indelible ink was used. After the completion of the field activities, the book was copied, and the original and copy are stored in two separate secured areas.

3.5.6 Surveying

At the conclusion of the project, Lydick Engineers returned to the site and surveyed the boring locations and the four corners of the trenches excavated during this investigation. A base map was generated (See Plate 1) to show the major site features (i.e., roads and fences) in addition to the sampling locations.

3.6 Deviations From Intended Sampling Locations

Following is a brief list of those samples that were collected from locations other than those previously specified in this chapter.

3.6.1 Soil Borings

Table 3-4 lists the soil boring samples that were taken from locations other than those originally proposed.

3.6.2 Trenches

The proposed sampling called for collection of a rubble sample and a native soil surface sample. The thickness of the rubble on the southern half of the site, however, varies from nonexistent to approximately three feet. Rubble was absent at trenches 12, 16, 18, and 19, so the "I" samples were collected within six inches below the surface samples in these trenches.

3.6.3 Resampling

On two occasions, the quality control program identified samples that were damaged during transportation. The surface sample from boring BG and all of the samples from boring 3a were compromised when water (from melted ice) penetrated the sample containers. On another occasion, samples CAN97-3a-I, CAN97-8a-I, CAN97-9-01, and CAN97-9-07, and all samples from boring 8a reached the lab above the required 4°C temperature. If any samples other than surface samples were damaged, the entire boring was redrilled and resampled. Because of this, borings 3a, 8a, 8b, and 9 have multiple locations designated as 3aa, 3aaa, etc. (See Plate 1).

Table 3-4

Alternative Soil Boring Sample Locations

Sample I.D.	Sampled from:	Reason
CAN97-BG-04	14-18 ft. BNS	Needed two spoons for adequate sample
CAN97-BG-06	No sample	Insufficient recovery
CAN97-09-11	49-53 ft. BNS	Needed two spoons for adequate sample
CAN97-11-10	46'-48'(not 44'-46')	No recovery from 44'-46' BNS
CAN97-11-11	51'-53'(not 49'-51')	No recovery from 49'-51' BNS

4.0 RESULTS

This section contains the field data from the 1992 sampling events at Landfill No. 25 and relevant conclusions made from these data. The following subsections are present:

- Overview of the 1992 sampling events and the tabulation of the detailed analytical results;
- Geologic results;
- Comparison of the field metals data to background soil metals data;
- Description of organic contaminants found at the site; and a
- Comparison of the field data to the recommended soil action levels listed in the RCRA proposed Subpart S Media Action Levels (40 CFR, Section 264.521).

4.1 Sampling Overview

A total of 14 soil borings, including a background boring, were drilled and nine trenches were excavated at Landfill No. 25. In seven of the borings, samples were collected at the native soil surface just below the rubble detritus, between 4 and 6 feet BNS (below native soil), and between 8 and 10 feet BNS. The other seven borings were sampled at the native soil surface and every 5 feet, from 5 to 60 feet BNS.

Nine trenches (locations 12 and 13 and locations 15 through 21) were excavated and sampled in the south half of Landfill No. 25. Three samples were taken at each of the trench locations. A rubble matrix sample was collected from the existing ground surface before the trench was excavated, a second sample was collected from just below the native soil and rubble interface, and a third sample was collected between 6 and 8 feet BNS. The sampling locations for all borings and trenches are shown in Figure 4-1. The designators BLS (below land surface) and BNS (below native soil) are used in

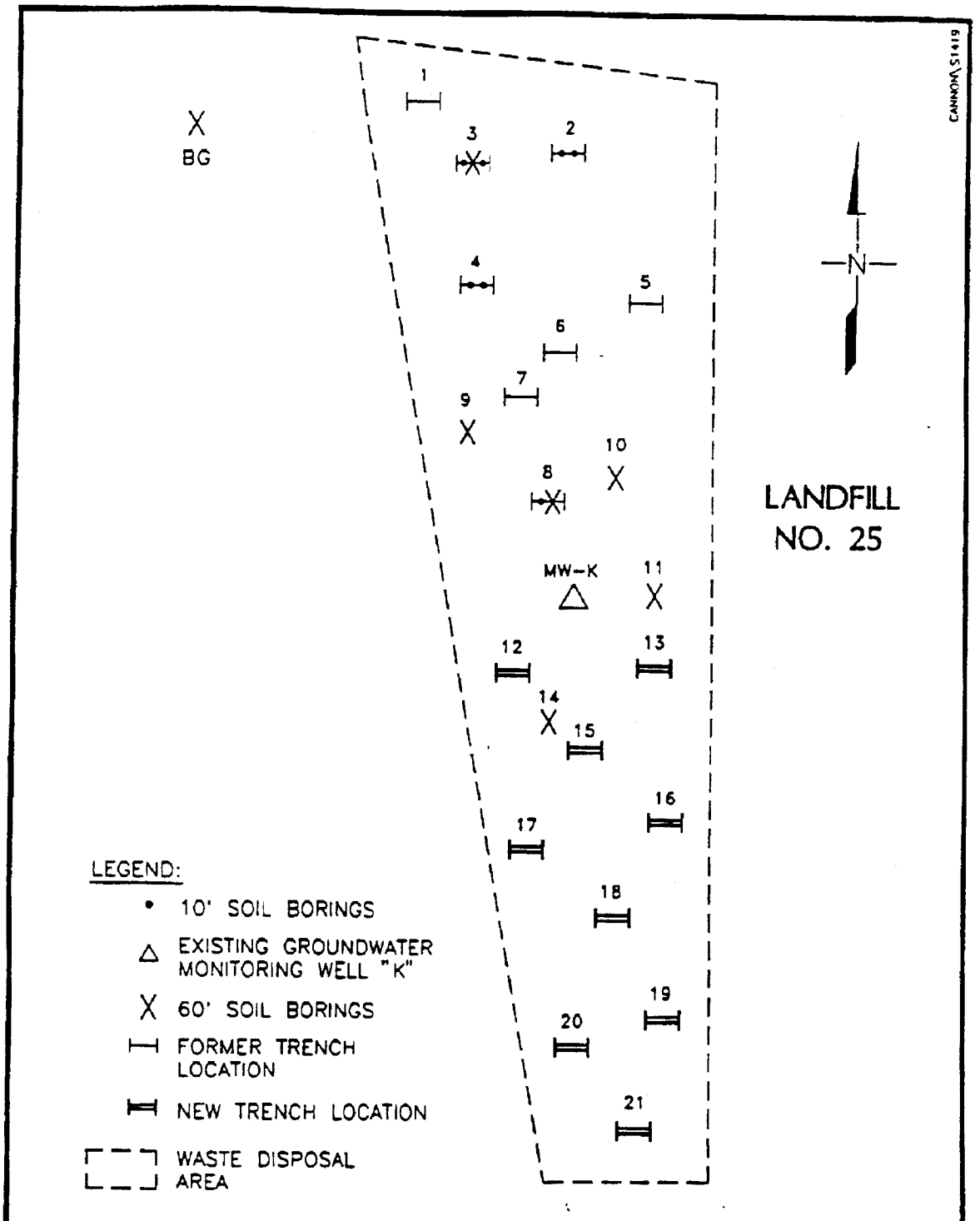


Figure 4-1

Sampling Locations
Landfill No. 25 (SWMU #97)
Cannon AFB, Clovis, New Mexico

this discussion. Where the surface is covered with rubble, BLS and BNS are not the same. The following results are presented as BLS.

This sampling program produced 139 field samples which were analyzed for organochlorine pesticides, polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), total recoverable petroleum hydrocarbons (TRPH), total analyte list (TAL) metals, and soil pH. In addition, 40 of the field samples were also analyzed for total extractable hydrocarbons (diesel, jet fuel, and kerosene), total purgeable hydrocarbons (gasoline and its components), and chlorinated herbicides. Three additional samples were analyzed for total purgeable hydrocarbons and herbicides. The geologic results are presented in Section 4.2. The analytical results are presented in Appendix B (Tables B-1 and B-2) and will be discussed in Sections 4.3 through 4.5. Table 4-1 lists the analytical methods used to analyze these samples.

4.2 Geologic Results

The geology of Landfill No. 25 is characterized from visual observations of the surface rubble, lithologic descriptions of the soil boring and trench samples, and selected sieve analysis.

4.2.1 General Stratigraphy of Landfill No. 25

The results suggest that the material present at Landfill No. 25 can be divided into five groups. These groups, shown in the generalized geologic column (Figure 4-2), are: the surface rubble; the subsurface rubble; the soil horizon; and two divisions within the Ogallala Formation.

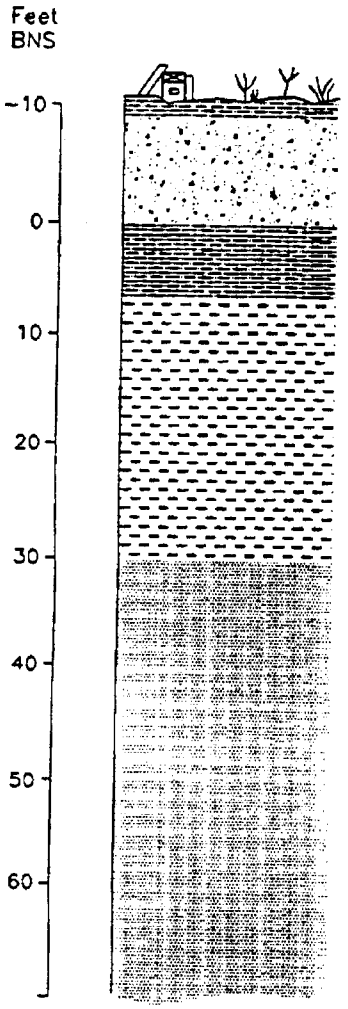
Table 4-1

Analytical Methods Used to Characterize Landfill No. 25 CAFB, Clovis, New Mexico

Parameter	Method
Organochlorine Pesticides and PCBs	SW 8080
Volatile Organic Compounds	SW 8240
Semivolatile Organic Compounds	SW 8270
Total Recoverable Petroleum Hydrocarbons	SW 9071/EPA 418.1[a]
TAL Metals - ICPES	SW 6010
Hg by CVAAS	SW 7471
As by GFAAS	SW 7060
Pb by GFAAS	SW 7421
Se by GFAAS	SW 7740
Sb by GFAAS	SW 7041
Tl by GFAAS	SW 7841
Total Extractable Hydrocarbons	SW 8015 ME[b]
Total Purgeable Hydrocarbons	SW 8015 MP[b]
Chlorinated Herbicides	SW 8150

[a] EPA 418.1 was used to analyze the extract generated using SW 9071.

[b] SW 8015 was modified according to California LUFT.



- SURFACE RUBBLE: Assorted building, runway and subgrade material.

- SUBSURFACE RUBBLE: Smaller pieces of rubble mixed with native soil.

- ARIDISOL: Minor organic layer. Calcic enriched layer. Primarily, fine sands, silts, and clays. (Coarse gravel: 0–24%, Fine gravel: 0–9%, Coarse Sand: 0.1–5%, Medium sand: 1–20%, Fine sand: 29–63%, Silt and Clay: 27–54%)

- SANDSTONE/CALICHE: Well cemented sandstone with calcite cement. Solid, but friable, pure caliche layers and nodules. A non-homogeneous mix of gravels, sands, and silts with some minor clay. (Coarse gravel: 0–37%, Fine Gravel: 0–11%, Coarse sand: 0–11%, Medium sand: 2–10%, Fine sand: 15–59%, Silt and Clay: 8–76%)

- SAND: Unconsolidated fine-grained sands with minor caliche layers. (Coarse gravel: 2–15%, Fine gravel: 1–8%, Coarse sand: 1–6%, Medium sand: 5–13%, Fine sand: 48–78%, Silt and Clay: 7–26%)

FIGURE 4-2

GENERALIZED GEOLOGIC COLUMN
LANDFILL NO. 25
CAFB, NM

269069-9300074-MIL

Surface Rubble

The surface rubble was not the focus of this investigation, but visual observations support the results of the 1990 Environmental Assessment (USACE, 1991). The surface rubble consists of construction debris, bricks, concrete blocks, tiles, concrete culvert, asphalt roofing shingles, asphalt and concrete paving, and sub-base material (USACE, 1991).

Subsurface Rubble

The subsurface rubble has a make-up similar to the surface rubble. It consists of assorted building, runway, and sub-grade material, generally 5 inches in diameter or less. Occasionally, there are large pieces of concrete or asphalt at depth. The rubble is mixed with sands and gravels that appear to be from the upper portion of the Ogallala Formation.

Soil Horizon

The soils found on Landfill No. 25 consist of a thin sandy topsoil, generally less than 4 inches thick, a large calcic zone of accumulation ranging from 2 to 3 feet thick, and a c-horizon made of broken down Ogallala Formation. Total thickness of the soil ranges from nonexistent, where eroded from wind or water, to more than 4 feet thick. On the north side of the site, where the subsurface rubble is as much as 15 feet thick, the original (i.e. pre-dumping) surface soil was evident in samples collected at the base of the rubble.

Sandstone/Caliche

The upper 25 to 30 feet of the Ogallala Formation underlying Landfill No. 25 is a well cemented sandstone with extremely hard caliche layers and nodules. The

caliche ranges from the consistency of concrete to a more friable material that can be crumbled by hand. The sands are well cemented, red to white, and medium to fine grained.

Sand

By 30 feet BNS, the Ogallala Formation consists of unconsolidated sand. The sand is red to white, fine to medium grained, and well sorted. Some caliche layers are present, but not nearly as abundant as in the top 25 feet.

4.2.2 Geologic Cross Sections

Two site specific cross sections were completed from the soil boring data. Figure 4-3 is a cross section through borings 3c, 4a, 9, 8b, and 14. Figure 4-4 is a cross section through borings 2, 10, and 11. The boring logs are included as Appendix C.

4.2.3 Sieve Analysis

Forty-seven samples were sieve analyzed for grain size. The cumulative results are shown in Table 4-2 and the original results from the laboratory are included as Appendix E.

4.3 Comparison of the Field Results to Site Specific Background Metals Concentrations

Site specific background metals data were determined from background soil boring samples taken west of Perimeter Road and north of the sewage lagoons at depths ranging from 0 to 60 feet. A statistical analysis of the background data was used to calculate an upper tolerance limit (UTL) for the metals in the Landfill No. 25 soil.

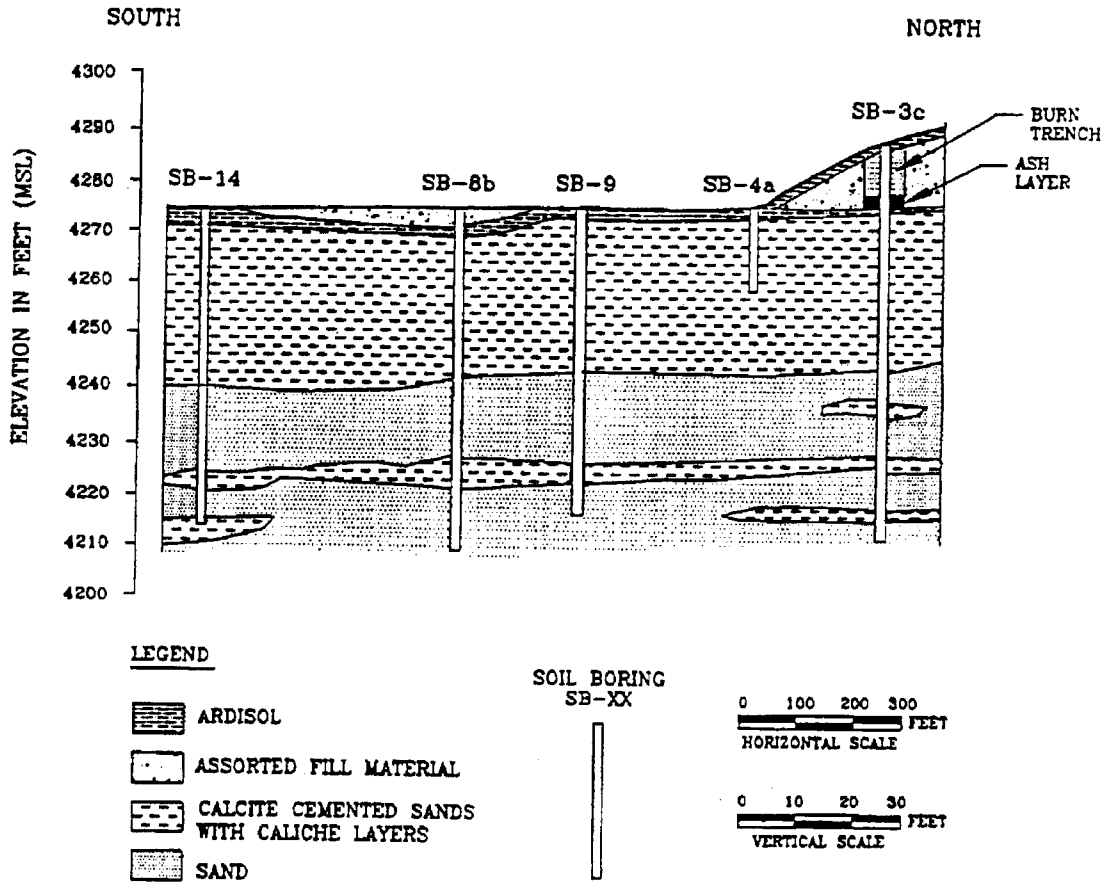
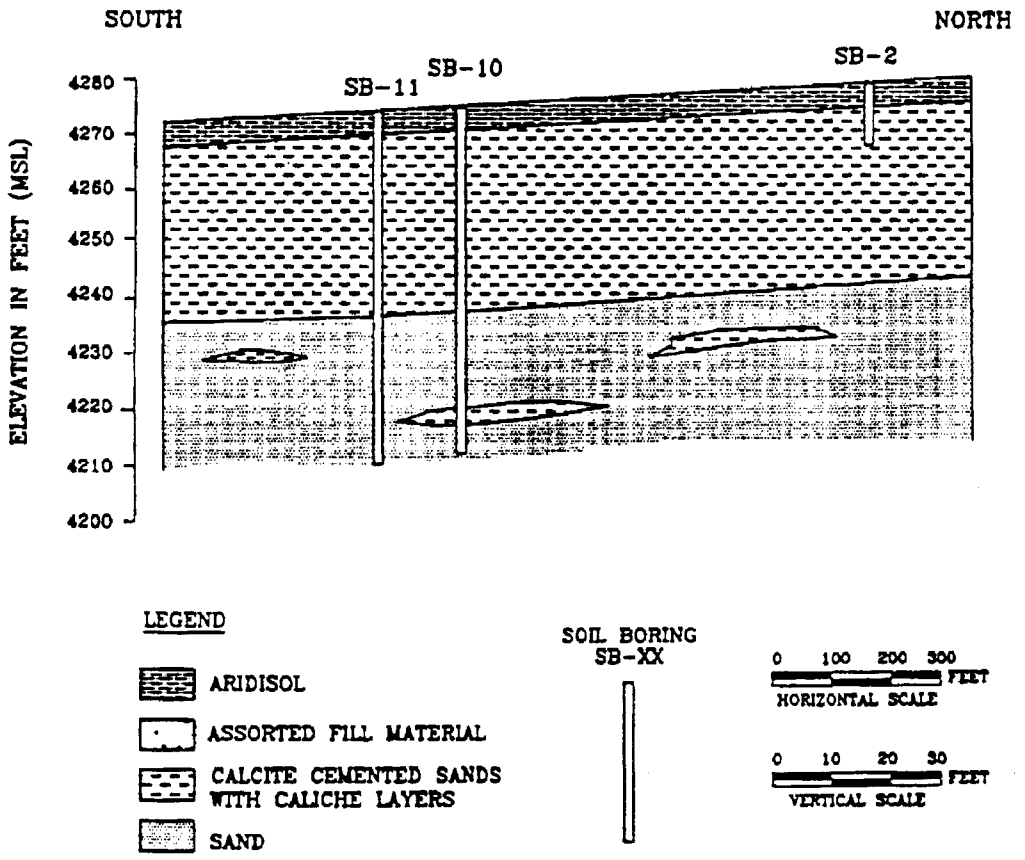


FIGURE 4-3

CROSS SECTION THROUGH BORINGS
3c, 4a, 8b, 9 AND 14
LANDFILL NO. 25

269069-9300073-MIL



CANNON\SOIL4

FIGURE 4-4

CROSS SECTION THROUGH BORINGS
2, 10 AND 11
LANDFILL NO. 25

Table 4-2

Grain Size per Major Geologic Division

Material	%Coarse Gravel	%Fine Gravel	%Coarse Sand	%Medium Sand	%Fine Sand	%Silt/ Clay
Soil	0-24	0-9	0-5	1-20	29-63	27-54
Sandstone - caliche	0-37	0-11	0-11	2-10	15-59	8-76
Sand	2-15	1-8	1-6	5-13	48-78	7-26

Coarse gravel: $x > 20$mm
Fine gravel: 5mm $< x < 20$mm
Coarse sand: 2mm $< x < 5$mm
Medium sand: 0.5mm $< x < 2$mm
Fine sand: 0.08mm $< x < 0.5$mm
Silt/clay: $x < 0.08$mm (Fetter, 1988)

Upper tolerance limits are calculated to establish the concentration range that will contain a specific portion (in this case 95%) of the background data with a specified level of confidence (95%). Upper tolerance limits are extreme value tests. The background data is used to define the upper tolerance limit (UTL), which is defined as the concentration that a large portion (95%) of the sample data should be below for a large proportion of the time (95%). Sample data can then be checked for evidence of contamination by determining whether they fall below the UTL. Extreme value tests, such as UTLs, are used to determine whether a site has any "hot spots", or areas of contamination.

Data exceeding the UTLs are by definition significantly greater than background concentrations for that metal. The UTLs for each constituent were calculated based on a 95% confidence level, where the UTL (95%) defines a limit such that 95% of the background results should be less than the UTL 95% of the time (i.e, a coverage of 95 percent). The background data was tested to determine if it was normally distributed about the mean. If data were found to be normally distributed, a normal test was used to determine the UTL. If the data were not normally distributed, a non-parametric test was used to determine a more conservative UTL. However, when a non-parametric test is used, the coverage may be less than 95 percent. For silver, which was not detected in the background soil samples, and thallium, which was not analyzed by graphite furnace atomic absorption (GFAAS) in any background samples, the maximum detection limit in the field samples was used as the UTL. The UTLs for the background soil are listed in Table 4-3. These procedures are consistent with the RCRA and/or EPA guidance for determining background UTLs and are described in Appendix F.

Arsenic, lead, mercury, and selenium were analyzed by atomic absorption spectroscopy (AAS); the remainder of the metals were analyzed by inductively coupled plasma emission spectroscopy (ICPES). Most samples contained high concentrations of

Table 4-3

Soil Samples Upper Background Limits
Confidence Level = 95%
for Landfill No. 25, CAFB, Clovis, New Mexico

Analyte	Method	Total Number of Results	Percent Detected (%)	Test Type	Minimum BG Rep. Limit (mg/kg)	Maximum BG Rep. Limit (mg/kg)	Maximum BG Det. Conc. (mg/kg)	Upper Background Limit (mg/kg)	Coverage (%)
Aluminum	SW6010	12	100	Normal	14	17	11000	15100	95
Antimony	SW7041	2	100	Normal	0.4	0.52	0.07	1.67	95
Arsenic	SW7060	12	100	Normal	0.28	0.60	6.9	8.65	95
Barium	SW6010	12	100	Non-Parametric	0.71	0.84	860	860	77
Beryllium	SW6010	12	100	Normal	0.14	0.17	0.48	0.62	95
Cadmium	SW6010	12	100	Normal	0.37	0.42	0.45	0.61	95
Calcium	SW6010	12	100	Normal	74	660	220000	290000	95
Chromium	SW6010	12	100	Normal	0.71	0.84	7.2	10.5	95
Cobalt	SW6010	12	100	Normal	0.74	0.84	3.2	3.9	95
Copper	SW6010	12	100	Normal	1.4	1.7	4.9	5.7	95
Iron	SW6010	12	100	Normal	3.7	4.2	6800	8840	95
Lead	SW7421	12	100	Non-Parametric	0.21	1.0	9.15	9.15	77
Magnesium	SW6010	12	100	Normal	84	84	7700	10700	95
Manganese	SW6010	12	100	Non-Parametric	0.71	0.84	140	140	77
Mercury	SW7471	12	91.7	Normal	0.037	0.054	0.06	0.08	95
Molybdenum	SW6010	12	100	Normal	3.7	4.2	0.51	0.69	95
Nickel	SW6010	12	100	Normal	1.5	6.7	12.5	16.7	95
Potassium	SW6010	12	100	Normal	220	250	2000	2850	95

Table 4-3

(Continued)

Analyte	Method	Total Number of Results	Percent Detected (%)	Test Type	Minimum BG Rep. Limit (mg/kg)	Maximum BG Rep. Limit (mg/kg)	Maximum BG Det. Conc. (mg/kg)	Upper Background Limit (mg/kg)	Coverage (%)
Selenium	SW7740	12	66.7	Normal	0.35	0.42	0.78	1.2	95
Silver	SW6010	12	0.0	None	0.71	0.84	--	--[b]	--
Sodium	SW6010	12	100	Normal	74	84	210	317	95
Thallium	SW7841	0	--	None	0.38[a]	0.51[a]	--	--[b]	--
Vanadium	SW6010	12	100	Normal	1.4	1.7	17	24	95
Zinc	SW6010	12	100	Normal	1.4	1.7	15.5	21	95

[a] Reporting limits are from field data; no background samples were analyzed for thallium by GFAAS.

[b] When the constituent was not detected in the background soils (i.e., silver and thallium), the maximum detection limit was used as the UTL.

Notes:

1. Random numbers were substituted for non detects.
2. Limits not calculated when background is all non-detect.

calcium which interfered with the antimony analyses, and the ICPES thallium detection limits were not low enough to adequately evaluate the data. Therefore 18 field samples, selected based on high detection limits or apparent hits when analyzed by ICPES, were submitted for analysis by graphite furnace atomic absorption (GFAAS). These samples are listed in a footnote to Table 4-4.

The metals data were then compared to the UTLs. Those samples containing metals concentrations greater than the UTLs are listed in Table 4-4.

4.3.1 Trenches

The trench data were compared to the calculated site-specific UTLs and samples containing at least one target metal at concentrations exceeding the UTLs are listed in Table 4-4. Twenty-one samples from eight of the sampling locations (12, 13, and 15 through 20) exceed the manganese UTL of 140 mg/kg. These surface rubble samples (0 to 2 feet) had manganese concentrations of 300, 460, and 650 mg/kg, respectively. Eight additional surface samples exceeded the manganese UTL with concentrations ranging from 140 to 250 mg/kg. Eight of the samples from the rubble/native soil interface exceeded the manganese UTL with concentrations ranging from 150 mg/kg in CAN97-19-I to 250 mg/kg in sample CAN97-16-I. Samples CAN97-19-06 (150 mg/kg) and CAN97-21-06 (140 mg/kg), from the 6 to 8 feet BLS depth interval, also exceeded the manganese UTL. Trench location 19 exhibited manganese concentrations which exceeded the manganese UTL at each of the three sampling depths.

Twenty-one of twenty-seven trench samples exceeded the background soil UTL for zinc. Surface rubble samples from eight of the locations also exceeded the UTL of 21.8 mg/kg for zinc. With the exception of samples CAN97-19-S and CAN97-20-S, which contained 130 and 63 mg/kg zinc respectively, the remaining rubble samples exceeding the UTL ranged from 22 to 36 mg/kg zinc. The only rubble/native soil

Table 4-4

Metals Found at Concentrations Greater Than the Background Soil UTLs in Field Samples From Landfill No. 25, CAFB, New Mexico, 1992

Sample ID	Depth ft. BLS	Metals (mg/kg)																				
		Aluminum	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Molybdenum	Potassium	Selenium	Silver	Sodium	Vanadium	Zinc
Background UTL		15100	8.65	860[a]	0.62	0.61	290000	10.5	3.9	5.7	8840	9.15[a]	10700	146[a]	0.08	0.69	2850	1.2	0.84[b]	317	24.6	21.8
Trenches																						
CAN-97-12-I	4-6	--	--	--	--	--	--	12	--	7.5@	10000	--	--	180	--	--	--	--	--	--	--	27
CAN-97-12-S	0-2	18000	--	--	0.62@	--	--	15	4.2	8.2	13000	16	--	210	--	--	3200	--	--	--	29	31
CAN-97-13-06	5-7	--	--	--	--	1.1@	--	--	4.0@	--	--	--	--	--	--	--	--	--	--	--	--	--
CAN-97-13-I	4-6	--	--	--	--	--	--	13	4.3@	7.8@	11000	--	--	210	--	--	--	--	--	--	--	26
CAN-97-13-S	0-2	--	--	--	--	--	--	13	4.0@	7.3@	11000	9.3	--	230	--	--	--	--	--	--	--	28
CAN-97-13-99[a]	0-2	--	--	--	--	--	--	12	--	7.0@	10000	--	--	210	--	--	--	--	--	--	--	27
CAN-97-15-06[c, f]	6-8	--	--	--	--	--	--	--	--	--	9100	--	--	--	--	--	--	--	--	--	27	--
CAN-97-15-I	4-6	--	--	--	--	--	--	13	4.4	7.0@	12000	--	--	220	--	0.9@	--	--	--	--	--	27
CAN-97-15-S	0-2	--	--	--	--	1.2@	640000	11	--	7.8	9200	25	--	200	--	--	--	--	--	--	--	36
CAN-97-16-06	5-7	--	--	--	--	1.7@	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	22@
CAN-97-16-I	4-6	--	--	--	--	--	--	14	4.4@	8.1@	12000	--	--	250	--	--	--	--	--	--	--	30
CAN-97-16-99[a]	0-0	--	--	--	--	--	--	13	4.5	7.9@	11000	--	--	240	--	0.78@	--	--	--	--	--	29
CAN-97-16-S	0-2	--	--	--	--	--	--	14	4.1	7.6	12000	11	--	230	--	--	2900	--	--	--	25	33
CAN-97-17-06[c]	6-8	--	--	--	--	--	--	--	--	--	9100	--	--	--	--	--	--	--	--	--	--	--
CAN-97-17-I	4-6	--	--	--	--	--	--	14	4.6	7.5@	12000	--	--	240	--	0.88@	--	--	--	--	25	28
CAN-97-17-S	0-2	--	9.0	--	--	--	--	--	--	--	--	120	--	460	0.098@	--	--	--	--	--	--	--
CAN-97-18-06[c]	5-7	--	--	--	--	--	--	--	--	--	10000	--	--	--	--	0.82@	--	--	--	--	26	--
CAN-97-18-I[c]	4-6	21000	--	--	0.76@	--	--	17	5.0	9.6	15000	--	--	230	--	--	3100	--	--	--	32	35
CAN-97-18-S	0-2	--	--	--	--	--	--	--	--	7.0@	9300	14	--	210	--	--	--	--	--	--	--	26
CAN-97-19-06[c]	5-7	16000	--	--	--	--	--	13	--	6.7@	11000	--	--	150	--	0.73@	--	--	--	--	--	28
CAN-97-19-I[c]	4-6	--	--	--	--	--	--	--	--	6.7@	9100	--	--	150	--	--	--	--	--	--	--	33
CAN-97-19-S	0-2	--	--	--	--	--	--	12	--	6.4@	9900	16	--	200	--	--	--	--	--	--	--	130

Table 4-4

(Continued)

Sample ID	Depth ft. BLS	Metals (mg/kg)																				
		Aluminum	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Molybdenum	Potassium	Selenium	Silver	Sodium	Vanadium	Zinc
Background UTL		15100	8.65	868[a]	0.62	0.61	290000	10.5	3.9	5.7	8840	9.15[a]	10700	140[a]	0.08	0.69	2850	1.2	0.84[b]	317	24.6	21.8
CAN-97-19-99[a]	0-2	--	--	--	--	--	--	--	--	--	--	--	--	650	--	--	--	--	--	--	--	--
CAN-97-20-06	7-9	--	--	--	--	--	--	12	4.0@	6.4@	11000	--	--	--	--	--	--	--	--	--	--	24
CAN-97-20-I	4-6	18000	--	--	0.63@	--	--	15	4.3@	7.8@	13000	--	--	170	--	1.1@	--	--	--	--	27	32
CAN-97-20-S	0-2	--	--	--	--	--	--	11	--	10	9900	23	--	300	--	--	--	--	--	--	--	63
CAN-97-21-06	5-7	17000	--	--	0.62@	--	--	14	4.4	6.6@	12000	--	--	140	--	0.8@	--	--	--	--	26	27
Soil Borings (0-11 ft)																						
CAN-97-09-01	0-2	--	--	--	--	--	--	--	--	5.7@	--	--	--	--	--	0.8@	--	--	--	--	--	--
CAN-97-10-01[c]	0-2	--	--	--	--	--	--	--	--	--	--	9.2	--	--	--	--	--	--	--	--	--	22
CAN-97-11-01[c]	0-2	--	--	--	--	--	--	15	4.1@	8.8@	12000	9.2	--	220	--	--	3200	--	--	--	26	34
CAN-97-11-03	9-11	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	23@
CAN-97-14-01	0-2	--	--	--	--	--	--	11	4.1@	7.5@	10000	--	--	240	--	--	--	--	--	--	--	26
CAN-97-14-02	4-6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.3@	--	--	--	--
CAN-97-2A-06	8-10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.9@	--	--	--	--
CAN-97-2A-I	4-6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.7@	--	--	--	--
CAN-97-2A-S	0.5-1	--	--	--	--	--	--	11	--	5.9@	8900	--	--	170	--	--	--	1.3@	--	--	--	23
CAN-97-2B-06	8-10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.7@	--	--	--	--
CAN-97-2B-99[i]	4-6	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.8	--	--	--	--
CAN-97-2B-S	0.5-1	--	--	--	--	--	--	11	--	--	--	--	--	140	--	--	--	1.3@	--	--	--	22
CAN-97-3B-06[f]	8-10	--	--	--	0.71@	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CAN-97-3B-S[f]	0-2	--	--	--	0.62@	--	--	11	4.0@	--	9500	--	--	--	--	--	--	--	--	--	26	23
CAN-97-4A-I[f]	4-6	--	--	1000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CAN-97-4A-S	0.5-1	--	--	--	--	--	--	--	--	--	9000	--	--	150	--	--	--	--	--	--	--	--
CAN-97-4A-99[j]	0.5-1	--	--	--	--	--	--	--	--	--	9200	--	--	160	--	--	--	--	--	--	--	--
CAN-97-4B-S	0-2	--	--	--	--	--	--	11	--	--	--	--	--	140	--	--	--	--	--	--	--	24

Table 4-4

(Continued)

Sample ID	Depth ft. BLS	Metals (mg/kg)																				
		Aluminum	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Molybdenum	Potassium	Selenium	Silver	Sodium	Vanadium	Zinc
Background UTL		**15100**	**8.65**	**868[a]**	**0.62**	**0.61**	**290000**	**10.5**	**3.9**	**5.7**	**8840**	**9.15[a]**	**10700**	**140[a]**	**0.08**	**0.69**	**2850**	**1.2**	**0.84[b]**	**317**	**24.6**	**21.8**
CAN-97-8A-06[f]	8-10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	380@	--	--
CAN-97-8A-I[f]	4-6	--	--	1100	--	--	--	--	--	--	--	--	--	--	--	--	--	1.8@	--	--	--	--
CAN-97-8A-S	0.5-1	17000	--	--	--	0.87@	--	14	--	13	11000	14	--	160	--	--	2900	--	--	--	25	53
CAN-97-8B-01[f]	4-6	--	--	1700	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	85
CAN-97-8B-02	8-10	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	380@	--	--
CAN-97-BG-01	0-2	--	--	--	--	--	--	--	--	--	--	9.7	--	140	--	--	--	--	--	--	--	--
Soil Borings (> 11 ft)																						
CAN-97-10-04	14-16	--	--	--	--	--	--	--	--	7.5@	--	--	--	--	--	--	--	1.6@	--	--	--	--
CAN-97-10-05	19-21	--	--	--	--	--	--	--	--	--	--	--	12000	--	--	--	--	--	--	--	--	--
CAN-97-10-99[d]	19-21	--	--	--	--	--	--	--	--	--	--	--	11000	--	--	--	--	--	--	--	--	--
CAN-97-10-06	24-26	--	--	--	--	--	--	--	--	--	--	--	12000	--	--	--	--	--	--	--	--	--
CAN-97-11-04[e]	14-16	--	--	--	--	--	--	12	--	--	--	--	--	--	--	--	3300	--	--	330@	32@	23@
CAN-97-11-05[e]	19-21	20000	--	--	0.85@	--	--	13	--	--	11000	--	--	150	--	--	4500	--	--	370@	39	29
CAN-97-11-10[e]	46-48	--	--	--	--	1.3@	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
CAN-97-14-04	14-16	--	--	1100	--	--	--	--	--	--	--	--	--	--	--	--	--	1.2@	--	--	--	--
CAN-97-14-06	24-26	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	5.0	--	--	--
CAN-97-14-07[e]	29-31	--	--	1000	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.1@	--	--	--
CAN-97-3A-06	21-25	--	--	--	0.63@	--	--	--	--	--	9200	--	--	--	--	0.73@	2900	--	--	--	--	22
CAN-97-3A-I	19-21	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	330@	--	--
CAN-97-3A-S[f]	15-17	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	420@	--	--
CAN-97-3C-01	12-14	--	--	--	0.63@	--	--	12	--	7.9@	11000	--	--	170	--	0.74@	--	--	--	--	--	28
CAN-97-3C-02	18-20	--	--	--	0.64@	--	--	--	--	--	10000	--	--	150	--	--	--	--	--	--	27	24
CAN-97-3C-03	23-25	--	--	--	--	--	--	--	--	--	--	--	--	170	--	--	--	--	--	--	--	--
CAN-97-3C-04	28-30	--	--	--	0.68@	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 4-4

(Continued)

Sample ID	Depth ft. BLS	Metals (mg/kg)																				
		Aluminum	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Molybdenum	Potassium	Selenium	Silver	Sodium	Vanadium	Zinc
Background UTL		15100	8.65	860 [a]	0.62	0.61	290000	10.5	3.9	5.7	8840	9.15 [a]	10700	140 [a]	0.08	0.69	2850	1.2	0.84 [b]	317	24.6	21.8
CAN-97-3C-09	53-55	--	--	--	--	--	--	--	--	--	--	--	15000	--	--	--	--	--	--	--	--	--
CAN-97-8B-03	14-16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	330@	--	--
CAN-97-BG-99 [k]	59-61	--	--	--	--	--	--	--	--	--	--	--	--	140	--	--	--	--	--	--	--	--

@ Result is less than five times the detection limit.

[a] Maximum detected value in background soil used as UTL when data is not normally distributed.

[b] Maximum detection limit used. Analyte not detected in the background soil.

[c] Samples reanalyzed for thallium by GFAAS. None of these results were above the background UTL of 0.51 mg/kg.

[d] Field duplicate of CAN-97-10-05.

[e] Field duplicate of CAN-97-13-S.

[f] Samples reanalyzed for antimony by GFAAS. None of these results were above the background UTL of 0.07 mg/kg.

[g] Field duplicate of CAN-97-16-I.

[h] Field duplicate of CAN-97-19-S.

[i] Field duplicate of CAN-97-2B-I.

[j] Field duplicate of CAN-97-4A-S.

[k] Field duplicate of CAN-97-BG-01.

Note: Atomic absorption data were used to compare arsenic, lead, and selenium data to the UTLs. All field samples were analyzed for antimony and thallium by ICPES. Due to the high concentrations of calcium in these samples, the ICPES antimony and thallium results were biased high. About 10 percent of the field samples (the 18 exhibiting the highest ICPES concentrations or detection limits for Sb and/or Tl) were submitted for analyses by GFAAS. These analyses indicate that Sb and Tl are at/or below the UTLs for this site.

Results not listed are below background soil UTLs.

interface sample that did not exceed the zinc UTL was CAN97-21-I. The other interface samples contained 26 to 32 mg/kg zinc. Samples CAN97-15-06, CAN97-19-06, CAN97-20-06, and CAN97-21-06, from the 6 to 8 feet BLS depth interval, exceeded the zinc UTL with concentrations ranging from 22 to 28 mg/kg. Trench locations 15, 19, and 20 contained zinc concentrations exceeding the UTL at each of the three sampling depths.

Surface rubble samples from eight of the locations exceeded the UTL of 9.15 mg/kg for lead. With the exception of samples CAN97-17-S which contained 120 mg/kg, the sample concentrations ranged from 9.3 to 25 mg/kg lead. The rubble/native soil interface samples and the 6 to 8 feet BLS interval trench samples did not exceed the lead UTL.

Surface samples from seven of the trenches exceeded the UTL of 5.7 mg/kg for copper with concentrations ranging from 6.4 to 10 mg/kg. Eight of the rubble/native soil interface samples exceeded the copper UTL with concentrations ranging from 6.7 to 9.6 mg/kg. Samples CAN97-19-06, CAN97-20-06, and CAN97-21-06, from the 6 to 8 feet BLS depth interval, exceeded the copper UTL with concentrations ranging from 6.4 to 6.7 mg/kg. Trench locations 19 and 20 contained copper concentrations exceeding the UTL at each of the three sampling depth intervals.

Chromium was found in six of the surface rubble samples at concentrations ranging from 11 to 15 mg/kg, exceeding the UTL of 10.5 mg/kg. Seven of the rubble/surface soil interface samples exceeded the UTL with chromium concentrations ranging from 12 to 17 mg/kg. Chromium was also found in the 6 to 8 feet BLS samples from trenches 19, 20, and 21 with concentrations ranging from 12 to 14 mg/kg. Trench 20 contained chromium at concentrations exceeding the UTL at all three depth intervals.

At least three samples from each depth interval exceeded the cobalt UTL of 3.9 mg/kg. These samples contained 4 to 5 mg/kg cobalt. Only trench location 13 contained cobalt concentrations exceeding the UTL at all three depth intervals.

At least one of the trench samples from each of the three depth intervals exceeded the UTLs for arsenic (9.0 mg/kg), beryllium (0.62 mg/kg), cadmium (0.61 mg/kg), mercury (0.08 mg/kg), molybdenum (0.69 mg/kg), and vanadium (24.6 mg/kg). None of these metals was detected at all three intervals at a trench location.

4.3.2 Soil Boring Samples (0 to 11 feet BLS)

The metals data from both the shallow soil borings and the deep soil boring samples from the 0 to 11 feet BLS depth interval were compared to the calculated site-specific UTLs and samples containing at least one target metal at concentrations exceeding the UTLs are listed in Table 4-3. Eight soil boring samples from the 0 to 2 feet depth interval exceeded the manganese UTL of 140 mg/kg with concentrations up to 240 mg/kg in sample CAN97-14-01. Manganese concentrations in the 4 to 6 feet and 8 to 10 feet depth intervals did not exceed the manganese UTL.

The 0 to 2 feet interval samples from nine of the locations exceeded the UTL of 21.8 for zinc. With the exception of sample CAN97-8A-S, which contained 53 mg/kg zinc, the remaining 0 to 2 feet samples exceeding the UTL ranged from 22 to 34 mg/kg zinc. CAN97-8B-01 (4 to 6 feet BLS) contained 85 mg/kg zinc.

The native soil surface samples (0 to 2 feet) from three of the soil boring locations exceeded the UTL of 9.15 mg/kg for lead with concentrations ranging from 9.2 to 14 mg/kg lead. The remaining soil boring samples did not contain lead concentrations above the UTL.

Surface samples from five of the soil borings exceeded the UTL of 5.7 mg/kg for copper with concentrations ranging from 5.7 to 13 mg/kg. Copper did not exceed the UTL in the remaining 4 to 6 feet and 8 to 10 feet soil boring samples.

Chromium was found in seven of the surface (0 to 2 feet) samples at concentrations ranging from 11 to 15 mg/kg, exceeding the UTL of 10.5 mg/kg. Chromium did not exceed the UTL in the remaining 4 to 6 feet and 8 to 10 feet soil boring samples.

At least two samples from each depth interval (0 to 2 feet, 4 to 6 feet, and 8 to 10 feet) exceeded the selenium UTL of 1.2 mg/kg. These samples contained 1.3 to 1.9 mg/kg selenium. Only shallow soil boring locations 2A and 2B exceeded the selenium UTL at all three depth intervals.

At least one of the shallow soil boring samples exceeded the UTLs for barium (860 mg/kg), beryllium (0.62 mg/kg), cadmium (0.61 mg/kg), molybdenum (0.69 mg/kg), and vanadium (24.6 mg/kg). None of these metals were detected at all three shallow intervals at a given boring location.

4.3.3 Soil Boring Samples (deeper than 11 feet BLS)

The metals data from the deep soil boring samples taken at depth intervals deeper than 11 feet BLS were compared to the calculated site-specific UTLs and samples containing at least one target metal at concentrations exceeding the UTLs are listed in Table 4-3. Samples CAN97-3C-01 (12-14 feet BLS), CAN97-3C-02 (18-20 feet BLS), CAN97-3C-03 (23-25 feet BLS), and CAN97-11-05 (19-21 feet BLS) exceeded the manganese UTL of 140 mg/kg with concentrations ranging from 150 to 170 mg/kg. Manganese concentrations did not exceed the UTL in samples taken below 25 feet.

The silver UTL of 0.84 mg/kg was exceeded in samples CAN97-14-06 (24-26 feet BLS) and CAN97-14-07 (29 to 31 feet BLS) at concentrations of 5.0 and 2.1 mg/kg, respectively.

At least one sample from each depth interval up to 31 feet exceeded UTLs for barium (860 mg/kg), beryllium (0.62 mg/kg), chromium (10.5 mg/kg), copper (5.7 mg/kg), molybdenum (0.69 mg/kg), selenium (1.2 mg/kg), vanadium (24.6 mg/kg), and zinc (22 mg/kg). None of these metals were detected at concentrations greater than two times the respective UTL.

Only one sample taken below 31 feet contained a metal at a concentration exceeding a site-specific UTL. Sample CAN97-11-10 contained 1.3 mg/kg cadmium, which exceeded the UTL of 0.61 mg/kg.

Soil boring samples taken below 48 feet did not contain any target metals at concentrations exceeding the UTLs.

4.4 Organic Compounds Detected at Landfill No. 25

In 1992

The Landfill No. 25 samples were analyzed for organochlorine pesticides, polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), total recoverable petroleum hydrocarbons (TRPH). In addition, forty of the field samples were also analyzed for total extractable hydrocarbons (diesel, jet fuel, and kerosene), total purgeable hydrocarbons (gasoline and its components), and chlorinated herbicides. Three additional samples were analyzed for total purgeable hydrocarbons and herbicides. Tables 4-5 through 4-7 list only those samples where one or more of a target organic compound was detected at concentrations greater than the method reporting limits. J-Flagged data (data above the instrument detection limit but below the method reporting limit) are only reported for those samples

Table 4-5

Organochlorine Pesticides and PCBs Found in Soil Samples from Landfill No. 25, 1992
CAFB, Clovis, New Mexico

Sample ID	Depth ft BLS	Organochlorine Pesticides and PCBs (SW8080), (µg/kg)													
		4,4'-DDD	4,4'-DDE	4,4'-DDT	Aldrin	Chlordane	Dieldrin	Endosulfan Sulfate	Endrin	Heptachlor	Heptachlor Epoxide	alpha-BHC	beta-BHC	delta-BHC	gamma-BHC
Reporting Limit		0.39	0.39	0.78	0.39	2.0	0.39	2.0	0.39	0.39	0.39	0.39	0.39	0.39	0.39
Trenches															
CAN-97-12-I	4-6	<	<	1.4@	<	<	<	<	<	<	0.11J	<	<	<	<
CAN-97-12-S	0-2	< [k]	8.4@	3.8J	< [k]	< [l]	< [k]	< [l]	< [k]	< [k]	< [k]	< [k]	< [k]	< [k]	< [k]
CAN-97-13-S	0-2	< [k]	4.3@	2.4J	1.9J	< [l]	< [k]	< [l]	< [k]	< [k]	< [k]	< [k]	< [k]	< [k]	< [k]
CAN-97-13-99[d]	0-2	< [k]	4.4@	2.3J	< [k]	< [l]	< [k]	< [l]	< [k]	< [k]	< [k]	< [k]	< [k]	< [k]	1.6J
CAN-97-15-I	4-6	<	<	<	<	<	<	<	<	<	<	<	<	<	0.56G@
CAN-97-15-S	0-2	< [l]	17@	27J	< [l]	< [m]	< [l]	< [m]	< [l]	0.12J	< [l]	< [l]	< [l]	< [l]	< [l]
CAN-97-16-06	5-7	<	<	0.34J	<	<	<	<	<	<	0.94G@	<	<	<	<
CAN-97-16-I	4-6	<	12	6.1	<	<	<	<	<	<	<	<	<	<	<
CAN-97-16-99[e]	0-0	<	12	6.6	<	<	<	<	<	<	<	<	<	0.35G@	<
CAN-97-16-S	0-2	< [k]	10@	4.8J	< [k]	< [l]	< [k]	< [l]	< [k]	< [k]	< [k]	< [k]	< [k]	< [k]	< [k]
CAN-97-17-06	6-8	<	0.88@	0.94G@	<	<	<	<	<	<	<	<	<	<	<
CAN-97-17-99[f]	6-8	<	0.83@	2.3@	<	<	<	<	<	<	<	<	<	<	0.31J
CAN-97-17-I	4-6	<	1.6@	1.1@	<	<	<	<	<	<	<	<	<	<	0.27J
CAN-97-17-S	0-2	5.9B@	0.75J	5.3J	5.7@	< [l]	1.2J	< [l]	2.5J	< [k]	< [k]	< [k]	1.3J	< [k]	< [k]
CAN-97-18-06	5-7	<	<	<	<	<	<	<	<	<	<	<	<	0.86G@	0.37G@
CAN-97-18-I	4-6	0.19J	0.26J	<	4G	<	<	<	<	<	0.79G@	<	<	0.4G@	<
CAN-97-18-S	0-2	< [k]	4.8@	11@	< [k]	< [l]	< [k]	1.6J	< [k]	< [k]	< [k]	< [k]	< [k]	< [k]	1.6J
CAN-97-19-06	5-7	0.31JJ	17	8.5	<	17	0.37G	<	<	<	<	<	<	<	0.34J
CAN-97-19-I	4-6	0.86G@	5.9	9.2	<	10	0.43@	<	<	<	<	<	<	<	0.31J
CAN-97-19-S	0-2	3.8B@	2.6J	8@	< [k]	< [l]	< [k]	< [l]	< [k]	< [k]	< [k]	< [k]	< [k]	< [k]	< [k]
CAN-97-19-99[g]	0-2	4.2B@	3.5@	10@	< [k]	< [l]	< [k]	< [l]	< [k]	< [k]	< [k]	< [k]	< [k]	< [k]	< [k]
CAN-97-20-I	4-6	<	<	1.1@	<	<	<	<	<	<	<	<	<	<	<
CAN-97-20-S	0-2	9.9B@	1.6J	< [n]	< [k]	< [l]	< [k]	38G@	< [k]	< [k]	< [k]	< [k]	< [k]	< [k]	< [k]
CAN-97-21-99	5-7	<	0.42G@	<	<	<	<	<	<	<	<	<	<	<	<

Table 4-5

(Continued)

Sample ID	Depth ft BLS	Organochlorine Pesticides and PCBs (SW8080), (µg/kg)													
		4,4'-DDD	4,4'-DDE	4,4'-DDT	Aldrin	Chlordane	Dieldrin	Endosulfan Sulfate	Endrin	Heptachlor	Heptachlor Epoxide	alpha-BHC	beta-BHC	delta-BHC	gamma-BHC
Reporting Limit		0.39	0.39	0.78	0.39	2.0	0.39	2.0	0.39	0.39	0.39	0.39	0.39	0.39	0.39
CAN-97-21-I	4-6	<	0.48@	<	0.27J	<	<	<	<	<	<	<	<	<	<
CAN-97-21-S	0-2	< [k]	0.76J	< [e]	< [k]	< [l]	< [k]	< [l]	< [k]	5.9G@	< [k]	< [k]	< [k]	< [k]	< [k]
Soil Borings (0-11 ft)															
CAN-97-09-01	0-2	0.35J	20	10	<	12	<	<	<	<	<	<	<	<	<
CAN-97-09-02	4-6	<	0.29J	<	<	<	<	<	<	<	<	<	<	0.51G@	<
CAN-97-10-01	0-2	< [k]	220	110	2.1J	< [l]	< [k]	< [l]	< [k]	< [k]	1.8J	< [k]	< [k]	< [k]	< [k]
CAN-97-10-02	4-6	0.43GB@	0.21J	0.61J	<	<	<	<	<	0.11J	<	<	<	<	<
CAN-97-11-01	0-2	< [k]	15@	13@	< [k]	< [l]	< [k]	< [l]	< [k]	< [k]	< [k]	< [k]	< [k]	< [k]	< [k]
CAN-97-11-02	4-6	0.8@	<	<	<	<	<	<	<	<	<	<	<	<	<
CAN-97-14-01	0-2	< [k]	8.8@	10@	< [k]	< [l]	< [k]	< [l]	< [k]	< [k]	< [k]	< [k]	< [k]	< [k]	< [k]
CAN-97-14-02	4-6	< [k]	< [k]	0.93@	0.44@	<	<	<	<	<	<	<	<	<	<
CAN-97-14-03	9-11	0.76@	<	<	<	<	<	<	0.54@	0.45@	<	<	<	0.82@	<
CAN-97-2A-06	8-10	<	<	<	<	<	<	<	<	<	<	<	<	0.68G@	<
CAN-97-2A-I	4-6	<	1@	<	<	<	<	<	<	<	<	<	<	<	0.33J
CAN-97-2A-S	0-2	< [k]	8.9@	37	< [k]	< [l]	< [k]	< [l]	< [k]	< [k]	< [k]	< [k]	< [k]	< [k]	< [k]
CAN-97-2B-06	8-10	<	<	<	<	<	<	<	<	<	<	<	<	<	0.46GB@
CAN-97-2B-99 [h]	4-6	<	<	1.4G@	<	<	<	<	<	<	<	<	<	<	0.34J
CAN-97-2B-S	0-2	9.4@	10@	30@	< [e]	< [e]	< [e]	< [e]	< [e]	< [e]	< [e]	< [e]	1.3J	< [e]	< [e]
CAN-97-3B-06	8-10	0.43G@	0.059J	<	<	<	<	<	<	0.1J	<	<	<	<	<
CAN-97-3B-I	4-6	<	<	0.83@	<	<	<	0.078J	<	<	<	<	<	<	<
CAN-97-3B-S	0-2	0.59@	<	1.1G@	<	<	<	<	<	<	0.45G@	<	<	<	<
CAN-97-4A-06	8-10	0.41GB@	<	0.53J	<	<	<	<	<	0.11J	<	<	<	<	<
CAN-97-4A-I	4-6	0.39GB@	0.097J	0.4J	<	<	<	<	<	0.041J	<	<	<	<	<
CAN-97-4A-S	0-2	0.43GB@	0.5@	1.6@	1.2G@	<	0.15J	<	<	<	0.7GB@	<	<	0.54@	3.5G
CAN-97-4A-99 [j]	0-2	<	1.2@	0.84@	1.3G@	<	<	<	<	<	0.86GB@	<	<	0.97@	<
CAN-97-4B-06	8-10	0.4G@	0.059J	0.46J	<	<	<	<	0.13J	0.057J	<	<	<	<	<

Table 4-5

(Continued)

Sample ID	Depth ft BLS	Organochlorine Pesticides and PCBs (SW8080), (µg/kg)													
		4,4'-DDD	4,4'-DDE	4,4'-DDT	Aldrin	Chlordane	Dieldrin	Endosulfan Sulfate	Endrin	Heptachlor	Heptachlor Epoxide	alpha-BHC	beta-BHC	delta-BHC	gamma-BHC
Reporting Limit		0.39	0.39	0.78	0.39	2.0	0.39	2.0	0.39	0.39	0.39	0.39	0.39	0.39	0.39
CAN-97-4B-S	0-2	< [k]	6.1@	3.8J	< [k]	< [l]	< [k]	< [l]	< [k]	< [k]	< [k]	< [k]	< [k]	< [k]	< [k]
CAN-97-8A-06	8-10		<	0.62J	<	<	<	<	<	0.16J	9.6G	<	<	1@	<
CAN-97-8A-I	4-6	0.028J	17	8.4	<	<	<	<	<	<	<	<	<	<	0.36J
CAN-97-8A-S	0-2	< [k]	35	19@	< [k]	< [l]	< [k]	< [l]	< [k]	< [k]	< [k]	< [k]	< [k]	< [k]	< [k]
CAN-97-8B-01	4-6	1.1G@	16	41	<	9.4	<	<	<	<	<	<	<	0.42@	<
Soil Borings (>11 ft)															
CAN-97-09-06	24-26	0.41@	1.4@	0.99@	<	<	<	<	<	<	<	<	<	<	<
CAN-97-09-99[a]	24-26	<	1.6@	1@	<	<	<	<	<	<	0.24J	<	<	<	<
CAN-97-09-10	44-46	<	3	<	<	<	<	<	0.022J	<	<	<	<	0.41G@	0.28J
CAN-97-10-04	14-16	0.4GB@	1.2@	0.83@	<	<	<	<	<	<	<	<	<	<	<
CAN-97-10-99[b]	19-21	0.46GB@	<	0.73J	<	<	<	<	0.17J	0.1J	<	<	<	<	<
CAN-97-10-06	24-26	<	0.68@	0.34J	<	<	<	<	<	<	0.34J	<	<	<	<
CAN-97-10-07	29-31	0.39B@	<	0.17J	<	<	<	<	<	<	<	<	<	<	<
CAN-97-10-08	34-36	0.39GB@	<	0.42J	<	<	<	<	<	<	<	<	<	<	<
CAN-97-10-09	39-41	0.38B@	<	<	<	<	<	<	<	<	<	<	<	<	<
CAN-97-10-10	44-46	0.38GB@	<	0.42J	<	<	<	<	<	<	<	<	<	<	<
CAN-97-10-11	49-51	0.4GB@	0.064J	0.51J	<	<	<	<	0.13J	0.082J	<	<	<	<	<
CAN-97-10-12	54-56	0.44GB@	<	0.63J	<	<	<	0.073J	<	0.12J	<	<	<	<	<
CAN-97-10-13	59-61	0.4GB@	<	<	<	<	<	<	0.11J	0.0066J	<	<	<	<	<
CAN-97-11-04	14-16	<	<	0.95@	<	<	<	<	<	<	<	<	<	<	<
CAN-97-11-07	29-31	0.8@	0.51@	0.92@	<	<	<	<	<	0.26J	<	<	0.2J	<	<
CAN-97-11-99[c]	39-41	0.74@	<	<	<	<	<	<	<	<	<	<	<	<	<
CAN-97-11-10	46-48	0.8@	<	1@	<	<	<	<	0.53@	0.31J	<	<	<	<	<
CAN-97-11-11	51-53	<	<	0.82@	<	<	<	<	<	0.31J	<	<	<	<	<
CAN-97-14-09	39-41	<	<	1.2@	<	<	<	<	<	<	<	<	<	<	<
CAN-97-14-10	44-46	<	<	0.91@	0.47@	<	<	<	<	<	<	<	0.22J	<	<

Table 4-5

(Continued)

Sample ID	Depth ft BLS	Organochlorine Pesticides and PCBs (SW8080), (µg/kg)													
		4,4'-DDD	4,4'-DDE	4,4'-DDT	Aldrin	Chlordane	Dieldrin	Endosulfan Sulfate	Endrin	Heptachlor	Heptachlor Epoxide	alpha-BHC	beta-BHC	delta-BHC	gamma-BHC
Reporting Limit		0.39	0.39	0.78	0.39	2.0	0.39	2.0	0.39	0.39	0.39	0.39	0.39	0.39	0.39
CAN-97-14-13	59-61	<	<	1@	<	<	<	<	<	<	<	<	<	<	<
CAN-97-3C-01	12-14	3@	<	< [illegible]	3@	< [illegible]	9.2G	< [illegible]	1.9G@	5.8G@	2.5G@	2.4@	< [illegible]	< [illegible]	7.5G@
CAN-97-3C-02	18-20	<	<	<	<	<	<	<	<	<	0.21J	<	4.3G	<	<
CAN-97-3C-04	28-30	<	<	<	<	<	<	<	0.37@	<	<	<	4.8G	<	<
CAN-97-3C-05	33-35	<	<	<	<	<	<	<	0.52@	<	<	<	0.95@	<	<
CAN-97-3C-06	38-40	<	0.41@	0.52J	<	<	<	<	<	<	<	<	<	<	<
CAN-97-3C-99[illegible]	38-40	<	<	<	<	<	<	<	<	<	<	<	4.7G	<	<
CAN-97-3C-08	48-50	<	<	<	<	<	<	<	<	<	0.21J	<	9.9G	<	<
CAN-97-3C-09	53-55	<	<	0.49J	<	<	<	<	<	<	0.26J	<	12G	<	<
CAN-97-8B-03	14-16	0.55G@	<	0.97@	<	<	0.15J	<	0.28J	0.16J	<	<	<	<	<
CAN-97-8B-04	19-21	0.42G@	0.072J	0.55J	<	<	<	<	0.13J	0.06J	<	<	<	<	<
CAN-97-8B-05	24-26	0.4G@	0.075J	0.34J	<	<	<	<	0.11J	0.067J	<	<	<	<	<
CAN-97-8B-06	29-31	0.43G@	<	<	<	<	<	<	<	0.12J	<	<	<	<	<
CAN-97-8B-07	34-36	<	0.43@	0.62J	<	<	<	<	<	<	0.17J	<	<	<	<
CAN-97-8B-10	49-51	0.41G@	<	<	<	<	<	0.09J	0.11J	0.057J	<	<	<	<	<
CAN-97-8B-11	54-56	0.39@	<	<	<	<	<	<	0.1J	0.016J	<	<	<	<	<
CAN-97-8B-13	64-66	0.41G@	0.066J	<	<	<	<	<	0.12J	0.078J	<	<	<	<	<

@ Result is less than five times the reporting limit.
B Analyte detected in blank.
G Presence of analyte confirmed by second column but quantitation is estimated due to matrix interferences.
J Estimated result less than reporting limit.

Table 4-5

(Continued)

Note: Only samples and analytes with at least one result greater than the reporting limit are included in this table. Complete results are in Appendix B.

[a] Field duplicate of CAN-97-09-06
[b] Field duplicate of CAN-97-10-04
[c] Field duplicate of CAN-97-11-07
[d] Field duplicate of CAN-97-13-S
[e] Field duplicate of CAN-97-16-I
[f] Field duplicate of CAN-97-17-06
[g] Field duplicate of CAN-97-19-S
[h] Field duplicate of CAN-97-2B-I
[i] Field duplicate of CAN-97-3C-06
[j] Field duplicate of CAN-97-4A-S

[k] Sample diluted for analyses. Reporting limit is 3.7 μg/kg.
[l] Sample diluted for analyses. Reporting limit is 19 μg/kg.
[m] Sample diluted for analyses. Reporting limit is 85 μg/kg.
[n] Sample diluted for analyses. Reporting limit is 6.8 μg/kg.
[o] Sample diluted for analyses. Reporting limit is about 9 μg/kg.
[p] Sample diluted for analyses. Reporting limit is 44 μg/kg.
[q] Sample diluted for analyses. Reporting limit is 1.8 μg/kg.

< Compound not detected at the reporting limit. All compounds detected between the instrument detection limit and the reporting limit are reported and "J-flagged."

Table 4-6

Semivolatile Organic Compounds Found at Landfill No. 25, 1992
CAFB, Clovis, New Mexico

Sample ID	Depth ft BLS	SVOCs (SW8270), µg/kg												TICs						
		Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Butylbenzylphthalate	Chrysene	Fluoranthene	Phenanthrene	Pyrene	bis(2-Ethylhexyl)phthalate	C4-Tetrahydrofuran	Cyclohexanol	Chlorocyclohexanol	Cyclohexanone	Dimethylisopropylnaphthalene	Trichloropropane(s)	Cyclohexanone
Reporting Limit	370	370	370	370	370	370	370	370	370	370	370	370	-	-	-	-	-	-	-
Trenches																			
CAN-97-13-99[b]	0-2	<	<	11JX	<	11JX	<	<	8.4J	9.4J	7.9J	<		380					
CAN-97-15-S	0-2	730@	970@	1000@	270J	890@	<	780@	1100@	540@	970@	120JB							
CAN-97-17-S	0-2	18J	180J	180J	<	180J	22J	120J	33J	45J	120J	1300@							
Soil Borings (0-11 ft)																			
CAN-97-10-02	4-6	<	<	<	<	<	<	<	<	<	<	<				290			
CAN-97-11-01	0-2	70J	86J	200JX	58J	200JX	<	94J	79J	32J	79J	230JB					190		
CAN-97-11-02	4-6	<	<	<	<	<	<	<	<	<	<	530B@							
CAN-97-3B-I	4-6	<	<	<	<	<	<	<	<	<	<	<						190	
CAN-97-4A-S	0-2	<	<	<	<	<	<	<	<	<	<	<				180			
CAN-97-4B-06	8-10	<	<	<	<	<	<	<	<	<	<	<						280	
CAN-97-4B-S	0-2	<	<	<	<	<	<	<	<	<	<	<		280					
CAN-97-8A-06	8-10	<	<	<	<	<	<	<	<	<	<	48J			180	180		260	
CAN-97-8A-S	0-2	<	<	<	<	<	<	<	<	<	<	<				140			
CAN-97-8B-01	4-6	<	<	<	<	<	<	<	<	<	<	<						140	
CAN-97-BG-01	0-2	69J	<	<	<	<	<	96J	290J	430@	270J	92J							
CAN-97-BG-02	4-6	<	<	<	<	<<	<	<	<	<	<	<			260			780	
CAN-97-BG-03	9-11	<	<	<	<	<	<	<	<	<	<	<		220					

Table 4-6

(Continued)

Sample ID	Depth ft BLS	SVOCs (SW8270), µg/kg											TICs						
		Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Butylbenzylphthalate	Chrysene	Fluoranthene	Phenanthrene	Pyrene	bis(2-Ethylhexyl)phthalate	C4-Tetrahydrofuran	Cyclohexanol	Chlorocyclohexanol	Cyclohexanone	Dimethylisopropylnaphthalene	Trichloropropane(G)	Cyclohexanone
Reporting Limit		370	370	370	370	370	370	370	370	370	370	370	-	-	-	-	-	-	-
Soil Borings (>11 ft)																			
CAN-97-09-06	24-26	<	<	<	<	<	<	<	<	<	<	160J	210	280		140			
CAN-97-09-99*	24-26	<	<	<	<	<	<	<	<	<	<	160J	240	350				320	
CAN-97-10-12	54-56	<	<	<	<	<	<	<	<	<	<	<				170			
CAN-97-14-12	54-56	<	<	<	<	<	<	<	<	<	<	<						240	
CAN-97-3A-S	15-17	<*	<*	<*	<*	<*	<*	<*	<*	<*	<*	6800JB				5800			
CAN-97-3C-02	18-20	<	<	<	<	<	<	<	<	<	<	<						600	
CAN-97-3C-03	23-25	<	<	<	<	<	<	<	<	<	<	<		360		220			
CAN-97-3C-04	28-30	<	<	<	<	<	<	<	<	<	<	29J		180					
CAN-97-3C-05	33-35	<	<	<	<	<	<	<	<	<	<	<		340		150			
CAN-97-3C-06	38-40	<	<	<	<	<	<	<	<	<	<	<		370		190			
CAN-97-3C-99*	38-40	<	<	<	<	<	<	<	<	<	<	<				180			
CAN-97-3C-07	43-45	<	<	<	<	<	<	<	<	<	<	<						480	
CAN-97-3C-11	63-65	<	<	<	<	<	<	<	<	<	<	<						420	
CAN-97-3C-12	68-70	<	<	<	<	<	<	<	<	<	<	<				280		390	
CAN-97-3C-13	71-73	<	<	<	<	<	<	<	<	<	<	<		280		180			
CAN-97-8B-03	14-16	<	<	<	<	<	<	<	<	<	<	<						150	
CAN-97-8B-04	19-21	<	<	<	<	<	<	<	<	<	<	5300							
CAN-97-8B-06	29-31	<	<	<	<	<	<	<	<	<	<	<		780	590	160		190	

Table 4-6

(Continued)

Sample ID	Depth ft BLS	SVOCs (SW8270), µg/kg											TICs						
		Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Butylbenzylphthalate	Chrysene	Fluoranthene	Phenanthrene	Pyrene	bis(2-Ethylhexyl)phthalate	C4-Tetrahydrofuran	Cyclohexenol	Chlorocyclohexenol	Cyclohexenone	Dimethylisopropylnaphthalene	Trichloropropene(s)	Cyclohexanone
Reporting Limit	370	370	370	370	370	370	370	370	370	370	370	370	-	-	-	-	-	-	-
CAN-97-8B-07	34-36	<	<	<	<	<	<	<	<	<	<	<						390	
CAN-97-8B-08	39-41	<	<	<	<	<	<	<	<	<	<	<		600		180		250	
CAN-97-8B-09	44-46	<	<	<	<	<	<	<	<	<	<	<						170	
CAN-97-8B-10	49-51	<	<	<	<	<	<	<	<	<	<	<		240				180	140
CAN-97-8B-12	59-61	<	<	<	<	<	<	<	<	<	<	28J							
CAN-97-8B-99[4]	59-61	<	<	<	<	<	<	<	<	<	<	<						340	
CAN-97-8B-13	64-66	<	<	<	<	<	<	<	<	<	<	<		950				140	
CAN-97-BG-04	17-19	<	<	<	<	<	<	<	<	<	<	<						250	
CAN-97-BG-05	19-21	<	<	<	<	<	<	<	<	<	<	480@		180				880	
CAN-97-BG-07	32-34	<	<	<	<	<	<	<	<	<	<	<						730	
CAN-97-BG-08	34-36	<	<	<	<	<	<	<	<	<	<	<						780	
CAN-97-BG-09	39-41	<	<	<	<	<	<	<	<	<	<	<						720	
CAN-97-BG-10	44-46	<	<	<	<	<	<	<	<	<	<	32J		250				470	
CAN-97-BG-11	51-53	<	<	<	<	<	<	<	<	<	<	220J		170				850	
CAN-97-BG-12	56-58	<	<	<	<	<	<	<	<	<	<	<						650	

Table 4-6

(Continued)

@ Result is less than five times the reporting limit.
B Analyte detected in blank.
J Estimated results is less than reporting limit.
X Benzo(b)fluoranthene and benzo(k)fluoranthene coelute. The result reported is the combined total of the two compounds.
< Compound was not detected in the sample at the method reporting limit. All compounds detected between the instrument detection limit and the method reporting are reported and "J-flagged."

[a] Field duplicate of CAN-97-09-06
[b] Field duplicate of CAN-97-13-S
[c] Field duplicate of CAN-97-3C-06
[d] Field duplicate of CAN-97-8B-12
[e] Detection of sample for high concentrations of cyclohexenone (TIC) resulted in a reporting limit of 12000 $\mu g/kg$ for this sample.

Note: Only samples and analytes with results greater than the detection limit are included in this table. Complete results are in Appendix __. The results for tentatively identified compounds (TICs) are semi-quantitative and are listed only when a TIC is detected in a sample; reporting limits are not available for TICs.

Table 4-7

TPH, Chlorinated Herbicides, and Volatile Organic Compounds Found in Soil Samples at Landfill No. 25, 1992 CAFB, Clovis, New Mexico

Sample ID	Depth ft BLS	TRPH (9071/ 418.1) mg/kg	TPH (8015 MB and 8015 MP) (µg/kg)		Herbicides (8150) (µg/kg)					VOCs (8240) (µg/kg)					VOC TICs				
			Diesel	Gasoline	2,4,5-T	2,4,5-TP	2,4-DB	Dichloroprop	MCPP	Acetone	Benzene	Methylene chloride	Toluene	Xylenes	Ethyl acetate	Decanal	Methyl acetate	Nonanal	2-Ethylhexyl acetate
Reporting Limit		29		5800	7.8	6.6	36	25	7500	120	5.9	5.9	5.9	5.9	–	–	–	–	–
Trenches																			
CAN-97-12-06	5-7	<	21000GB@	<	<	<	<	<	<	<	<	<	<	<					
CAN-97-12-I	4-6	35@								<	<	<	<	<					
CAN-97-12-S	0-2	67@								<	<	32	2.4J	<					
CAN-97-13-I	4-6	<	18000GB@	<	0.88J	2.9J	<	<	2000J	<	<	<	<	<					
CAN-97-13-S	0-2	62@								<	2.7J	11@	37	2.6J					
CAN-97-13-99[b]	0-2	93@								34J	3.8J	7.1@	36	2.6J					
CAN-97-15-S	0-2	1600	120000G@	5000G@	<	<	34G@	17J	<	<	6.7@	6.3@	79	3.6J					
CAN-97-16-06	5-7	<	15000GB@	<	<	<	<	11J	<	<	<	<	<	<					
CAN-97-16-I	4-6	32@								<	<	<	<	<					
CAN-97-16-S	0-2	75@								120@	<	100	68	4.9J					
CAN-97-16-99[e]	0-2	46@								<	<	<	<	<					
CAN-97-17-06	6-8	47@								<	<	<	<	<					
CAN-97-17-I	4-6	100@	13000GB@	<	<	2.1J	9.4J	18J	<	45J	<	<	1.1J	<					
CAN-97-17-S	0-2	9900								30J	2J	86	7.8@	<					
CAN-97-17-99[e]	6-8	42@								<	<	<	<	<					
CAN-97-18-S	0-2	110@	17000GB@	3000J	9.6G@	17G@	<	190G	<	<	<	6.6@	25	1.4J					
CAN-97-19-06	5-7	56@	100000G@	<	<	13G@	5.6J	16J	<	<	<	<	<	<					
CAN-97-19-I	4-6	180								<	<	<	0.79J	<					
CAN-97-19-S	0-2	400								<	2.7J	43	21@	<					
CAN-97-19-99[f]	0-2	340								16J	3.1J	36	44	3.1J					

Table 4-7

(Continued)

Sample ID	Depth ft BLS	TRPH (9071/418.1) mg/kg	TPH (8015 ME and 8015 MP) (µg/kg)		Herbicides (8150) (µg/kg)					VOCs (8240) (µg/kg)					VOC TICs				
			Diesel	Gasoline	2,4,5-T	2,4,5-TP	2,4-DB	Dichloroprop	MCPP	Acetone	Benzene	Methylene chloride	Toluene	Xylenes	Ethyl acetate	Decanal	Methyl acetate	Nonanal	2-Ethylhexyl acetate
Reporting Limit		25		5800	7.8	6.6	36	25	7500	120	5.9	5.9	5.9	5.9	–	–	–	–	–
CAN-97-20-I	4-6	33@	19000GB@	<	<	4.5J	4.8J	<	<	<	<	<	<	<					
CAN-97-20-S	0-2	610								31J	2.8J	<	100	<					
CAN-97-21-S	0-2	25@	33000GB@	5400G@	3.7J	<	12J	<	<	<	8.2@	74	220	25					
Soil Borings (0-11 ft)																			
CAN-97-09-01	0-2	27@								<	<	<	<	<					
CAN-97-09-03	9-11	<	6800GB@	<	<	<	<	<	520J	<	<	3.4J	1J	<					
CAN-97-10-01	0-2	48@								<	<	4.9J	4.7J	<					
CAN-97-10-03	9-11	<	7700GB@	<	<	<	<	3.2J	<	<	<	<	0.63J	<					
CAN-97-11-01	0-2	160								<	<	<	5.2J	<					
CAN-97-11-02	4-6	<	12000GB	<	<	<	<	6.6J	<	<	<	<	5.2J	<					
CAN-97-14-01	0-2	52@								<	<	<	30	4.1J					
CAN-97-14-02	4-6	<	8700GB@	<	<	<	<	3.8J	<	<	<	<	<	<					
CAN-97-14-99[e]	4-6	<	5800GB@	<	<	<	<	<	<	<	<	<	<	<					
CAN-97-2A-I	4-6	42@	5400J	<	<	<	<	<	<	180@	<	5.3J	<	<					
CAN-97-2A-S	0-2	1300					<			<	<	8.8@	4.1J	1.2J					
CAN-97-2B-I	4-6	29@								38J	<	<	<	<					
CAN-97-2B-S	0-2	2500	49000J	<	<	<	<	4J	<	<	<	18@	2.3J	<					
CAN-97-2B-99[e]	4-6	32@								<	<	<	<	<					
CAN-97-3B-06	8-10	31@								<	<	<	<	<	42				
CAN-97-3B-I	4-6	110@								<	<	2.9J	0.61J	<				9.3	
CAN-97-3B-S	0-2	34@	6900GB@	<	<	<	<	<	<	<	<	4.7J	0.4J	<					
CAN-97-4A-I	4-6	<	3700J	<	<	<	<	<	<	780	<	<	<	<					
CAN-97-4B-06	8-10	38@								<	<	<	<	<					

Table 4-7

(Continued)

Sample ID	Depth ft BLS	TRPH (9071/418.1) mg/kg	TPH (8015 ME and 8015 MP) (µg/kg)		Herbicides (8150) (µg/kg)					VOCs (8240) (µg/kg)					VOC TICs				
			Diesel	Gasoline	2,4,5-T	2,4,5-TP	2,4-DB	Dichloroprop	MCPP	Acetone	Benzene	Methylene chloride	Toluene	Xylenes	Ethyl acetate	Decanal	Methyl acetate	Nonanal	2-Ethylhexyl acetate
Reporting Limit		29		5800	7.8	6.6	36	25	7500	120	5.9	5.9	5.9	5.9	–	–	–	–	–
CAN-97-4B-I	4-6	29@	7200GB@	<	<	<	<	2.8J	<	<	<	<	0.18J	<					
CAN-97-4B-S	0-2	85@								<	<	<	3.5J	1.2J					
CAN-97-8A-06	8-10	30@								<	<	<	<	<					
CAN-97-8A-I	4-6	39@	4300J	<	<	<	<	<	<	150@	<	<	<	<					
CAN-97-8A-S	0-2	87@								<	<	<	5.2J	1.7J					
CAN-97-BG-01	0-2	1700	33000GB@	<	<	<	<	10J	680J	<	<	<	3.7J	<					
CAN-97-BG-99[1]	0-2	1600	36000GB@	<	<	4.9J	<	<	5800J	<	<	<	8.8@	0.59J					
Soil Borings (>11 ft)																			
CAN-97-09-05	19-21	<								<	<	3.7J	1.7J	<	17				
CAN-97-09-06	24-26	<								<	<	<	<	<	7.6				
CAN-97-09-07	29-31	<	6100GB@	<	<	<	<	12J	<	<	<	<	<	<					
CAN-97-09-08	34-36	<								16J	<	<	<	<		5.4		6.4	
CAN-97-09-09	39-41	<	5000J	<	<	<	<	14J	<	10J	<	7.9@	4.2J	<	27				
CAN-97-09-10	44-46	<								<	<	6.8@	15@	<	87		13		
CAN-97-09-12	54-56	<								<	<	<	1J	<	8.4				
CAN-97-09-13	59-61	<								<	<	3.5J	0.73J	<	5				
CAN-97-10-05	19-21	<								<	<	<	<	<	12				
CAN-97-10-08	34-36	<	8600GB@	<	<	<	<	<	<	<	0.85J	<	0.8J	1.4J	9.9				
CAN-97-10-09	39-41	<								<	<	<	1.2J	<	6.6				
CAN-97-10-10	44-46	<								97J	1.6J	<	1.9J	<	8.2				
CAN-97-10-11	49-51	<								<	<	<	<	<	10				5
CAN-97-10-12	54-56	<								<	<	<	<	<	5.4				
CAN-97-11-04	14-16	30@	13000GB@	<	<	<	<	3.7J	<	<	<	<	11@	<	35				

Table 4-7

(Continued)

Sample ID	Depth ft BLS	TRPH (9071/418.1) mg/kg	TPH (8015 ME and 8015 MP) (µg/kg)		Herbicides (8150) (µg/kg)					VOCs (8240) (µg/kg)					VOC TICs				
			Diesel	Gasoline	2,4,5-T	2,4,5-TP	2,4-DB	Dichloroprop	MCPP	Acetone	Benzene	Methylene chloride	Toluene	Xylenes	Ethyl acetate	Decanal	Methyl acetate	Nonanal	2-Ethylhexyl acetate
Reporting Limit		29		5800	7.8	6.6	36	25	7500	120	5.9	5.9	5.9	5.9	–	–	–	–	–
CAN-97-11-05	19-21	<								<	<	<	1J	<	18				
CAN-97-11-06	24-26	<								<	<	<	0.97J	<	14				
CAN-97-11-08	34-36	<								<	<	<	5.9@	<	29		9.5		
CAN-97-11-09	39-41	<	7600GB@	<	<	<	<	3.3J	<	<	<	<	<	<	21				
CAN-97-11-99*	39-41	<	6400GB@	<	<	<	<	4.2J	<	<	<	<	1.6J	<	38		8.1		
CAN-97-11-10	46-48	<								<	<	<	5.7@	<	48				
CAN-97-11-11	51-53	<								<	<	<	0.98J	<	11		9.2		
CAN-97-11-12	54-56	<								<	<	<	4.4J	<	110		8.4		
CAN-97-11-13	59-61	<								<	<	<	0.97J	<	5.9		7.4		
CAN-97-14-04	14-16	<								<	<	<	<	<	7.8				
CAN-97-14-06	24-26	<	9400GB@	<	<	<	<	4.2J	<	26J	<	<	<	<	8.6				
CAN-97-14-07	29-31	<								25J	<	<	<	<	5.2				
CAN-97-14-08	34-36	<	6900GB@	<	<	<	<	3.9J	<	<	<	<	<	<	16				
CAN-97-14-09	39-41	<								<	<	<	<	<	5.9				
CAN-97-14-10	44-46	<								<	<	<	<	<	5.7				
CAN-97-14-11	49-51	<								<	<	<	0.97J	<	66				
CAN-97-14-12	54-56	<								<	<	<	2.4J	<	58				
CAN-97-14-13	59-61	37@								<	<	<	4.5J	<	23				
CAN-97-3A-06	21-25	<	5400J		<	<	<	21J	<	100J	<	9.5@	9.2@	2.8J					
CAN-97-3A-I	19-21	<	4800J		<	<	<	17J	<	<	<	<	<	<		7.8		7.8	
CAN-97-3A-S	15-17	330	5300J	<	<	<	<	<	<	<	<	<	1.2J	<	40				4.6
CAN-97-3C-01	12-14	69@	44000GB	<	<	22G@	<	49G@	9300G@	14J	<	35	1.9J	<					
CAN-97-3C-03	23-25	<								<	<	<	<	<		8.8		22	

Table 4-7

(Continued)

Sample ID	Depth ft BLS	TRPH (9071/418.1) mg/kg	TPH (8015 ME and 8015 MP) (µg/kg)		Herbicides (8150) (µg/kg)					VOCs (8240) (µg/kg)					VOC TICs				
			Diesel	Gasoline	2,4,5-T	2,4,5-TP	2,4-DB	Dichloroprop	MCPP	Acetone	Benzene	Methylene chloride	Toluene	Xylenes	Ethyl acetate	Decanal	Methyl acetate	Nonanal	2-Ethylhexyl acetate
Reporting Limit		29		5800	7.8	6.6	36	25	7500	120	5.9	5.9	5.9	5.9	–	–	–	–	–
CAN-97-3C-04	28-30	<	16000GB@	<	<	<	<	180G	<	<	<	<	<	<		13		23	
CAN-97-3C-05	33-35	49@								<	<	8.8@	<	<					
CAN-97-3C-06	38-40	<	19000GB@	<	<	<	<	670G	<	<	<	4.4J	<	<					
CAN-97-3C-99[h]	38-40	<	24000GB@	<	<	<	<	<	<	<	<	<	<	<		6.7		5.6	
CAN-97-3C-08	48-50	<								<	<	<	<	<				5.6	
CAN-97-3C-09	53-55	<								<	<	<	<	<		9		9	
CAN-97-3C-10	58-60	<								<	<	<	<	<	78	8.6		11	
CAN-97-3C-11	63-65	<								<	<	<	<	<	31	7.3		7.3	
CAN-97-3C-12	68-70	<								<	<	<	<	<	7.4	6.3		8.4	
CAN-97-3C-13	71-73	<								<	<	<	<	<		5.3			
CAN-97-8B-03	14-16	33@	18000GB@	<	<	<	<	3.2J	<	9.7J	<	<	<	<					
CAN-97-8B-04	19-21	<	7100GB@		<	<	<	5.6J	<	<	<	<	<	<	41				
CAN-97-8B-05	24-26	51@								<	<	2.7J	<	<	30				
CAN-97-8B-06	29-31	35@								<	<	<	<	<	17				6.4
CAN-97-8B-07	34-36	<	21000GB@	<	<	<	<	250G	<	<	<	<	<	<	46				
CAN-97-8B-08	39-41	31@								<	<	<	<	<	16				
CAN-97-8B-09	44-46	40@								<	<	<	<	<	10				
CAN-97-8B-10	49-51	38@								<	<	<	<	<	42				
CAN-97-8B-11	54-56	29@	7200GB@	<	<	<	<	4.7J	<	<	<	<	<	<	71				
CAN-97-8B-12	59-61	<								<	<	<	<	<		8.3		7.1	
CAN-97-8B-99[i]	59-61	<								<	<	<	<	<		9.2		7.1	
CAN-97-BG-05	19-21	<								<	<	2.4J	0.28J	0.27J	7.1				
CAN-97-BG-07	32-34	<	7900GB@	<	<	<	<	<	<	<	1.6J	4.1J	2J	7.9@					

Table 4-7

(Continued)

Sample ID	Depth ft BLS	TRPH (9071/ 418.1) mg/kg	TPH (8015 ME and 8015 MP) (µg/kg)		Herbicides (8150) (µg/kg)					VOCs (8240) (µg/kg)					VOC TICs				
			Diesel	Gasoline	2,4,5-T	2,4,5-TP	2,4-DB	Dichloroprop	MCPP	Acetone	Benzene	Methylene chloride	Toluene	Xylenes	Ethyl acetate	Decanal	Methyl acetate	Nonanal	2-Ethylhexyl acetate
Reporting Limit		29		5800	7.8	6.6	36	25	7500	120	5.9	5.9	5.9	5.9	–	–	–	–	–
CAN-97-BG-08	34-36	<	6200GB@	<	<	<	<	<	<	<	<	<	0.72J	0.81J	15				
CAN-97-BG-09	39-41	<								<	<	<	<	<	10				
CAN-97-BG-10	44-46	<								<	<	<	<	<	6.4				
CAN-97-BG-11	51-53	<								<	<	<	<	<	11		4.7		
CAN-97-BG-12	56-58	<								<	<	<	2.8J	<	29		4.9		
CAN-97-BG-13	59-61	<								<	<	<	0.83J	<	11		5.4		

@ Result is less than five times reporting limit.
B Analyte detected in blank.
C Presence and concentration of analyte confirmed by second column analysis.
G (Herbicides) Presence of analyte confirmed by second column analysis but quantitation is estimated due to matrix interferences. (Diesel) Result does not match the characteristic diesel pattern but elutes in the retention time window, so is quantified as diesel.
J Estimated result is less than reporting limit.
< Compound was not detected in the sample at the reporting limit. All compounds detected between the instrument detection limit and the reporting limit are reported and "J-flagged."

[a] Field duplicate of CAN-97-11-09
[b] Field duplicate of CAN-97-13-S
[c] Field duplicate of CAN-97-14-02
[d] Field duplicate of CAN-97-16-I
[e] Field duplicate of CAN-97-17-06
[f] Field duplicate of CAN-97-19-S
[g] Field duplicate of CAN-97-2B-I
[h] Field duplicate of CAN-97-3C-06
[i] Field duplicate of CAN-97-8B-12
[j] Field duplicate of CAN-97-BG-01

Note: Only samples and analytes with at least one result greater than the reporting limit are included in this table. Complete results are in Appendix B. The results for tentatively identified compounds (TICs) are semi-quantitative and are listed only when a TIC is detected in a sample. Reporting limits are not available for TICs.

containing another target organic compound at concentrations above the method reporting limit. The B-flag indicates that the compound was also detected in the method blank associated with the sample. Sample concentrations have not been corrected for the blank concentrations. These results will be discussed in the following subsections. A detailed listing of these results is presented in Appendix B, Tables B-1 and B-2.

The mass spectral analyses of samples for VOCs and SVOCs result in the identification and quantitation of compounds given in the Target Compound List (TCL). Sometimes the mass spectra indicate the presence of additional organic compounds that are not on the TCL. These spectra are compared to a mass spectra library, and the compounds are tentatively identified based on similarities to the library spectra. These compounds are called tentatively identified compounds (TICs), and the assigned identity of the compound is, in most cases, highly uncertain. When a tentative identification cannot be made the compound is labeled as an unknown.

SW-846 provides procedures to identify and estimate the concentration of TICs. These estimates, however, are highly uncertain and could be orders of magnitude higher or lower than the actual concentration. When evaluating TIC data, it is important to note that the assigned identity may be incorrect and that the quantitation is likely to be inaccurate. Therefore, both the identification of TICs and their quantitation are highly uncertain and should be evaluated accordingly. TICs are listed in the data tables only when detected in a sample. Reporting limits are not available for TICs.

4.4.1 Organochlorine Pesticides and PCBs (SW8080)

Organochlorine pesticides were detected in 91 of the 139 field samples from Landfill No. 25. These included 4,4'-DDD, 4,4'-DDE, 4,4'-DDT, aldrin, chlordane, dieldrin, endosulfan, endrin, heptachlor, heptachlor epoxide, alpha-BHC, beta-BHC, delta-BHC, and gamma-BHC. No PCBs were detected in these samples. Table 4-5 lists

only the samples found to contain one or more of the organochlorine pesticides detected above the reporting limit in a Landfill No. 25 sample. A G-flag on this data indicates that the second column analyses confirms the presence of the compound but that the concentration is estimated due to matrix interferences.

Trenches

The most prevalent organochlorine pesticides detected in the surface rubble (0 to 2 feet) samples from the trenches were 4,4'-DDE, 4,4'-DDD, and 4,4'-DDT. The maximum concentration of these compounds were found in samples CAN97-20-S (9.9 μg/kg 4,4'-DDD), CAN97-16-99 (12 μg/kg 4,4'-DDE), and CAN97-15-S (27 μg/kg 4,4'-DDT). The rubble/native soil interface samples contained up to 0.86 μg/kg 4,4'-DDD (CAN97-19-I), 12 μg/kg 4,4'-DDE (CAN97-16-I), and 9.2 μg/kg 4,4'-DDT (CAN97-19-I). Chlordane was also present in sample CAN97-19-I (10 μg/kg). The 6 to 8 feet BNS trench sample CAN97-19-06 contained 0.31 μg/kg 4,4'-DDD, 17 μg/kg 4,4'-DDE, 8.5 μg/kg 4,4'-DDT, and 17 μg/kg chlordane. The trench samples also contained dieldrin, endosulfan, endrin, heptachlor, heptachlor epoxide, and gamma-BHC. Each of these compounds were present at concentrations less than five times the method reporting limits for these samples.

Soil Boring Samples (0 to 11 feet BLS)

Chlordane, 4,4'-DDE, and 4,4'-DDT were the only target compounds present in concentrations greater than five times the method reporting limit in the soil boring samples from the 0 to 2, 4 to 6, and 8 to 10 feet depth intervals. One or more of these were present in four surface (0 to 2 feet) boring samples: CAN97-10-01 with 220 μg/kg 4,4'-DDE, 110 μg/kg 4,4'-DDT; CAN97-09-01 containing 20 μg/kg 4,4'-DDE, 10 μg/kg 4,4'-DDT, and 12 μg/kg chlordane; CAN97-8A-S with 4,4'-DDE; and CAN97-2A-2 containing 37 μg/kg 4,4'-DDT. Two samples from the 4 to 6 feet interval also exceeded these levels: CAN97-8A-I with 17 μg/kg 4,4'-DDE and CAN97-8B-01 which contained 16

μg/kg 4,4'-DDE, 41 μg/kg 4,4'-DDT, and 9.4 μg/kg chlordane. Samples from the 8 to 10 feet range did not contain any organochlorine pesticides at concentrations greater than five times the method reporting limits.

Soil Boring Samples (deeper than 11 feet BLS)

Only four organochlorine pesticides were detected at concentrations greater than five times the reporting limit in the deep soil boring samples. These include 4,4'-DDT (3 μg/kg in sample CAN97-9-10, 44 to 46 feet BLS), dieldrin (9.2 μg/kg in CAN97-3C-01, 12 to 14 feet BLS), gamma-BHC (7.5 μg/kg in CAN97-3C-01, 12 to 14 feet BLS), and beta-BHC. Beta-BHC was found in samples CAN97-3C-02 (18-20 feet BLS), CAN97-3C-04 (28-30 feet BLS), CAN97-3C-99 (duplicate of 38 to 40 feet BLS), CAN97-3C-08 (48 to 50 feet BLS), and CAN97-3C-09 (53 to 55 feet BLS) at concentrations up to 12 μg/kg. The dieldrin, beta-BHC, and gamma-BHC data is flagged with a G, indicating an estimated value due to matrix interferences.

4.4.2 Semivolatile Organic Compounds (SW8270)

Semivolatile organic compounds (SVOCs) results for samples with at least one or more of the target analytes detected at concentrations above the method reporting limit are listed in Table 4-6. Target SVOCs found in the Landfill No. 25 samples include benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, fluoranthene, phenanthrene, pyrene, butyulbenzylphthalate, and bis(2-ethylhexyl)phthalate. In addition, seven tentatively identified compounds (TICs) were detected in these samples including; tetrahydrofuran, cyclohexenol, chlorocyclohexenol, cyclohexenone, dimethylisopropylnaphthalene, trichloropropene(s), and cylohexanone. The results for TICS are semiquantitative and are listed only when a TIC is detected in a sample. Reporting limits are not available for TICs.

The TICs cyclohexenol, chlorocyclohexenol, cyclohexenone may be the degradation products cyclohexanol, chlorocyclohexanol, and cyclohexanone due to weathering. Tetrahydrofuran, cyclohexanol, chlorocyclohexanol, trichloropropene(s), and cyclohexanone are all solvents which have historically been used in paint and varnishes, tar and grease removers, or as pesticide solvents. Historical uses for these compounds support the possibility that they may be present at the site.

Trenches

The target SVOCs listed above were detected in the surface rubble samples from the trenches. All of these compounds were found in concentrations less than five times the method detection limits. Sample CAN97-13-99 also contained approximately 380 μg/kg cyclohexenol, a TIC. This compound was not detected in the field duplicate for this sample.

Soil Boring Samples (0 to 11 feet BLS)

The surface soil (0 to 2 feet BLS) from boring 11 and the background boring contained traces of PAHs. Three TICs were observed in the surface samples: 280 μg/kg cyclohexenol in CAN97-4B-S, 180 μg/kg dimethylisopropylnaphthalene in CAN97-11-01, and up to 180 μg/kg cyclohexenone in samples CAN97-4A-S and CAN97-8A-S. The only target analyte found in the 4 to 6 feet samples was bis(2-ethylhexyl)phthalate, which was detected in sample CAN97-11-02 at about twice the method reporting limit of 350 μg/kg. Three TICs were also found in this 4 to 6 feet BLS depth interval: 260 μg/kg chlorocyclohexenol in CAN97-BG-02, 290 μg/kg cyclohexenone in CAN97-10-02, and up to 780 μg/kg trichloropropene(s) in samples CAN97-3B-I, CAN97-8B-01, and CAN97-10-02. No target SVOCs were detected above the method reporting limit in the 8 to 10 feet BLS interval samples. Sample CAN97-8A-06 did contain three TICs: chlorocyclohexenol at 180 μg/kg, cyclohexenone at 180 μg/kg, and trichloropropene(s) at 260 μg/kg.

Soil Boring Samples (deeper than 11 feet BLS)

Bis(2-ethylhexyl)phthalate was the only target SVOC detected in the deep soil boring samples. Sample CAN97-8B-04 contained 5300 μg/kg, CAN97-BG-05 contained 480 μg/kg, and all other detected concentrations were less than the method reporting limit. Several TICs were observed in these samples. Sample CAN97-09-06 and its field duplicate, CAN97-09-99, contained about 220 μg/kg tetrahydrofuran. Chlorocyclohexenol was found in sample CAN97-8B-06 at 590 μg/kg. At least ten of the deep boring samples contained up to 950 μg/kg cyclohexenol, 5800 μg/kg cyclohexenone, and 880 μg/kg trichloropropene(s). These TICs were detected most frequently at locations 8B, 3A, 3C, and BG (background).

4.4.3 Total Recoverable Petroleum Hydrocarbons (SW9071/EPA 418.1)

The Landfill No. 25 samples were analyzed for total recoverable petroleum hydrocarbons (TRPH). Table 4-7 lists the results for samples found to contain detectable quantities of TRPH.

Trenches

TRPH was detected in all nine of the trench surface rubble samples (0 to 2 feet). The surface soil samples from locations 15, 17, 19, and 20 contained 1600, 9900, 400, and 610 mg/kg TRPH, respectively. Rubble/native soil trench sample CAN97-19-I contained 180 mg/kg TRPH. In the remaining trench samples, TRPH concentrations were less than five times the method reporting limit of 29 mg/kg.

Soil Boring Samples (0 to 11 feet BLS)

The surface soil (0 to 2 feet) from locations 2A, 2B, 11, and background contained up to 1700 mg/kg TRPH. The remaining soil boring samples (down to 11

feet) had TRPH concentrations less than five times the method reporting limit of 29 mg/kg.

Soil Boring Samples (deeper than 11 feet BLS)

Sample CAN97-3A-S (15 to 17 feet BLS) contained 330 mg/kg TRPH. The remaining deep soil boring samples (deeper than 11 feet BLS) had TRPH concentrations less than two times the method reporting limit of 29 mg/kg.

Total recoverable petroleum hydrocarbons (TRPH), benzene, diesel, gasoline, toluene, xylenes, 2,4,5-T, 2,4,5-TP, 2,4-DB, dichloroprop, MCPP, acetone, and methylene chloride were detected in one or more samples from Landfill No. 25. Table 4-7 lists only samples where one or more of these compounds was detected above the reporting limit.

4.4.4 Total Petroleum Hydrocarbons (SW8015MP/SW8015ME)

Forty of the field samples were analyzed for total extractable hydrocarbons (diesel, jet fuel, and kerosene) and total purgeable hydrocarbons (gasoline and its components). Table 4-6 lists the results for samples found to contain detectable quantities of purgeable and extractable TPH. Diesel was reported above the reporting limits in all of the equipment and method blanks associated with the field samples. Nearly all of the blank and field sample results are within a factor of five of the reporting limit (results flagged with an @), which indicates that these results are due to laboratory contamination. All of the diesel results are also flagged with a G, indicating that, although the laboratory reported this compound as diesel based on its retention time, the chromatograph did not match the characteristic diesel pattern. Therefore, field results up to five times the reporting limit (or 25,000 μg/kg) may be due to laboratory contamination. Corrective actions implemented to resolve the diesel contamination issue are described in the Quality Control Summary Report (Radian, February 1993). This

issue is addressed further in a supplemental report in Appendix P. Kerosene, jet fuel, gasoline, or its components were not detected in the equipment or method blanks. Since more reliable identification and quantitation for benzene, ethylbenzene, toluene, and xylenes is available by the mass spectral method SW8240, the results for these gasoline components will be discussed with the VOC data.

Trenches

The diesel contamination reported in samples CAN97-15-S (12,000 μg/kg), CAN97-BG-01 (33,000 μg/kg), and CAN97-19-06 (100,000 μg/kg) appears to be caused by the presence of asphalt in the samples. The chromatographs for the samples did not match the characteristic diesel pattern or the pattern observed in the associated blanks. Notations in field logbooks note the presence of asphalt at these locations. All other diesel results reported for the trench samples are attributed to laboratory contamination. This issue is addressed further in the supplemental report in Appendix P. Jet fuel and kerosene were not observed in the trench samples.

A gasoline-like compound was observed at or below the method reporting limit in trench samples CAN97-15-S, CAN97-18-S, and CAN97-21-S. These gasoline results are also flagged with a G, indicating that, although the laboratory reported this compound as gasoline based on its retention time, the chromatograph did not match the characteristic gasoline pattern. This compound was not observed in the associated blanks.

Soil Boring Samples (0 to 11 feet BLS)

All the diesel concentrations reported in the soil borings samples taken from 0 to 11 feet can be attributed to laboratory contamination. Jet fuel, kerosene, and gasoline were not detected in these samples.

Soil Boring Samples (deeper than 11 feet BLS)

All the diesel concentrations reported in the soil borings samples taken from depths deeper than 11 feet BLS can be attributed to laboratory contamination as discussed in Appendix P. Jet fuel, kerosene, and gasoline were not detected in these samples.

4.4.5 Chlorinated Herbicides (SW8150)

Forty-three field samples were analyzed for chlorinated herbicides. Table 4-7 lists the results for samples found to contain detectable quantities of chlorinated herbicides. Herbicide results flagged with a G indicate that the presence of the compound was confirmed by second column analyses, but that the quantitation is estimated due to matrix interferences.

Trenches

Dichloroprop, 2,4,5-T, 2,4,5-TP, 2,4-DB, and MCPP were detected in the trench samples. Samples containing chlorinated herbicides at concentrations greater than the method reporting limits were: CAN97-18-S (0 to 2 feet) which contained 9.6 μg/kg 2,4,5-T, 17 μg/kg 2,4,5-TP, and 190 μg/kg dichloroprop; CAN97-15-S (0 to 2 feet) with 34 μg/kg 2,4-DB; and CAN97-19-06 (5 to 7 feet) with 13 μg/kg 2,4,5-TP. All of these concentrations are estimated due to matrix interferences and are within a factor of five of the method reporting limits. No other target herbicides were present at concentrations greater than the method reporting limits in the trench samples.

Soil Boring Samples (0 to 11 feet BLS)

No target herbicides were present at concentrations greater than the method reporting limits in soil boring samples taken from 0 to 11 feet.

Soil Boring Samples (deeper than 11 feet BLS)

Dichloroprop, 2,4,5-TP, and MCPP were detected at locations 3C and 8B in the soil boring samples taken from depths greater than 11 feet. Samples containing these herbicides at concentrations greater than the method reporting limits were: CAN97-3C-01 (12 to 14 feet BLS) which contained 22 μg/kg 2,4,5-TP, 49 μg/kg 2,4,dichloroprop, and 9300 μg/kg MCPP; CAN97-3C-03 (23 to 25 feet BLS) with 180 μg/kg dichloroprop; CAN97-3C-05 (33-35 feet BLS) containing 670 μg/kg dichloroprop; and CAN97-8B-07 (34 to 36 feet BLS) with 250 μg/kg dichloroprop. All of these concentrations are estimated due to matrix interferences and are within a factor of five of the method reporting limits. No other target herbicides were present at concentrations greater than the method reporting limits in the soil boring samples taken from depths greater than 11 feet BLS.

4.4.6 Volatile Organic Compounds (SW8240)

Volatile organic compounds (VOCs) results for samples with at least one or more of the target analytes detected at concentrations above the method reporting limit are listed in Table 4-7. Target VOCs found in the Landfill No. 25 samples include; acetone, benzene, methylene chloride, toluene, and xylenes. In addition, five TICs were detected in these samples including; ethyl acetate, decanal, methyl acetate, nonanal, and 2-ethylhexyl acetate. The results for TICS are semiquantitative and are listed only when a TIC is detected in a sample. Reporting limits are not available for TICs.

Ethyl acetate, methyl acetate, and 2-ethylhexyl acetate have historically been used in plastic and coatings solvents, paint removers, lacquer solvent, and resin, wax and oil solvents. The historical uses for these compounds indicate that they may be present at the site. Decanal and nonanal have been used most frequently in perfumes and flavorings. The presence of these compounds do not appear to be consistent with

typical base practices. Therefore, the identification of decanal and nonanal are questionable.

Trenches

Acetone and benzene were detected in the trench soil samples at concentrations less than two times the method detection limits. Methylene chloride was detected in the surface rubble (0 to 2 feet) from all nine trench locations. Samples CAN97-13-S (37 μg/kg), CAN97-16-S (100 μg/kg), CAN97-17-S (86 μg/kg), CAN97-19-S (43 μg/kg), and CAN97-21-S (74 μg/kg) contained methylene chloride at concentrations exceeding five times the detection limit. With the exception of trench location 12, toluene was found in all the surface rubble trench samples at concentrations greater than the method detection limit of 5.9 μg/kg. The toluene concentration in these samples ranged from 7.8 μg/kg in CAN97-17-S to 220 μg/kg in CAN97-21-S. Only trench sample CAN97-21-S (25 μg/kg) contained xylenes at a concentration greater than the method reporting limit of 5.9 μg/kg.

Rubble/native soil interface samples in these trenches did not contain any VOCs at concentrations greater than the method detection limits. VOCs were not detected in the 6 to 8 feet trench samples. No TICs were detected in the trench samples.

Soil Boring Samples (0 to 11 feet BLS)

Acetone was the only target VOC detected at a concentration greater than three times the method reporting limit in the soil boring samples taken from 0 to 11 feet BLS. Sample CAN97-4A-I (4 to 6 feet BLS) contained 780 μg/kg acetone. Acetone was not detected in the other location 4A samples taken from the 0 to 2 feet or 8 to 10 feet intervals. Ethyl acetate (about 40 μg/kg), decanal (7.8 μg/kg), nonanal (about 8.5 μg/kg), and 2-ethylhexyl acetate (4.6 μg/kg) were observed at these locations.

Soil Boring Samples (deeper than 11 feet BLS)

With the exception of 35 μg/kg methylene chloride in CAN97-3C-01 (12 to 14 feet BLS), the soil boring samples taken from intervals deeper than 11 feet did not contain any target VOCs at concentrations greater than three times the method reporting limit.

However, a number of TICs were observed in these samples. Ethyl acetate was present in samples from each of the boreholes with concentrations ranging from 5 to 110 μg/kg. The background borehole contained ethyl acetate at concentrations up to 29 μg/kg in sample CAN97-BG-12 (56-58 feet BLS). Decanal was found in CAN97-09-08 (34-36 feet BLS) at 5.4 μg/kg; in the 3C borehole at depths ranging from 23 to 73 feet and concentrations ranging from 5.3 to 13 μg/kg; and in sample CAN97-8B-11 (59 to 61 feet BLS) at a concentration of about 9 μg/kg. Methyl acetate was detected in CAN97-09-10 (44-46 feet BLS); borehole 11 from 34 to 61 feet; and at the background borehole from 51 to 61 feet at concentrations ranging from 4.7 to 13 μg/kg. Nonanal was found CAN97-09-08 (34 to 36 feet BLS); borehole 3C from 23 to 70 feet; and borehole 8B from 54 to 61 feet at concentrations up to 23 μg/kg. 2-Ethylhexyl acetate was detected in only two of the deep boring samples: CAN97-10-11 (49 to 51 feet BLS) at 5 μg/kg and CAN97-8B-06 (29-31 feet BLS) at 6.4 μg/kg.

4.5 Comparison of Field Data to Soil Action Levels

The field data from the 1992 sampling efforts were compared to the soil action levels given in Appendix G; RCRA Proposed Subpart S Media Action Levels. These recommended media action levels were calculated according to the guidelines delineated in the Proposed Subpart S (40 CFR, Section 264.521) and the most current toxicological data. Action levels are not cleanup standards; rather, exceeding the media action level potentially triggers the need for a corrective measures study of a solid waste management unit.

One surface sample, CAN97-17-S, had a lead concentration of 120 mg/kg. This exceeded the soil action level of 114 mg/kg. The concentrations of all other target metals in the Landfill No. 25 samples, including those which exceeded background soil metals concentrations, were less than the proposed noncarcinogenic actions levels.

The CAFB background soil concentration for beryllium exceeds the carcinogenic soil action level listed in RCRA Subpart S, indicating that this criterion is not appropriate for the site. Nine of the Landfill No. 25 samples, containing 0.63 to 0.85 mg/kg beryllium, exceed the background soil beryllium concentration (0.62 mg/kg) established for CAFB.

Matrix spike recoveries for antimony by GFAAS indicate that those results could be biased as much as 95% low. If these results are corrected for such a bias, all antimony concentrations are still well below the action level of 32 mg/kg.

Similarly, selenium results could be biased as much as 50% low, but even when corrected for this bias, all selenium concentrations in samples are below the action level.

Eight of twenty matrix spikes for barium show very low recoveries for samples from the background as well as the affected areas. If corrected for a low bias of 95%, the five samples where barium was detected above the background UTL would all exceed the soil action level of 5,600 mg/kg. These samples contained high concentrations of calcium which interfered with the barium analyses.

All nine field samples in which thallium was detected by ICPES, plus nine more samples selected to provide information across the site at various depths, were reanalyzed for thallium by GFAAS. These samples all contained less than 1.2 mg/kg of thallium, which is below the soil action criterion of 4 mg/kg.

All organics results were below the noncarcinogenic soil action levels. Trench sample CAN97-15-S contained 970 μg/kg benzo(a)pyrene and 1000 μg/kg benzo(b)fluoranthene exceeding the carcinogenic soil action levels of 121 μ/kg and 864 μg/kg, respectively. All other target organic analytes were below the carcinogenic soil action levels.

5.0 DISCUSSION

This section discusses the results presented in Section 4.0. The discussion will follow the same format as the presentation of the results.

5.1 Site Geology and Ecology

Landfill No. 25 contains a mix of surface and subsurface rubble (Figure 1-6). The site is underlain by the Ogallala Formation that changes with depth from a well cemented sandstone with abundant caliche to an unconsolidated sand (Figures 4-2, 4-3, and 4-4). The subsurface rubble pile on the north side of the site supports an immature soil horizon which tends to disguise the subsurface rubble. Various grasses, shrubs, and trees grow from the subsurface rubble. It is possible that these trees, which are absent on the southern half of the site, are present because of increased infiltration through the less consolidated rubble. Water may pool at the rubble/native soil interface where it becomes an ample source of water for this vegetation.

The overall vegetative cover is patchy. Grasses, shrubs, and rubble cover up to 50% of the site and the rest is exposed sandy soil. Consequently, the site is moderately susceptible to erosion from wind and runoff. Runoff from the site eventually collects in Playa Lake which is located southeast of Landfill No. 25.

The Ogallala formation underlying the rubble is fine-grained and alkaline. While the caliche layers are not likely to provide a physical impedance to downward migration of chemicals, the alkaline and oxidizing conditions inhibit metal solubility, and consequently, downward migration.

5.2 Metals

Arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, manganese, mercury, molybdenum, selenium, vanadium, and zinc where all detected at concentrations exceeding the upper tolerance levels (UTL) which were calculated based on background soil concentrations (see Section 4.3). Data exceeding the UTLs are by definition significantly greater than background concentrations for that metal. On average, the highest concentration of metals was found in the top 11 feet of soil. Metals concentrations greater than twice the UTL were not detected below 11 feet. Other than one cadmium detection at 48 feet, no samples below 31 feet had metal concentrations exceeding the UTLs.

One surface sample exceeded the noncarcinogenic RCRA Proposed Subpart S Media Action Level for lead. All other target metals, including those listed above as being above background UTLs, were less than the proposed noncarcinogenic action levels.

Beryllium was the only metal detected at concentrations above the carcinogenic soil action level. However, beryllium in background samples also exceeded this level suggesting that this proposed soil action level is not appropriate for this site.

5.3 Organochlorine Pesticides and PCBs

4,4'-DDD, 4,4'-DDE, 4,4'-DDT, aldrin, chlordane, dieldrin, endosulfan, endrin, heptachlor epoxide, alpha-BHC, beta-BHC, delta-BHC, and gamma-BHC were detected in one or more of the samples collected from Landfill No. 25. No PCBs were detected at the site.

The most prevalent organochlorine pesticides detected were in the near surface samples. All detections for samples taken below 11 feet are either flagged "G" or "@" indicating matrix interference or levels close to the reporting limit.

No organochlorine pesticides were detected at concentrations exceeding either the noncarcinogenic or the carcinogenic soil action levels.

5.4 Semivolatile Organic Compounds

Eleven target SVOCs were detected in shallow soils, including nine PAHs and bis(2-ethylhexyl)phthalate. All concentrations of these compounds from the 0 to 2 foot depth interval were less than five times the reporting limit. One target SVOC (phenanthrene) was detected at twice the reporting limit in one sample from the 4 to 6 foot depth. Target SVOCs were not detected at concentrations greater than the method reporting limit from 8 to 11 feet. Below 11 feet, bis(2-ethylhexyl)phthalate was detected in boring 8B and in the background boring. No other target SVOC compounds were above method reporting limits in samples collected below 11 feet.

All target SVOC compounds are below the noncarcinogenic soil action levels. One surface sample, CAN97-15-S, exceeded the carcinogenic soil action level for benzo(a)pyrene and benzo(b)fluoranthene. No other SVOCs were found in concentrations exceeding the carcinogenic soil action levels.

The SVOC TICs, tetrahydrofuran, cyclohexanol, chlorocyclohexanol, trichloropropene, and cyclohexanone are all solvents that historically have been used in paint and varnishes, tar and grease removers, or as pesticide solvents. These compounds are tentatively identified in samples from all depth ranges. Historical uses for these compounds support the possibility that they may have been present at the site.

5.5 Total Recoverable Petroleum Hydrocarbons

TRPH concentrations are highest at the surface with a maximum concentration of 9900 mg/kg and decrease with depth. From 4 to 11 feet, TRPH concentrations are within five times the method reporting limit. Other than one sample (CAN97-3A-S), all levels below 11 feet are within twice the method reporting limit.

5.6 Total Petroleum Hydrocarbons

Three samples, one each from trenches 15, 19, and BG, had high levels of diesel that is suspected to be asphalt. All of the remaining detected concentrations can be attributed to laboratory contamination. This issue is addressed further in a supplemental report in Appendix P. No gasoline, jet fuel, or kerosene was detected.

5.7 Chlorinated Herbicides

Herbicides were at concentrations greater than five times the reporting limit in the surface samples from trenches 15 and 18, and in the 5 to 7 foot sample from trench 19. No herbicides were detected in the borings between 0 and 11 feet. Herbicides were detected in borings 3C and 8B to a depth of 40 feet, but were within the range of five times the method reporting limit. No other herbicides were found at concentrations above the method reporting limit.

No chlorinated herbicides were detected at concentrations that exceed the noncarcinogenic or carcinogenic soil action levels.

5.8 Volatile Organic Compounds

Acetone, benzene, toluene, and methylene chloride were detected in some trench surface samples. Acetone was found in the 4 to 6 foot sample from trench 8A at

a concentration less than two times the method reporting limit. VOCs were not detected above the method reporting limit in the remaining trench samples taken from 4 to 8 feet. Acetone in the 4 to 6 foot sample from borehole 4A and methylene chloride in the 12 to 14 foot sample from borehole 3C were found at concentrations above the method reporting limits. No other target VOCs were detected in the subsurface soil at concentrations greater than the method reporting limit.

VOC TICs were detected in boring samples from the northern half of the site. Ethyl acetate, nonanal, 2-ethylhexyl acetate, and methyl acetate were detected in samples down to 61 feet. No volatile TICs were detected in the trenches. No VOCs detected exceeded the noncarcinogenic or carcinogenic soil action levels.

Section Tab

6

6.0 RISK ASSESSMENT

This section of the report presents the risk assessment and receptor/pathway identification conducted to support an informed decision regarding the need for remediation at Landfill No. 25. Section 6.1 describes the process used to identify the chemicals of potential concern and presents those chemicals that are quantified for risk in this report. Section 6.2 presents an assessment of the populations potentially exposed to the chemicals of potential concern and includes a conceptual site model. Section 6.3 identifies exposure pathways and scenarios. A toxicity assessment of the chemicals of potential concern is presented in Section 6.4 (toxicological profiles are presented in Appendix N). Potential health risks are described in the risk characterization presented in Section 6.5. Section 6.6 presents a qualitative environmental evaluation. Section 6.7 presents conclusions of the baseline risk assessment.

6.1 Identification of Chemicals of Potential Concern

Contaminants of potential concern for CAFB Landfill No. 25 were identified following guidance in Chapter 5 (Data Evaluation) of *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual* (Part A) (USEPA, 1989a), and the *Guidance for Data Useability in Risk Assessment* (EPA, 1992). USEPA guidance stipulates the following nine-step data evaluation process to organize the data into a form appropriate for a comprehensive risk assessment:

1. Gather all data available from the site investigation and sort by medium;
2. Evaluate the analytical methods used;
3. Evaluate the quality of data with respect to sample quantitation limits;
4. Evaluate the quality of data with respect to qualifiers and codes;
5. Evaluate the data with respect to blanks;

6. Evaluate tentatively identified compounds;

7. Compare potential site-related contamination with background.

8. Develop a set of data for use in the risk assessment; and

9. If appropriate, further limit the number of chemicals to be carried through the risk assessment.

This subsection summarizes the data review process and its results.

6.1.1 Step 1: Data Available from Site Investigations

Analytical data from the 1992 RCRA Facility Investigation (RFI) performed at Landfill No. 25 have been used in this risk assessment. Additional soil data collected from the Sampling and Analysis Plan for the Concrete Rubble Pile (SWMU 97) prepared by the Tulsa District of the U.S. Army Corps of Engineers (USACE), February 1991, were reviewed and compared to soil data under the 1992 RI. Background data from pertinent IRP and RI documents summarized by Woodward-Clyde and those collected during this investigation were also reviewed. Frequency of detection and inorganic concentration ranges for each of these sampling events are presented in Table 6-1.

Between 1990 and 1991, the Tulsa District USACE conducted an environmental assessment at the north end of Landfill No. 25 to gather information on soil characteristics. The assessment focused on a concrete rubble pile and the underlying soil. Nine trenches were excavated during this assessment. Four trenches were excavated through the rubble and extended five feet into undisturbed soil. Two soil samples were collected from each of the trenches at depths between 0 and 1 foot and 4 and 5 feet. Figure 2-1 in Section 2.2 of this report shows the location of soil borings and excavation trenches. NDRC Laboratories analyzed the samples for organic and inorganic contaminants using standard USEPA methods. Benzidine and bis(2-

Table 6-1

Concentration Ranges of Soil Data Collected for Landfill No. 25, CAFB, Clovis, New Mexico

Analytes	1990-91 Data [a]		1992 Data [b]		Background Concentrations [c]	
	Frequency of Detection	Concentration Ranges (mg/kg)	Frequency of Detection	Concentration Ranges (mg/kg)	Frequency of Detection	Concentration Ranges (mg/kg)
Arsenic	8/8	1.7 - 3.0	122/125	0.23 - 9.0	49/49	0.63 - 28
Barium	8/8	63.9 - 705	125/126	7.3 - 1700	52/52	7.6 - 1200
Cadmium	8/8	1.8 - 45.5	100/126	0.39 - 1.2	21/38	0.065 - 4.2
Cobalt	8/8	3.1 - 6.7	124/126	0.94 - 5.0	53/53	400 - 22,000
Chromium	8/8	5.9 - 15.4	125/126	2.0 - 17	42/45	1.6 - 15.4
Copper	8/8	3.3 - 20.2	125/129	1.4 - 13	24/40	0.69 - 4.9
Mercury	7/8	0.01 - 0.65	56/130	0.098	45/45	17 - 216
Manganese	8/8	57 - 198	126/127	20 - 460	11/29	0.0235 - 0.062
Molybdenum	6/8	28 - 106	102/130	0.0023 - 1.1	12/12	0.075 - 0.505
Nickel	8/8	7.1 - 13.1	125/126	1.4 - 13	44/45	1.3 - 12.5
Selenium	6/8	0.3 - 2.7	74/129	0.03 - 1.9	14/35	0.0016 - 123.9
Vanadium	8/8	12.3 - 27.9	127/127	5.0 - 39	45/45	5 - 28.3
Zinc	8/8	14.6 - 31.6	126/126	3.6 - 130	27/43	4 - 27.5

[a] On-site data taken from the 1990 - 1991 environmental assessment of the concrete rubble pile (USACE, 1991).

[b] On-site data collected during the 1992 RFI (Radian, 1992).

[c] On-site background data compiled from the 1992 RFI (Radian, 1992) and other IRP projects (Woodward-Clyde, 1993). Statistical analysis was performed to compare background data to site data, see Appendix I.

ethylhexyl) phthalate were detected once, but no other organic contaminants were detected or identified. Benzidine was not detected during the 1992 RFI and bis(2-ethylhexyl) phthalate was eliminated (from the 1992 results) due to contamination. Arsenic, barium, cadmium, cobalt, chromium, copper, mercury, manganese, molybdenum, nickel, selenium, vanadium, and zinc were detected in the surface and subsurface soils during the 1990-91 environmental assessment. Sampling procedures and analytical methods are comparable to those used in the 1992 RFI. Results from the 1990-91 environmental analyses were not included in this risk assessment, because QA/QC data were not available for review. However, considering the small number of samples collected in 1990-91, including the data with the 1992 data would have minimal, if any, impact on the results of the risk assessment. Additional background data were taken from a review of pertinent IRP and RI documents summarized by Woodward-Clyde Consultants (Woodward-Clyde, 1993). Data taken from this report are presented in Appendix H.

The objective of the 1992 RFI at Landfill No. 25 was to further define and confirm subsurface contamination. Field investigation activities occurred between 28 September and 18 October 1992. Soil samples were taken from 14 soil borings and 9 excavated trenches. Nine of the 14 soil borings were drilled through approximate locations of four former excavation trenches to confirm the presence of contamination previously identified in the 1990-91 environmental assessment. Eight soil borings were drilled to 60 feet below native soil (BNS) with samples collected on the surface and at five feet intervals. One of the 60 feet borings was a background boring located west of the perimeter road and north of the sewage lagoons. The other six borings were drilled to 10 feet with soil samples collected on the surface, between 4 and 6 feet, and between 8 to 10 feet. All results from the 1992 RFI were evaluated in this risk assessment. Figure 4-1 presents the sample locations.

Appendix H presents analytical data used in this risk assessment.

6.1.2 Step 2: Analytical Methods

A detailed evaluation of the analytical methods used and a Quality Assurance/Quality Control (QA/QC) evaluation of the data are presented under separate cover in the Quality Control Summary Report (QCSR) (Radian, 1993). The QA/QC evaluation of the data was a factor in choosing the list of chemicals of potential concern. A summary of the QA/QC concerns that pertain to the risk assessment are discussed below.

Total Recoverable Petroleum Hydrocarbons (TRPH)

- TRPH was detected above the reporting limit in three of seven equipment blanks. TRPH was not detected above the reporting limit (0.25 mg/L) in the method blanks. TRPH concentrations up to 0.41 mg/L may be due to incomplete decontamination of sampling equipment.

Metals

- Based on recovery of barium in matrix spike samples, reported concentrations for barium may be biased low. This is due to the high levels of calcium in the field samples; calcium interferes with the analysis of barium.
- Sixteen of 24 selenium matrix spike recoveries fell below the acceptance criteria of 75-125 percent. Reported field samples concentrations may be up to 50% low for selenium.
- Lead was detected above the reporting limit (0.003 mg/L) in four of seven equipment blanks, ranging from 0.0045 to 0.0086 mg/L. These equipment blanks are CAN-97-ER-01, CAN-97-ER-02, CAN-97-ER-03, and CAN-97-ER-04. Lead was detected above the reporting limit (0.3 mg/kg) in one method blank (0.34 mg/kg). Field samples associated with these equipment blanks may be expected to show similar background levels of lead.

Method 8015 (Diesel and Gasoline)

- A compound eluting within the diesel retention time, and reported as diesel, was detected in both equipment blanks and all eight method blanks. Although reported as diesel, the chromatographic pattern for the compound does not match the characteristic pattern for diesel. Since the chromatographic pattern for the field results match the pattern for the blank results, the contaminant listed as diesel in the report is probably due to laboratory contamination. (See Appendix P for further detail.) To provide the most conservative estimate of risk, the contaminant was included as diesel in this risk assessment.

Method 8080 (Organochlorine Pesticides and PCBs)

- Low levels of several pesticides were detected in equipment blank CAN-97-ER-03, including alpha-BHC (0.011 μg/L), 4,4'-DDD (0.025 μg/L), endrin (0.018 μg/L), heptachlor (0.078 μg/L), and heptachlor epoxide (0.015 μg/L). Delta-BHC was also detected in CAN-97-ER-05 and CAN-97-ER-02, at 0.016 and 0.015 μg/L, respectively. Aldrin was detected in CAN-97-ER-04 at 0.011 μg/L. The reporting limit is 0.01 μg/L for all associated compounds. Similar low levels of these pesticides in associated field samples may be due to outside sources of contamination.

- The following samples may be affected by method blank contamination above the reporting limit for 4,4'-DDD: CAN-97-19-99; CAN-97-19-S; CAN-97-20-S; CAN-17-S; CAN-97-4A-I; CAN-97-4A-06; CAN-97-4A-S; CAN-97-10-07; CAN-97-10-08; CAN-97-10-09; CAN-97-10-10; CAN-97-10-11; CAN-97-10-04; CAN-97-10-12; CAN-97-10-13; and CAN-97-10-02. 4,4'-DDD was detected up to 0.40 μg/kg in method blanks. The reporting limit for 4.4'-DDD is 0.33 μg/kg.

- Samples that may be affected by method blank contamination above the reporting limit for gamma-BHC include: CAN-97-2B-99; CAN-97-2B-06; CAN-97-2B-I; CAN-97-8A-I; and CAN-97-2A-I. Gamma-BHC was detected up to 0.79 μg/kg in the method blank for these samples. The reporting limit for gamma-BHC is 0.33 μg/kg.

- The following samples may be affected by method blank contamination above the reporting limit for heptachlor epoxide: CAN-97-20-06; CAN-97-16-06; CAN-97-13-06; CAN-97-4A-99; CAN-97-4A-S; CAN-97-10-01; CAN-97-10-06; and CAN-97-12-I. Heptachlor epox-

ide was detected up to 1.3 μg/kg; this amount was reported as estimated. The reporting limit for heptachlor epoxide is 0.33 μg/kg.

Method 8240 (Volatile Organics)

- Samples associated with trip blank CAN-97-TB-27 may contain methylene chloride just above the reporting limit, at or near 7.1 μg/L, due to contamination. The reporting limit for methylene chloride is 5 mg/L. These samples include: CAN-97-3A-I; CAN-97-8B-02; CAN-97-4A-I; CAN-97-09-08; CAN-97-09-01; CAN-97-8B-12; CAN-97-8B-99; CAN-97-09-07; CAN-97-09-06; CAN-97-09-99; and CAN-97-8B-07.

Method 8270 (Semivolatile Organics)

- Bis(2-ethylhexyl) phthalate was detected in equipment blank CAN-97-ER-02 above the reporting limit (10 μg/L), at 14 μg/L. Similar levels may be expected in field samples associated with this equipment blank due to contamination.

6.1.3 Step 3: Quantitation Limits

RFI data reports provide reporting limits (RLs) specific to each sample. The sample RLs take into account sample characteristics (e.g., matrix; dry weight), and analytical dilutions. RLs represent the lower bound of reliable laboratory data using multiple instruments and are the equivalent of method quantitation limits (the minimum concentration that can be measured and reported). The RL reported for each sample is the lowest reliable concentration available and is used as the sample quantitation limit (QL) for this risk assessment.

For the purpose of this risk assessment, a positive result included values at and below the RL. If a chemical was not detected in any sample, it was eliminated from the list of chemicals of potential concern. If a chemical was detected in some but not all

samples, one-half the RL was used as a proxy concentration for non-detects. Samples with an analytical result of non-detect associated with unusually high RLs were eliminated from the quantitative risk assessment. RLs were considered unusually high if the proxy concentration (one-half the RL) exceeded positive results for the same chemical in other samples.

Data associated with the chemicals to which no uncertainties are attached concerning the assigned identity of the chemical or the significance of site-related concentrations compared to background concentrations (inorganic chemicals only) are appropriate for use in the quantitative risk assessment.

6.1.4 Step 4: Data Qualifiers or Codes

Data qualifiers or codes were presented with the analytical results so that uncertainties could be identified and evaluated. Laboratory qualifier codes associated with the analytical data are described below.

All Methods

B Blank subtraction was not performed for analytes detected in associated system, method, or field blank. Use of these data in the risk assessment is discussed in Section 6.1.5.

@ Reported result was greater than the RL, but less than five times greater. The reported value was used in the risk assessment.

J The RL is higher than the reported result. The value was used in the risk assessment.

Methods 8080/8150

G Identity of analyte confirmed by second column analysis but the quantitation is estimated. Primary column result was used in the risk assessment.

Method 8015

G Result does not match the characteristic diesel pattern, but elutes in the retention time window, so was quantitated as diesel. (See Appendix P.)

Method 8270

X Benzo(b)fluoranthene co-elutes with benzo(k)fluoranthene. The recovery reported is the combined total of the two compounds. The value was used in this risk assessment.

6.1.5 Step 5: Blanks

Field and laboratory blanks were included in the analytical program to provide an indication of the introduction of contaminants into samples during collection or analysis. Positive results qualified by the presence of the analyte in associated blanks were evaluated according to USEPA guidance (USEPA, 1989a). Sample results for common laboratory contaminants (acetone, methylethyl ketone, methylene chloride, toluene, and the phthalate esters) were considered positive only if the concentration exceeded ten times the maximum amount detected in any associated blank. If the concentration of a common laboratory contaminant was less than or equal to ten times the blank concentration, the sample was considered to be contaminated. Chemicals that are not common laboratory contaminants were evaluated in the same way, but using five times the maximum blank-related concentration to distinguish between non-detects and contamination.

After eliminating samples due to blank contamination, if all results for a chemical were considered to be non-detects, that chemical was eliminated from the list of chemicals of potential concern. Appendix H lists all blank contaminated samples and their associated blanks.

6.1.6 Step 6: Tentatively Identified Compounds

The mass spectral analyses of samples for VOCs and SVOCs result in the identification and quantitation of compounds given in the Target Compound List (TCL). Sometimes the mass spectra indicate the presence of additional organic compounds that are not on the TCL. These spectra are compared to library spectra, and the compounds are tentatively identified based on similarities to the library spectra. These compounds are called tentatively identified compounds (TICs), and the assigned identity of the compound is, in most cases, highly uncertain.

The Contract Laboratory Protocol Scope of Work provides procedures to estimate the concentration of TICs. These estimates, however, are highly uncertain and could be orders of magnitude higher or lower than the actual concentration. When evaluating TIC data, it is important to note that the assigned identity may be incorrect and that the quantitation is likely to be inaccurate. Only three of the identified TICs (ethyl acetate, methyl acetate, and trichloropropene) have USEPA sanctioned toxicity values. None of the three are considered to be carcinogenic. Soil action levels (for noncarcinogenic effects) were calculated for these three TICs and compared to the highest value detected in soils at Landfill No. 25. There was at least two orders of magnitude difference between the highest detected value and the calculated soil action level for all three TICs. Therefore, no TICs were included in this risk assessment.

6.1.7 Step 7: Background Concentration Comparison

A statistical analysis was performed to compare analytical results of inorganic constituents found at Landfill No. 25 to results of inorganics found at several background sites. Background data collected during this investigation, as well as data from a Woodward Clyde document (Woodward-Clyde, 1993) were used in the analysis. The purpose of the comparison was to determine which on-site metal concentrations were significantly greater than naturally occurring metal concentrations. This comparison

provided a valid means for determining which metals to include as chemicals of potential concern. Inorganic constituents with results significantly greater than background concentrations were considered to be contaminants of potential concern.

Several statistical tests were used in the background concentration comparison of Landfill No. 25. The type of statistics used for analysis depended on distribution of the data and number of detects. The Wilcoxon rank sum test was performed on landfill and background results for aluminum, arsenic, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, mercury, molybdenum, selenium, vanadium, and zinc. Antimony, silver, and thallium were compared to background using the Poisson test. The Student's t-Test was run for nickel results. A log normal Student's t-Test was used on barium results for the background concentration comparison. A more detailed discussion of statistical methods used in this risk assessment is presented in Appendix I.

6.1.8 Steps 8 and 9: Data Set Used in the Risk Assessment

USEPA guidance (USEPA, 1989a) stipulates that the list of chemicals of potential concern include chemicals that were:

1. Positively detected in at least one sample in a given medium, including: a) chemicals with no qualifiers attached (excluding samples with unusually high RLs) and, b) chemicals with qualifiers attached that indicate known identities but unknown concentrations (e.g., J-qualified data);

2. Detected at levels significantly above levels of the same chemicals detected in associated blank samples; and

3. Detected at levels significantly above naturally occurring background levels of the same chemicals (inorganics only).

Appendix H presents all analytical data used in this risk assessment for chemicals of potential concern.

Elimination of chemicals from the risk assessment was limited due to the lack of historical documentation of Landfill No. 25 concerning types of wastes and disposal procedures. USEPA's preference is to include all chemicals that meet the three criteria described above. However, further procedures for reducing the number of chemicals included in the quantitative risk assessment are permissible under USEPA risk assessment guidelines (USEPA, 1989a). For this risk assessment, 73 chemicals met the criteria specified by USEPA. Taking this number of chemicals through the quantitative risk assessment would unnecessarily complicate the risk assessment and could distract from the dominant risks associated with Landfill No. 25. Therefore, the number of chemicals of concern were further reduced by eliminating essential nutrients and performing a concentration/ toxicity screen. This approach allowed identification of the chemicals most likely to contribute significantly to risks associated with Landfill No. 25 and focused the risk assessment on the risk drivers.

The concentration/toxicity screen used in this risk assessment is outlined in Section 5.9 of the *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual* (Part A) (USEPA, 1989a) and involved calculating a risk factor for each chemical. The risk factor was determined by multiplying the highest concentration detected for each chemical by its corresponding toxicity value (i.e., slope factor or 1/RfD). A different risk factor was calculated for carcinogenic and noncarcinogenic effects. Chemical-specific risk factors were then summed to obtain a total risk factor for carcinogenic or noncarcinogenic effects. The ratio of the risk factor for each chemical to the total risk factor approximates the relative risk for each chemical. Chemicals that were detected less than 10% of the time and contributed less than 1% of the total risk factor were eliminated from the quantitative risk assessment. Appendix H (Section 4) presents the results of the concentration/toxicity screen. Chemicals carried through the quantitative risk assessment are presented in Table 6-2. Table 6-3 lists all analytes eliminated from the quantitative risk assessment and the rationale for their elimination.

Table 6-2

Chemicals Taken Through the Quantitative Risk Assessment for Landfill No. 25 CAFB, Clovis, New Mexico

Analytes	
Organics	Inorganics
Benzene	Aluminum
Benzo(a)pyrene	Arsenic
Benzo(b)fluoranthene	Manganese
Benzo(k)fluoranthene	Thallium
Beta BHC	Vanadium
4,4'-DDE	Zinc
4,4'-DDD	
4,4'-DDT	
Diesel	
Fluoranthene	
Heptachlor epoxide	
Heptachlor	
Hydrocarbons	
MCPP	
Methylene chloride	
Pyrene	
Toluene	

Table 6-3

Analytes Eliminated From the Quantitative Risk Assessment for Landfill No. 25 CAFB, Clovis, New Mexico

Analytes	Rationale for Assessment
Organics	
Acenaphthene	Less than 1% of the total risk factor [a]
Acetone	Less than 1% of the total risk factor [a]
Acetophenone	Less than 5 times MB
Aldrin	Less than 1% of the total risk factor [a]
alpha BHC	Less than 1% of the total risk factor [a]
4-Aminobiphenyl	Less than 1% of the total risk factor [a]
Anthracene	Less than 1% of the total risk factor [a]
Benzo(a)anthracene	Less than 1% of the total risk factor [a]
Benzo(g,h,i)perylene	Less than 1% of the total risk factor [a]
Benzoic acid	Less than 5 times the EB
Bis (2-Ethylhexyl)phthalate	Less than 5 times the EB
Butylbenzyl-phthalate	Less than 1% of the total risk factor [a]
C_3-Naphthalene	Tentatively identified compound
Carbon disulfide	Less than 1% of the total risk factor [a]
Chlordane	Less than 1% of the total risk factor [a]
Chlorobenzene	Less than 1% of the total risk factor [a]
Chlorocyclohexenol	Tentatively identified compound
Chrysene	Less than 1% of the total risk factor [a]
Cyclohexenenone	Tentatively identified compound
Cyclohexenol	Tentatively identified compound
Cyclohexenol B	Tentatively identified compound
Cyclohexenone	Tentatively identified compound
Cyclohexenone B	Tentatively identified compound

[a] Chemicals were detected at a frequency of less than 10%. Approximately 0.2% and 0.6% of the total carcinogenic and noncarcinogenic risk factors, respectively, was eliminated by the concentration toxicity screen.

MB = Method blank
EB = Equipment blank
TB = Trip blank

Table 6-3
(Continued)

Analytes	Rationale for Assessment
2,4-D	Less than 1% of the total risk factor [a]
2,4-DB	Less than 1% of the total risk factor [a]
Decanal	Tentatively identified compound
Decanal B	Tentatively identified compound
delta BHC	Less than 1% of the total risk factor [a]
Dibenzo(a,h)anthracene	Less than 1% of the total risk factor [a]
Dibenzofuran	Less than 1% of the total risk factor [a]
Dibutylphthalate	Less than 1% of the total risk factor [a]
Dichloroprop	Less than 1% of the total risk factor [a]
Dieldrin	Less than 1% of the total risk factor [a]
Dimethylisopropylnaphthalene	Tentatively identified compound
Endosulfan I	Less than 1% of the total risk factor [a]
Endosulfan II	Less than 1% of the total risk factor [a]
Endosulfan sulfate	Less than 1% of the total risk factor [a]
Endrin	Less than 1% of the total risk factor [a]
Endrin aldehyde	Less than 1% of the total risk factor [a]
Endrin ketone	Less than 1% of the total risk factor [a]
Ethyl acetate	Tentatively identified compound
Ethylbenzene	Less than 1% of the total risk factor [a]
Flourene	Less than 1% of the total risk factor [a]
gamma BHC	Less than 1% of the total risk factor [a]
Gasoline (2)	Less than 1% of the total risk factor [a]
2-Hexanone	Less than 1% of the total risk factor [a]
Indeno(1,2,3-cd)pyrene	Less than 1% of the total risk factor [a]
Methyl acetate	Tentatively identified compound
Methyl ethyl ketone	Less than 10 times the TB

[a] Chemicals were detected at a frequency of less than 10%. Approximately 0.2% and 0.6% of the total carcinogenic and noncarcinogenic risk factors, respectively, was eliminated by the concentration toxicity screen.
MB = Method blank
EB = Equipment blank
TB = Trip blank

Table 6-3
(Continued)

Analytes	Rationale for Assessment
2-Methylnaphthalene	Less than 1% of the total risk factor [a]
Nananal	Tentatively identified compound
Naphthalene	Less than 1% of the total risk factor [a]
Phenanthrene	Less than 1% of the total risk factor [a]
2,4,5-T	Less than 1% of the total risk factor [a]
2,4,5-TP (silvex)	Less than 1% of the total risk factor [a]
Tetrahydrofuran	Tentatively identified compound
Trichloroethene	Less than 1% of the total risk factor [a]
Trichloropropene	Tentatively identified compound
Trichloropropene B	Tentatively identified compound
Unknown	Tentatively identified compound
Unknown acetate	Tentatively identified compound
Unknown aldehyde	Tentatively identified compound
Unknown alkane	Tentatively identified compound
Unknown alkene	Tentatively identified compound
Unknown alkene B	Tentatively identified compound
Unknown B	Tentatively identified compound
Unknown $C_{10}H_{16}$	Tentatively identified compound
Unknown carboxylic acid	Tentatively identified compound
Unknown cyclic ether	Tentatively identified compound
Unknown cyclic ether B	Tentatively identified compound
Unknown cyclohexane	Tentatively identified compound
Unknown ester	Tentatively identified compound
Unknown hydrocarbon	Tentatively identified compound
Unknown oxirane	Tentatively identified compound
Unknown PNA	Tentatively identified compound

[a] Chemicals were detected at a frequency of less than 10%. Approximately 0.2% and 0.6% of the total carcinogenic and noncarcinogenic risk factors, respectively, was eliminated by the concentration toxicity screen.

MB = Method blank
EB = Equipment blank
TB = Trip blank

Table 6-3
(Continued)

Analytes	Rationale for Assessment
Unknown silane	Tentatively identified compound
Unknown sterol	Tentatively identified compound
Unknown trichloropropene	Tentatively identified compound
Unknown trimethylhexene	Tentatively identified compound
Unknown turpene	Tentatively identified compound
Xylenes	Less than 1% of the total risk factor
Inorganics	
Antimony	Within background concentrations
Barium	Within background concentrations
Beryllium	Within background concentrations
Cadmium	Within background concentrations
Calcium	Necessary nutrient
Chromium	Within background concentrations
Cobalt	Within background concentrations
Copper	Within background concentrations
Iron	Necessary nutrient
Lead	Within background concentrations
Magnesium	Necessary nutrient
Mercury	Within background concentrations
Molybdenum	Within background concentrations
Nickel	Within background concentrations
Potassium	Necessary nutrient
Selenium	Within background concentrations
Silver	Within background concentrations
Sodium	Necessary nutrient

* Chemicals were detected at a frequency of less than 10%. Approximately 0.2% and 0.6% of the total carcinogenic and noncarcinogenic risk factors, respectively, was eliminated by the concentration toxicity screen.

MB = Method blank
EB = Equipment blank
TB = Trip blank

A total 0.2% of the carcinogenic risk factor and 0.6% of the noncarcinogenic risk factor was eliminated from the quantitative risk assessment using the concentration/toxicity screen.

6.1.9 Data Limitations/Data Gaps

During this investigation, soil samples were collected and analyzed. No groundwater samples or rubble pile samples from the northern portion of the landfill were taken. Therefore, the assessment of chemicals of concern was limited to contaminants found in the surface soil or in the soils beneath Landfill No. 25. Limitations of analytical methods in detection of chemicals below the instrument detection limit, use of estimated values below the RL, and values that were close to the RL further limit the data used in the risk assessment. Use of estimated values tends to result in overestimation of actual concentrations and the use of values close to the RL could either over- or underestimate contaminant concentrations.

6.2 Exposure Assessment

Exposure assessment is the determination or estimation (qualitative or quantitative) of the magnitude, frequency, duration, and route of human exposure for the chemicals of potential concern that are present at, or may have migrated from, a site. The characterizations of the environs of CAFB and the surrounding area provided in Section 2.0 and the brief description of the exposure setting presented in this section were used to assess the potential exposures associated with Landfill No. 25.

6.2.1 Characterization of Potentially Exposed Populations

A detailed description of the environmental setting of CAFB is presented in Section 1.3 of this report. Section 1.3.1 describes the cultural geography, physiography, and the climate of east-central New Mexico. Regional geologic history and

present day features of the Southern High Plains, including soil types, are discussed in Section 1.3.1. Regional hydrogeology, including surface water and groundwater, are summarized in Section 1.3.1. Section 1.3.2 provides a detailed description of Landfill No. 25.

6.2.2 Population Demographics

CAFB had a resident population of approximately 3,800, including military personnel and their dependents, in 1990. Currently, there are 1,841 housing units at CAFB. Base housing is located in the northwest quarter of CAFB and north of CAFB, west of New Mexico Highway 277. Base-related employment at CAFB includes approximately 4,900 positions (Woodward-Clyde, 1992b). The region potentially affected by activities at CAFB includes Curry and Roosevelt counties. Together these counties comprise an area within a 30-mile radius of CAFB. The population in the two-county region was 59,873 in 1990 (USAF, 1992). The city of Clovis, New Mexico is located approximately seven miles to the east of CAFB. In 1990, the population of Clovis was 30,954 persons. Over 95% of military personnel currently living off-base reside in Clovis. The remaining 5% reside in Portales. Portales is located approximately 19 miles south of Clovis and had a population 10,690 in 1990.

6.2.3 Current and Future Land Use

Land use is primarily agricultural within Curry as well as Roosevelt County. As of 1992, total land area in Curry county was 897,000 acres with 837,200 designated as farm land. Lands surrounding CAFB are classified as irrigated farm land with principal crops including corn, grain, sorghum, wheat, barley, oats, alfalfa, cotton, and various vegetables. Peanuts are the primary commodity in Portales. Cattle ranching and dairy farming occur throughout Curry and Roosevelt counties. Due to the number of feed lots and processing plants in the area, Clovis is known as the "Cattle Capital of the Southwest". Roosevelt county has the largest dairy industry in New Mexico and a strong

beef cattle industry. Currently no land use or zoning controls restrict the type and amount of construction in the proximity of CAFB. The U.S. Air Force has designated Compatible Use Zones (CUZs) around CAFB and provides recommendations for compatible uses in areas subject to noise and accident hazards (Woodward-Clyde, 1992b). However, Air Installation Compatible Use Zone land use guidelines are not legal or regulatory requirements and, therefore, are not enforceable.

There are no plans for closure of CAFB in the foreseeable future. The use of CAFB as a military installation is highly specialized and land use cannot be significantly altered (i.e., converted to private commercial or residential use) without the approval of the U.S. Congress and the Secretary of Defense. For security and safety reasons, ingress and egress to CAFB is restricted.

6.2.4 Subpopulations of Potential Concern

Potentially sensitive members of the population that may be exposed to chemicals originating from Landfill No. 25 include: children; the elderly; and those with preexisting conditions that may be aggravated by exposure to chemicals of potential concern. Locations where sensitive members of the population might reside include hospitals, retirement/nursing homes, schools, nurseries, and day care centers. Medical services for CAFB personnel and their dependents are provided by two general hospitals in the surrounding communities and by CAFB hospital. The High Plains Hospital is located several miles east of CAFB, toward Clovis, New Mexico. On-base support facilities, including schools, hospitals, and day care centers are located primarily northwest of the airfield area upgradient and generally upwind of Landfill No. 25. While a dairy is located next to the landfill, the nearest commercial facilities, consisting of a convenience store (Allsup's) and a barber shop, are approximately 1.5 miles from the site. These facilities represent the general population and not sensitive subpopulations.

6.2.5 Conceptual Site Model

Based on available information, a conceptual site model was developed to provide an understanding of the sources of contaminants, potential migration pathways of contaminants, and potential receptors considering geologic and hydrologic information. The conceptual site model is presented schematically in Figure 6-1 and provides the basis for the human health and ecological risk assessment. The chemicals of potential concern identified for use in this risk assessment are presented in Table 6-2.

Currently, the population potentially exposed to contaminants originating from Landfill No. 25 includes on-base residents and workers, off-base residents and consumers of locally produced agricultural crops and beef and dairy products. Expansion of the existing munitions facility has been proposed and will require clearing of the rubble at the north end of Landfill No. 25 to accommodate new construction. Therefore, on-site land use is likely to change in the near future and necessitates assessment of a future construction worker scenario.

6.3 Identification of Exposure Pathways and Scenarios

Human exposure to the chemicals of potential concern were evaluated by performing the following tasks:

1. Identification of releases into various media;
2. Determination of fate and transport in release media;
3. Evaluation of exposure points and exposure routes;
4. Determination of exposure scenarios;
5. Quantification of estimated exposure concentrations; and
6. Estimation of chemical intakes for individual pathways.

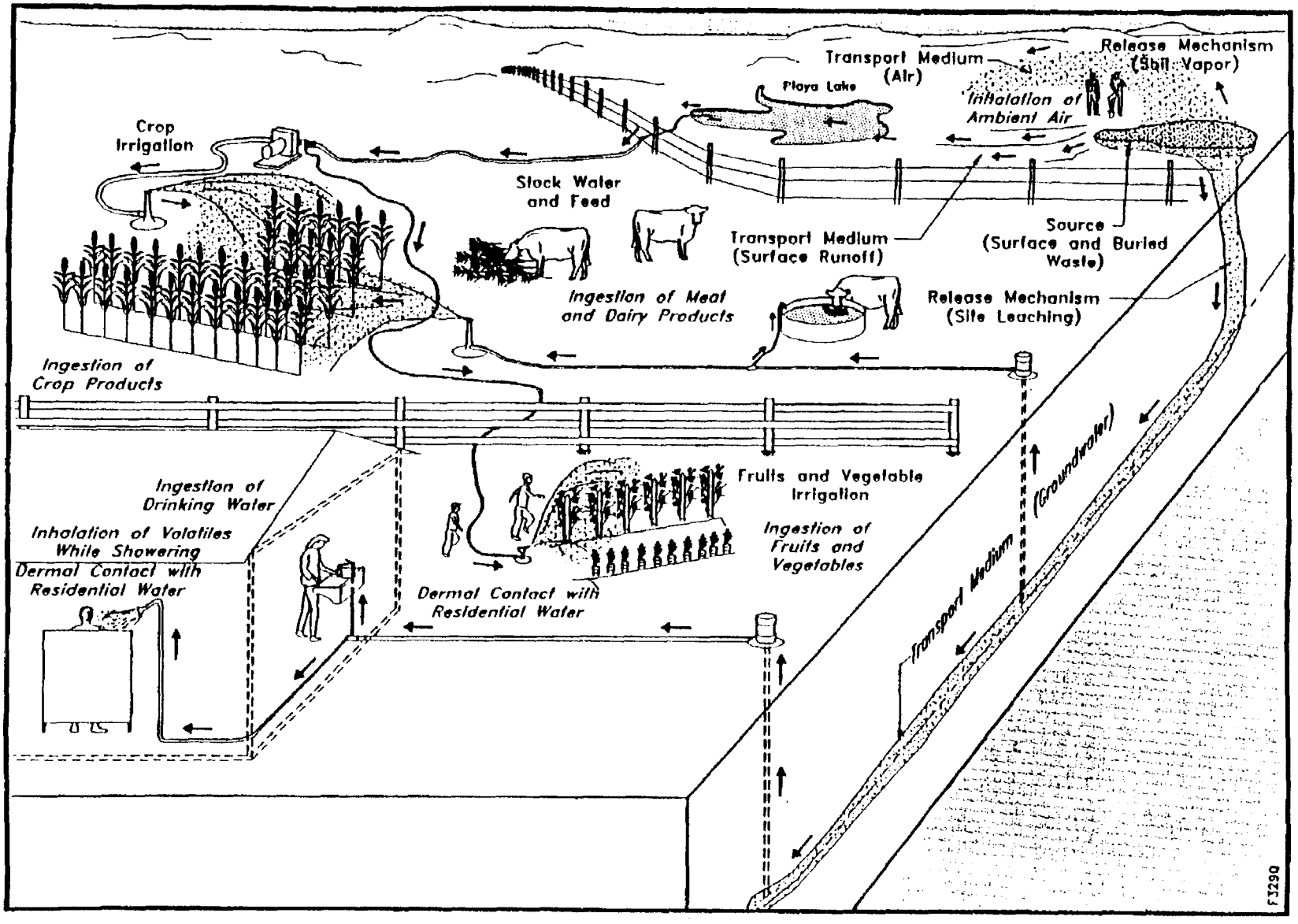


Figure 6-1. Conceptual Site Model Associated with Risks from Landfill No. 25, Cannon AFB, Clovis, New Mexico

The following subsections discuss the individual tasks used to evaluate human exposure for the chemicals of potential concern and the uncertainties associated with exposure assessment. Information about contaminant sources and receiving media at the site, the fate and transport of chemicals of concern, exposure points, and exposure routes are provided. Appendices J, K, L, and M present a detailed discussion of how estimated exposure concentrations were derived.

6.3.1 Task 1: Identification of Releases into Various Media

For the purpose of this risk assessment, the source of contamination is represented by the wastes that have been disposed of in Landfill No. 25 in the past, since no waste disposal in Landfill No. 25 is projected in the future. These wastes are the sole source of soil, and potential air, groundwater, and surface water contamination from the landfill. The potential releases to media from contaminants originating at Landfill No. 25 addressed in this risk assessment are those to 1) ambient air, 2) groundwater, and 3) surface water (Playa Lake). While the lower portion of the Ogallala formation is the primary regional aquifer, it is steadily declining at a rate of 2 feet per year due to high pumping rates. However, releases to the groundwater have been included even though the time required for the constituents to travel to the groundwater (173 years) is such that the Ogallala aquifer is unlikely to still be serving as a source of potable water for the area.

Results of chemical analyses of soil samples collected during the RFI indicated that a limited number of contaminants are present in the soil beneath Landfill No. 25 to a depth of 60 feet BNS. Section 4.0 presents and Section 5.0 summarizes the analytical data characterizing contamination at the site. Of the eight 60-foot soil borings taken, organic contaminants were found down to 60 feet on 10 occasions. Chemicals detected in soil samples that are above RLs are presented in Table 4-5. Selection of contaminants of potential concern is discussed in Section 6.1.

The primary source of contamination considered in this risk assessment is soil. While not analyzed during the site investigation, ambient air, groundwater, and surface water could potentially be contaminated with the chemicals of potential concern and may represent secondary sources of contamination. Therefore, contaminant concentrations were modeled to ambient air, surface water, and groundwater. Both primary and secondary sources of contamination are considered in this risk assessment.

6.3.1.1 Releases to Air

Volatilization of organic compounds from surface soil contamination, volatilization of organic compounds from buried wastes and wind entrainment of contaminated dust were considered in evaluating potential releases to air from Landfill No. 25. Air impacts were estimated using predictive equations recommended by the USEPA. Volatile compounds entrained in the soil may volatilize and eventually disperse into the atmosphere above the ground surface by simple diffusion. The chemicals detected at the site during this investigation with the potential to volatilize were benzene, diesel fuel, hydrocarbons, methylene chloride, and toluene. All of these compounds were detected in surficial soils. However, all of the benzene and diesel results were below the RL or were less than five times the RL. In addition, all of the diesel hits are believed to be due to laboratory contamination. The majority of the surficial hydrocarbon hits were less than five times the RL and the majority of the surficial toluene was detected below the RL or at less than five times the RL (refer to Sections 4.4.4 and 4.4.6 for further discussion on the source of hydrocarbons).

There is a potential for volatile chemicals to migrate through the soil pores and eventually volatilize to the atmosphere. Release of volatile organics from surface and subsurface soils is considered to occur for purposes of this risk assessment. Metals were also detected in subsurface and surficial soils. Non-volatile chemicals and metals can potentially enter the atmosphere as a result of wind entrainment of contaminated surface soil. Waste must be present in surface soil and uncovered by impervious

materials or vegetation to be subject to fugitive dust generation. The generation of fugitive emissions in the form of dust/particulates may be lessened by the fact that Landfill No. 25 is partially vegetated. However, because of wind conditions in the area, fugitive dust generation was evaluated in order to assume a worst-case scenario.

Organic materials in the waste are subject to microbial decomposition and may generate a variety of gases that may vent to the atmosphere. Low soil moisture content at CAFB inhibits waste decomposition resulting in a decreased rate of gas formation. Soil gases generated at Landfill No. 25 were considered to be negligible and were not evaluated for human health risks because of the arid climate in the area.

The Playa Lake, southeast of Landfill No. 25, is recharged primarily by treated effluent from the sewage lagoons and by storm water runoff from the site. Without recharge, playa lakes persist for only a few days or weeks. Water is lost from playa lakes by infiltration to the soil and by evaporation (Radian, 1986). Volatilization of organic compounds from the surface water is possible. Several contaminants were detected at or near the surface soil at Landfill No. 25. However, surface water runoff modeling presented in Appendix L indicates that the concentration of contaminants resulting from Landfill No. 25 in the Playa Lake are low. Therefore, volatilization of organics from the Playa Lake is not expected to be significant and this scenario was not evaluated in the risk assessment.

6.3.1.2 Releases to Groundwater

A secondary release mechanism from the soil includes the potential for leaching of chemicals into groundwater. Leachate is composed of liquid present in the waste, liquid entering the unit from precipitation, and chemical compounds that are dissolved or suspended in this liquid. Many factors affect the potential for contaminant migration including: 1) chemical characteristics; 2) waste management practices; and 3) soil characteristics. The potential for production of leachate to contaminate groundwater

is generally considered to be low because of the limited rainfall and high evaporation rate in this arid environment. However, the detection of a limited number of contaminants (primarily metals) at depths of 60 feet may indicate that contaminants from the site are migrating.

Groundwater flow and contaminant transport were modeled using analytical solutions for estimating the time of travel of soil moisture through unsaturated soil from the bottom of the landfill to the Ogallala aquifer, assuming steady-state conditions in the soil column. Appendix K contains a discussion of the methodology used to calculate groundwater concentrations.

6.3.1.3 Releases to Surface Water

One of the most prominent geomorphic features in the vicinity of CAFB are blowouts. Blowouts are broad shallow depressions which form as a result of soil erosion by wind. Runoff collects in blowouts to form ephemeral playa lakes during periods of rainfall. Generally, drainage in the area of Landfill No. 25 is to the southeast toward Playa Lake (see Figure 1-5). Therefore, direct release of surface contaminants detected at the landfill to surface water may occur at the site.

6.3.2 Task 2: Determination of Fate and Transport in Release Media

The contaminants detected at Landfill No. 25 may be transported from one medium to another by processes of solubilization, adsorption, bioaccumulation, or volatilization. Primary transport media for chemical substances in the environment include the air, groundwater, surface water, and soil. The potentially significant contaminant transport mechanisms considered for this risk assessment include:

- Emissions to ambient air;
- Migration of contaminated groundwater;

- Direct release of contaminants in soil to surface water; and
- Uptake by plants and animals.

6.3.2.1 Release to and Transport in Ambient Air

Ambient air monitoring has not been conducted at Landfill No. 25 to determine the contaminants and/or contaminant concentrations in the air. Several of the contaminants detected in soils at Landfill No. 25 have the potential for volatilization from the soil. Non-volatile organics and metals can enter the atmosphere via wind entrainment of contaminated surface soil. Small particles which carry pesticides or their degradation products may be distributed through the air. Wind entrainment is likely to be a significant transport mechanism at the site because of regional gusty winds and the semi-arid climate. Potential contamination of the air at the perimeter of Landfill No. 25 and at strategically placed receptors was estimated using conservative assumptions such as: 1) no plume rise; 2) concentration over a reduced area of the landfill; and 3) uniform distribution of subsurface contamination.

6.3.2.2 Release to and Transport in Groundwater

The detection of metals down to 60 feet may indicate that contaminants have migrated downward and suggests limited potential for leaching into the underlying Ogallala formation, which is 270 feet below ground level (BGL). However, even under the worst-case scenario, it would take 173 years for these contaminants to reach the aquifer. Furthermore, these metals are known to exist in the region at moderately high levels. Although the lower portion of the Ogallala formation is the primary regional aquifer for both potable and irrigation water, it is declining at a rate of 2 feet per year due to high pumping rates. This subsidence will likely preclude use of the aquifer as a potable water source 173 years in the future. However, in order to assess a worst-case scenario, and further evaluate the basis for a no-action decision, future (potential) groundwater contamination was modeled.

The majority of the contaminants detected at Landfill No. 25 were pesticides, polyaromatic hydrocarbons (PAHs), and metals, all of which generally have low water solubilities and should, therefore, be relatively immobile. However, any leachate reaching the aquifer would mix with the groundwater and flow laterally, generally in the direction of groundwater flow. Groundwater flows to the southeast with a regional gradient of about 13 feet/mile. Some chemicals can float on top of groundwater in a separate immiscible phase because of differing physical and chemical properties. Other chemicals may dissolve and move with the groundwater, or sink to the bottom of the aquifer and move more slowly.

6.3.2.3 Discharge to and Transport in Surface Water

Most precipitation that falls in the Clovis area is lost to evapotranspiration and shallow infiltration before runoff occurs. Generally, drainage in the Landfill No. 25 area is to the southeast, toward the Playa Lake which was chosen as the closest surface water receptor. Methylene chloride and toluene are readily leached from soils with low organic content and are moderately soluble in water. However, as discussed previously, the majority of the contaminants detected at Landfill No. 25 were pesticides, PAHs, and metals which generally are only slightly soluble in water. The transport of these compounds (pesticides, PAHs, and metals) in runoff is primarily caused by transport of particulates to which these compounds are bound. Because these compounds are bound strongly to soil, they are likely to be subject to sedimentation. Metals generally are not very mobile in most soil systems although the rate of transportation is dependent upon characteristics of the soil (pH, organic carbon content, oxidation potential, etc.). The lack of site-specific data required the use of estimated values from the literature to determine the leachability of metals from the soils at CAFB. Erosion, which is unlikely because of the arid climate, would be required for transport of metals to the Playa Lake. However, in order to evaluate the potential for human health risks associated with runoff from the site to the Playa Lake, contaminant migration to a surface water receptor was

modeled (see Appendix L for details of the calculations). The Playa Lake does not discharge to any waterway, but is used to irrigate nearby crops by a local farmer.

6.3.2.4 Uptake by Plants

Land use in the area surrounding CAFB is primarily agricultural. During the site visit, agricultural fields were noted to the east and south of Landfill No. 25. The crops grown on the fields vary depending on the season and the market price. Wheat, used for human consumption, is the primary crop grown on the fields near Landfill No. 25. However, alfalfa, corn, and milo are also grown on these fields and are used as cattle feed (Base Natural Resources Environmental Group, 1992). Agricultural crops are subject to accumulation of contaminants via root uptake of contaminants present in the soil or water used for irrigation.

The effluent to the Playa Lake located southeast of Landfill No. 25 and groundwater is used by a local farmer for irrigation purposes. Therefore, plants may be potentially exposed to contaminants originating from Landfill No. 25 and it is important to examine the possible accumulation of contaminants in crops. Many of the chemicals detected at Landfill No. 25 are lipophilic and some have long half lives. As a result, they tend to bioaccumulate in the food chain. While the groundwater modeling (Appendix K) indicates that these chemicals are not predicted to enter the groundwater for 173 years, this pathway was assessed in order to assume a worst-case scenario. In addition, irrigation using Playa Lake water was assessed using predicted concentrations in the Playa Lake.

6.3.2.5 Uptake by Livestock

There is a dairy located within a mile to the east of Landfill No. 25 and cattle were seen at the perimeter of CAFB, east of the site during the site visit. Livestock, including beef and dairy cattle, may be subject to accumulation of

contaminants originating from Landfill No. 25 via ingestion of contaminants in feed and water. Several crops that are typically used for livestock feed are grown nearby. As cattle ingest contaminated feed, the contaminants can be absorbed by the gastrointestinal tract. The more lipophilic compounds may accumulate in the milk and edible meat following gastrointestinal absorption, providing a mechanism for human exposure. Locally raised beef and dairy cattle are sustained primarily on locally grown (approximately 80%) agricultural products (New Mexico Agricultural Extension Office, 1992). To evaluate a worst-case scenario, 100% of the feed for beef cattle and dairy cows was assumed to come from crops grown near Landfill No. 25.

6.3.3 Task 3: Evaluation of Exposure Points and Exposure Routes

Normally, potential pathways are segregated into those that currently exist and those that may exist in the future. Current potential exposure pathways are those that may exist as a result of the current extent of contamination combined with existing land use and activity patterns. Future exposure pathways are considered to be those which may exist at some time in the future as a result of the current extent of contamination or projected future contaminant concentrations combined with future land use and activity patterns. Human exposure to contaminants originating at Landfill No. 25 could potentially occur on-site, in areas adjacent to the landfill, and at locations distant from the site assuming significant groundwater contamination. Access to the site is limited and currently there are no ongoing invasive activities occurring. Therefore, direct human contact is currently considered to be unlikely. However, this assessment is being conducted partially in response to a proposed expansion of the munitions facility onto the northern portion of the site. Inhalation of airborne contaminants as well as incidental ingestion of and dermal contact with soil were assessed as potential sources of exposure to contaminants at Landfill No. 25 for the future construction scenario, since land use at the site is likely to change in the future. Use of potentially contaminated surface water from the Playa Lake and groundwater for irrigation of agricultural crops consumed by humans and for feed crops consumed by livestock may serve as indirect

pathways of human exposure to contaminants from the landfill. Volatilization of volatile chemicals and fugitive dust generation at the site were also assessed as potential sources of exposure to contaminants originating at Landfill No. 25. Potential site releases are expected to be low-level and relatively continuous in nature. Short-term high level releases are considered to be unlikely and were not considered in this risk assessment.

6.3.3.1 Receptors

Potential receptors considered in this risk assessment are: 1) animal and plant receptors; 2) people who consume commercially produced agricultural crops grown at the perimeter of the site; 3) people who consume meat and/or milk from livestock fed on crops grown at the site perimeter and; 4) CAFB personnel, on-site workers, and nearby residents exposed to fugitive dust and volatilized chemicals from the site. A groundwater pathway was not considered in the current residential exposure scenario, because migration of contaminants from the landfill to the water table is estimated to require 173 years. The groundwater pathway is considered in the future residential scenario. Future land uses in the vicinity of CAFB will not significantly alter the exposure points and exposure routes. The size of the potentially exposed populations could change in the future; however, it would likely increase for some exposure routes and decrease for others.

6.3.3.2 Exposure Pathways

Potential exposure pathways associated with identified receptors were evaluated in order to determine whether they were complete and significant. The route can include media other than the source and the receptor must engage in activity that will cause the exposure to occur. Figure 6-2 depicts potential pathways for contaminants originating at Landfill No. 25 to move from the point of release to the point of human exposure. Pathways that are not complete have been crossed out and numbered to correspond with explanatory footnotes. Pathways that are completed but judged

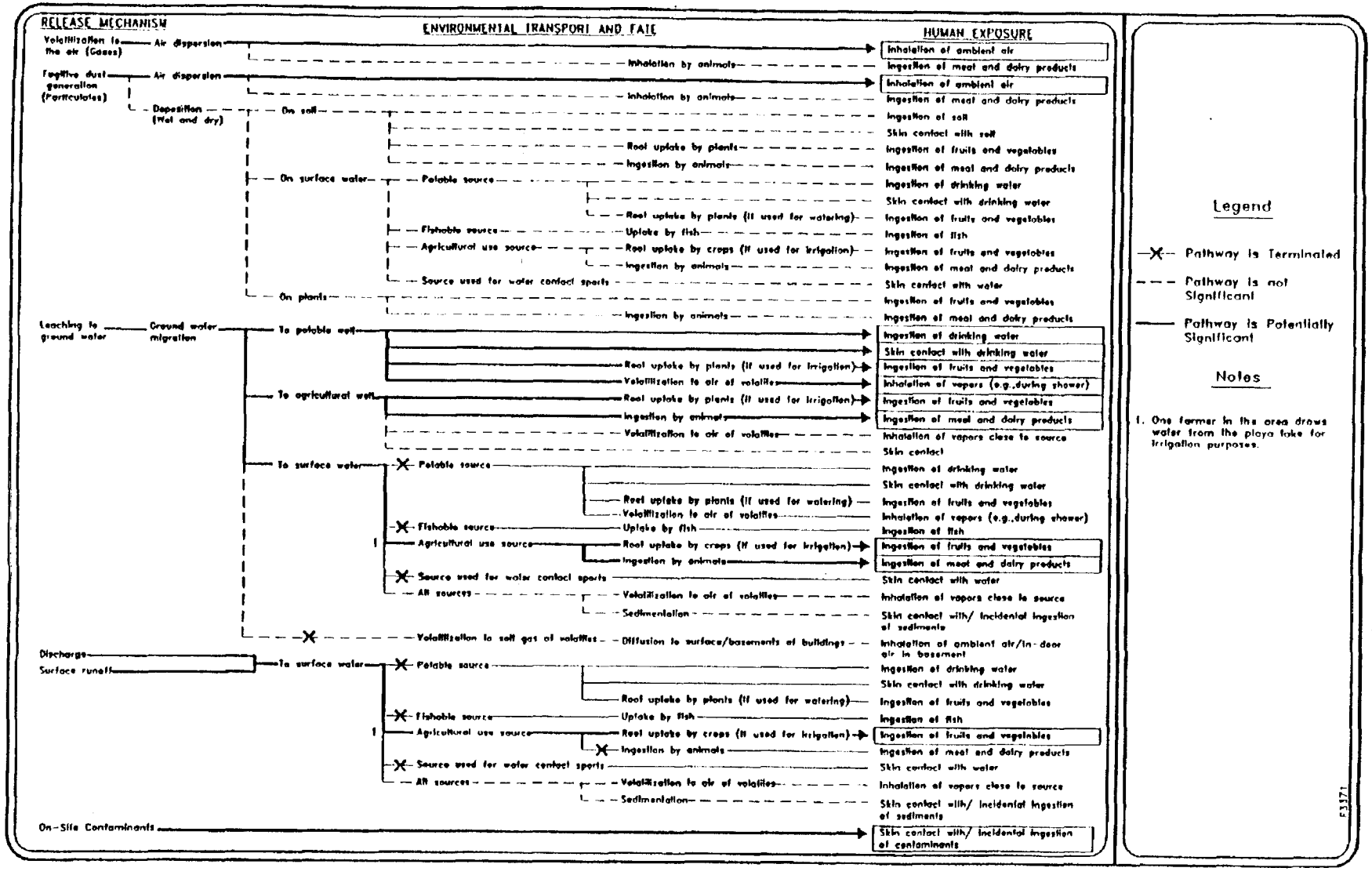


Figure 6-2. Environmental Fate and Transport for Landfill No. 25, Cannon AFB, Clovis, New Mexico

insignificant are indicated with dashed-lines. Potentially significant pathways that exist at the site are indicated with a solid bold line and include:

1. Ingestion of groundwater: leaching to groundwater; groundwater migration to groundwater well; ingestion of groundwater.

2. Dermal contact with groundwater: leaching to groundwater; groundwater migration to groundwater well; dermal contact while showering.

3. Inhalation of vapor phase chemicals from groundwater: leaching to groundwater; groundwater migration to groundwater well; inhalation of vaporized chemicals while showering.

4. Ingestion of agricultural crops: migration to surface or groundwater; irrigation of crops with surface or groundwater; uptake by plants; ingestion of plants by humans.

5. Ingestion of milk and meat: consumption of contaminated crops by cattle; transfer of contaminants to beef or milk; ingestion of beef or milk by humans.

6. Inhalation of vapor phase chemicals at the site: volatilization from soil; inhalation of volatilized chemicals in ambient air.

7. Inhalation of fugitive dust generated at the site: entrainment of contaminants in soil; dispersion into the atmosphere above the site; inhalation of fugitive dust.

8. Ingestion of/dermal contact with soil: leaching to soil; ingestion of and/or skin contact with soil.

These eight pathways were quantified in this risk assessment.

Pathways that may be complete but are likely to pose insignificant human health risks include: 1) inhalation of vapors volatilized from the Playa Lake; and 2) dermal contact with surface water drawn from the Playa Lake for agricultural purposes. The contribution of these exposure pathways is likely to be minor by comparison to exposure following ingestion of groundwater, agricultural crops, and beef or milk.

Potentially exposed populations, exposure media, exposure points and exposure routes for complete pathways are identified in Table 6-4. Also noted in this table are the decisions to select pathways for quantitative evaluation and the justification for including or excluding each pathway in the risk assessment.

6.3.4 Task 4: Determination of Exposure Scenarios

CAFB personnel, on-site workers, and individuals living in areas downgradient and down wind from Landfill No. 25 represent the significant populations potentially exposed to chemicals originating from the site that may leach into groundwater, migrate to the Playa Lake, or be emitted into the atmosphere above the site.

For chemicals released to the air, the highest concentrations are typically found in the direction that is predominantly downwind of the site. It is anticipated that inhalation exposure will primarily occur on-site and downwind from the site. Therefore, on-Base residents (located northwest of the site) are not likely to be significantly exposed to airborne contaminants via dispersion because prevailing winds in the area are to the south. In addition, the annual maximum air concentrations were predicted to exist at the landfill perimeter, CAFB perimeter (east of the site), and at the construction site. The annual maximum concentration predicted at CAFB perimeter (east of the site) was used for all residential scenarios and represents a worst-case scenario. Off-base residents were assumed to be exposed chronically to airborne contaminants potentially originating from Landfill No. 25. CAFB personnel and on-site workers working at or near Landfill No. 25 may be exposed chronically or subchronically to air emissions originating from the site depending on length of employment (tour of duty).

Table 6-4

Potentially Complete Exposure Pathways at Landfill No. 25 CAFB, Clovis, New Mexico

Exposure Route, Medium, and Exposure Point	Potentially Exposed Population	Pathway Selected for Evaluation	Reason for Selection or Exclusion
Inhalation of chemicals in ambient air at or nearby site	Base personnel, nearby residents, on-site workers	Yes	Emissions of volatile chemicals can result in inhalation exposure of Base personnel, on-site workers and nearby residents.
Inhalation of fugitive dust in ambient air	Base personnel, residents living nearby, and on-site workers	Yes	Wind entrainment of contaminated soils can result in inhalation exposure of Base personnel, on-site workers and nearby residents.
Dermal contact with contaminated soil	Future on-site construction workers	Yes	There are currently no invasive activities at the site; however, construction may occur on-site in the future, which will include excavation of soils.
Ingestion of contaminated soil	Future on-site construction workers	Yes	Incidental ingestion of soil could occur during construction activities.
Ingestion of meat and dairy products from cattle exposed to contaminants from Playa Lake or groundwater (stock water, irrigation of pasture/feed crops)	Consumers of locally produced meat and dairy products and nearby farm families	Yes	A dairy exists to the northeast of Landfill No. 25 and several stockyards are located in the vicinity of Cannon AFB.
Dermal contact with chemicals in water during agricultural use	Off-Base farmer drawing water from Playa Lake potentially contaminated with discharge from site and farmers using potentially contaminated groundwater for agricultural purposes	No	Contribution of dermal contact with water is likely to be minor by comparison to the contribution of ingestion of agricultural products and livestock.
Dermal contact with chemicals in groundwater during home use	Off-Base residents (On-Base residents are upgradient)	Yes	This risk assessment assumes use of potentially contaminated groundwater for bathing/showering and other domestic uses, during which dermal contact occurs.

Table 6-4

(Continued)

Exposure Route, Medium, and Exposure Point	Potentially Exposed Population	Pathway Selected for Evaluation	Reason for Selection or Exclusion
Inhalation of chemicals volatilized from groundwater during home use (while showering)	Off-Base residents (On-Base residents are upgradient)	Yes	This risk assessment assumes use of potentially contaminated groundwater for bathing/showering and other uses during which inhalation of vapor may occur.
Ingestion of contaminated groundwater migrating from the site to potable water wells downgradient from site	Off-Base residents living downgradient from site (on-Base residents are upgradient)	Yes	Although groundwater modeling indicates that leaching of contaminants into the water table will only occur far in the future, residents connected to the municipal water supply may be exposed in the future.
Ingestion of fruits and vegetables irrigated with surface water drawn from Playa Lake currently impacted by runoff from site or potentially contaminated groundwater in the future	Consumers of locally grown agricultural crops and nearby farm families	Yes	One farmer draws water from the potentially contaminated Playa Lake for agricultural purposes. There are agricultural wells in the vicinity of Landfill No. 25 that may potentially be contaminated with groundwater migrating from the site.

If contaminants originating from Landfill No. 25 reach the groundwater, direct human exposure to contaminants could occur in homes where groundwater is used as a potable source or for showering, etc. Human exposure could also occur from the consumption of beef and dairy products from farm animals exposed to potentially contaminated groundwater and feed crops, as well as from human consumption of contaminated agricultural products. Residents living adjacent to the site, who grow and consume agricultural crops grown at the site perimeter as well as beef and dairy products from livestock fed with these crops, represent a worst-case scenario. These individuals may be subject to chronic (long-term) exposure to site-related contaminants. Individuals who consume commercially produced crops grown at the site perimeter and commercially produced beef and milk from livestock sustained on crops grown at the site perimeter were not assessed because any contaminated commercial products would be widely distributed, thus reducing the potential for individual exposure by comparison to the farm family scenario.

Chronic exposure scenarios are based on current and future predicted lifetime (70 years) exposures. Subchronic exposure scenarios are based on 2-year exposure durations. These scenarios assume exposure to contaminant levels predicted by modeled results at the nearest receptor. The scenarios that were evaluated in the risk assessment are:

Lifetime, Off-base Residential (current and future)

1) adult, average
2) adult, reasonable maximum
3) child, average
4) child, reasonable maximum

Occupational (current and future)

1) adult, average
2) adult, reasonable maximum

Chronic exposure to adults and children was evaluated for: 1) an average case, using 50th percentile values for exposure parameters (i.e., exposure duration and frequency) when available and appropriate; and 2) a reasonable maximum case, using 90th or 95th percentile values for exposure parameters when available and appropriate. Risk estimates for noncarcinogenic effects were predicted for adults and children. Risk estimates for carcinogenic effects were predicted based on an exposure duration of 70 years.

6.3.5 Task 5: Quantification of Estimated Exposure Concentrations

This section describes the methodology used to estimate the magnitude, frequency, and duration of exposures for the populations and exposure pathways selected for quantitative evaluation. The various exposure media quantified for this risk assessment included ambient air, indoor air from residential water use, groundwater, surface water, fruits, vegetables, meat and dairy products. The exposure concentration estimates in the various exposure media and the methodologies used to obtain these estimates are discussed. Table 6-5 summarizes the average measured soil concentrations used to estimate exposure concentrations from the various media. Tables 6-6, 6-7, and 6-8 summarize the exposure concentration estimates for all exposure media (i.e.,

Table 6-5

Average Measured Soil Concentrations From Soil Borings at Landfill No. 25, CAFB, Clovis, New Mexico

Chemicals	Surface Soil Concentration (mg/kg)	Subsurface Soil Concentration (mg/kg)
Organics		
β-BHC	1.51E-03	5.23E-04
Benzene	3.16E-03	1.22E-03
Benzo(a)pyrene	1.60E-04	6.90E-05
Benzo(b)fluoranthene	1.80E-04	1.80E-04
Benzo(k)fluoranthene	1.70E-04	1.80E-04
4,4'-DDD	3.16E-03	2.83E-04
4,4'-DDE	1.84E-02	9.10E-04
4,4'-DDT	1.56E-02	1.23E-03
Diesel Fuel	8.45E+01	1.00E+02
Fluoranthene	1.70E-04	1.79E-04
Heptachlor	1.78E-03	2.40E-04
Heptachlor epoxide	3.20E-04	3.05E-04
Hydrocarbons	2.92E+01	8.73E+02
MCPP	ND	3.52E+00
Methylene chloride	3.36E-03	2.06E-02
Pyrene	1.60E-04	1.73E-04
Toluene	3.30E-02	2.65E-03
Inorganics		
Aluminum	1.20E+04	8.40E+03
Arsenic	1.15E+00	2.55E+00
Manganese	1.81E+02	7.47E+01
Thallium	1.20E-01	1.06E-01
Vanadium	2.10E+01	1.56E+01
Zinc	3.01E+01	1.41E+01

ND = Not detected

Table 6-6

Estimated Exposure Concentrations Associated with Landfill No. 25 CAFB, Clovis, New Mexico

Chemical	Ambient Air µg/m³			Indoor Air from Showering mg/m³		Groundwater mg/L		Surface Water mg/L	
	Residential	Construction	On-Site Worker	Average	Reasonable Maximum	Average	Reasonable Maximum	Average	Reasonable Maximum
Organics									
β-BHC	3.77E-08	1.07E-06	4.64E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.17E-09	1.20E-08
Benzene	1.26E-03	7.52E-03	1.56E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.98E-07	6.68E-07
Benzo(a)pyrene	9.22E-06	2.63E-04	1.18E-05	4.00E-10	8.00E-10	1.09E-08	1.09E-08	4.72E-09	7.91E-09
Benzo(b)fluoranthene	9.59E-06	2.73E-04	1.18E-05	9.09E-35	1.64E-34	2.31E-33	2.31E-33	1.13E-08	1.90E-08
Benzo(k)fluoranthene	9.47E-06	2.70E-04	1.16E-05	7.12E-87	1.28E-86	1.81E-85	1.81E-85	1.07E-08	1.80E-08
4,4'-DDD	5.97E-08	1.70E-06	7.20E-07	1.09E-21	1.96E-21	2.76E-20	2.76E-20	1.99E-09	3.34E-09
4,4'-DDE	3.75E-07	1.07E-06	4.60E-06	5.39E-21	9.73E-21	2.87E-19	1.37E-19	1.16E-08	1.94E-08
4,4'-DDT	3.17E-07	9.02E-06	3.90E-06	7.16E-18	1.29E-17	1.82E-16	1.82E-16	9.81E-09	1.65E-08
Diesel Fuel	2.14E-02	1.27E-01	2.64E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.91E-03	8.24E-03
Fluoranthene	9.40E-06	2.67E-04	1.16E-04	1.98E-26	3.58E-26	5.04E-25	5.04E-25	3.80E-08	6.37E-08
Heptachlor	3.61E-08	1.03E-06	4.40E-07	1.19E-21	2.16E-21	3.04E-20	3.04E-20	6.88E-08	1.15E-08
Heptachlor epoxide	4.28E-08	1.22E-06	5.20E-07	1.36E-21	2.46E-21	3.47E-20	3.47E-20	1.24E-09	2.08E-09
Hydrocarbons	1.78E+02	1.06E+03	2.19E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.08E-02	8.52E-02
MCPP	6.93E-05	1.97E-03	8.82E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Methylene chloride	1.50E-02	8.89E-02	1.90E-01	6.97E-41	1.26E-40	1.77E-39	1.77E-39	1.21E-06	2.01E-06
Pyrene	9.27E-06	2.64E-04	1.17E-04	3.19E-42	7.38E-42	1.04E-40	1.04E-40	3.66E-08	6.14E-08
Toluene	1.67E-03	9.93E-03	2.13E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.00E-06	3.36E-06

Table 6-6

(Continued)

Chemical	Ambient Air µg/m³			Indoor Air from Showering mg/m³		Groundwater mg/L		Surface Water mg/L	
	Residential	Construction	On-Site Worker	Average	Reasonable Maximum	Average	Reasonable Maximum	Average	Reasonable Maximum
Inorganics									
Aluminum	2.45E-01	6.97E+00	3.00E+00	0.00E+00	0.00E+00	1.36E+02	1.36E+02	7.00E-01	1.17E+00
Arsenic	5.71E-05	1.29E-03	7.27E-04	0.00E+00	0.00E+00	2.34E-03	2.34E-03	2.11E-05	3.55E-05
Manganese	3.67E-03	8.27E-02	4.68E-02	0.00E+00	0.00E+00	9.14E-03	9.14E-03	1.14E-05	1.91E-05
Thallium	2.44E-06	6.95E-05	3.00E-05	0.00E+00	0.00E+00	1.65E-03	1.65E-03	6.98E-06	1.17E-05
Vanadium	4.07E-04	1.16E-02	5.00E-03	0.00E+00	0.00E+00	2.47E-01	2.47E-01	1.22E-03	2.05E-03
Zinc	6.12E-04	1.38E-02	7.12E-03	0.00E+00	0.00E+00	9.90E-03	9.90E-03	1.75E-03	2.94E-03

Table 6-7

Estimated Present Exposure Concentrations in Foods Associated with Contamination Contributed by Landfill No. 25, CAFB, Clovis, New Mexico

Chemical	Fruits mg/kg		Vegetables mg/kg		Meat mg/kg		Dairy mg/kg	
	Average	Reasonable Maximum	Average	Reasonable Maximum	Average	Reasonable Maximum	Average	Reasonable Maximum
Organics								
β-BHC	8.94E-12	1.50E-11	8.94E-12	1.50E-11	3.16E-14	5.29E-14	1.04E-14	2.34E-14
Benzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.99E-14	3.34E-14	6.29E-15	1.06E-14
Benzo(a)pyrene	1.93E-13	3.23E-13	1.93E-13	3.23E-13	4.71E-12	7.89E-12	1.52E-12	2.55E-12
Benzo(b)fluoranthene	3.64E-13	6.12E-13	3.64E-13	6.12E-13	1.70E-11	2.85E-11	5.46E-12	9.17E-12
Benzo(k)fluoranthene	2.46E-13	4.15E-13	2.46E-13	4.15E-13	2.85E-11	4.79E-11	9.10E-12	1.53E-11
4,4'-DDD	1.38E-13	2.32E-13	1.38E-13	2.32E-13	8.02E-13	1.35E-12	2.63E-13	4.41E-13
4,4'-DDE	1.25E-12	2.09E-12	1.25E-12	2.09E-12	2.23E-12	3.73E-12	7.44E-13	1.24E-12
4,4'-DDT	4.34E-13	7.31E-13	4.34E-13	7.31E-13	8.53E-12	1.43E-11	2.76E-12	4.65E-12
Diesel Fuel	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fluoranthene	1.17E-11	1.96E-11	1.17E-11	1.96E-11	1.31E-12	2.19E-12	4.72E-13	7.91E-13
Heptachlor	1.03E-12	1.73E-12	1.03E-12	1.73E-12	7.60E-13	1.27E-12	2.59E-13	4.32E-13
Heptachlor epoxide	1.96E-13	3.30E-13	1.96E-13	3.30E-13	1.25E-13	2.10E-13	4.29E-14	7.20E-14
Hydrocarbons	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MCPP	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Methylene chloride	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.88E-15	1.49E-14	2.80E-14	4.69E-15
Pyrene	7.78E-12	1.31E-11	7.78E-12	1.31E-11	3.02E-16	5.06E-16	7.98E-13	1.34E-12
Toluene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.48E-14	2.49E-14	1.45E-13	2.43E-13

Table 6-7

(Continued)

Chemical	Fruits mg/kg		Vegetables mg/kg		Meat mg/kg		Dairy mg/kg	
	Average	Reasonable Maximum	Average	Reasonable Maximum	Average	Reasonable Maximum	Average	Reasonable Maximum
Inorganics								
Aluminum	2.46E-06	4.12E-06	1.43E-04	2.53E-05	1.57E-05	2.62E-05	2.12E-06	3.54E-06
Arsenic	6.85E-10	1.15E-09	4.57E-09	7.69E-09	6.96E-10	1.17E-09	2.31E-11	3.88E-11
Manganese	5.17E-09	5.17E-09	1.54E-08	2.58E-08	1.17E-10	1.96E-10	1.45E-10	2.41E-08
Thallium	1.51E-11	2.53E-11	1.51E-10	2.53E-10	5.22E-14	8.76E-14	2.11E-10	3.54E-10
Vanadium	1.98E-08	3.33E-08	3.63E-08	6.10E-08	9.17E-12	1.54E-11	3.72E-08	6.25E-08
Zinc	8.53E-06	1.43E-05	3.13E-06	5.25E-06	2.55E-11	4.28E-11	7.59E-07	1.27E-06

Table 6-8

Estimated Future Exposure Concentrations in Foods Associated with Contamination Contributed by Landfill No. 25, CAFB, Clovis, New Mexico

Chemical	Fruits mg/kg		Vegetables mg/kg		Meat mg/kg		Dairy mg/kg	
	Average	Reasonable Maximum	Average	Reasonable Maximum	Average	Reasonable Maximum	Average	Reasonable Maximum
Organics								
β-BHC	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(a)pyrene	4.45E-13	4.45E-13	4.45E-13	4.45E-13	7.21E-08	7.21E-08	2.28E-08	2.28E-08
Benzo(b)fluoranthene	7.46E-38	7.46E-38	7.46E-38	7.46E-38	2.31E-32	2.31E-32	7.31E-33	7.31E-33
Benzo(k)fluoranthene	4.17E-90	4.17E-09	4.17E-09	4.17E-09	3.22E-84	3.22E-84	1.02E-84	1.02E-84
4,4'-DDD	1.92E-24	1.92E-24	1.92E-24	1.92E-24	7.26E-20	7.26E-20	2.30E-20	2.30E-20
4,4'-DDE	1.48E-23	1.48E-23	1.48E-23	1.48E-23	1.69E-19	1.69E-19	5.33E-20	5.33E-20
4,4'-DDT	8.07E-21	8.07E-21	8.07E-21	8.07E-21	1.05E-15	1.05E-15	3.32E-16	3.32E-16
Diesel Fuel	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Fluoranthene	1.55E-28	1.55E-28	1.55E-28	1.55E-28	1.83E-03	1.83E-03	5.77E-04	5.77E-04
Heptachlor	4.57E-24	4.57E-24	4.57E-24	4.57E-24	3.36E-24	3.36E-24	1.14E-24	1.14E-24
Heptachlor epoxide	5.50E-24	5.50E-24	5.50E-24	5.50E-24	3.51E-24	3.51E-24	1.20E-24	1.20E-24
Hydrocarbons	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MCPP	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Methylene chloride	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.31E-47	1.31E-47	4.13E-48	4.13E-48

Table 6-8

(Continued)

Chemical	Fruits mg/kg		Vegetables mg/kg		Meat mg/kg		Dairy mg/kg	
	Average	Reasonable Maximum	Average	Reasonable Maximum	Average	Reasonable Maximum	Average	Reasonable Maximum
Pyrene	2.21E-44	2.21E-44	2.21E-44	2.21E-44	3.95E-41	3.95E-41	1.25E-41	1.25E-41
Toulene	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Inorganics								
Aluminum	4.79E-03	4.79E-03	2.94E-02	2.94E-02	2.04+02	2.04+02	2.72+01	2.72+01
Arsenic	1.78E-08	1.78E-08	1.10E-07	1.10E-07	1.01E-03	1.01E-03	3.04E-05	3.04E-05
Manganese	2.47E-06	2.47E-06	1.24E-05	1.24E-05	9.97E-06	9.97E-06	8.76E-06	8.76E-06
Thallium	2.38E-12	2.38E-12	2.38E-11	2.38E-11	9.86E-07	9.86E-07	4.99E-08	4.99E-08
Vanadium	4.01E-09	4.01E-09	7.35E-09	7.35E-09	9.26E-06	9.26E-06	7.53E-03	7.53E-03
Zinc	4.82E-05	4.82E-05	1.77E-05	1.77E-05	2.88E-05	2.88E-05	4.29E-06	4.29E-06

groundwater, shower vapors, surface water, meat, dairy, fruits, vegetables). In addition, the exposure assumptions and algorithms used to calculate human intake are briefly described in this section and are presented in detail in Appendix M.

6.3.5.1 Ambient Air

Estimated emission rates of chemical compounds derived from volatilization and wind entrainment of contaminated dust from Landfill No. 25 were entered into the USEPA approved Industrial Source Complex Short-Term (ISCST2) dispersion model to estimate worst-case maximum short-term (hourly) and average annual chemical concentrations in the atmosphere at the periphery of the landfill and at a location representing a hypothetical maximum exposed off-base individual. The location representing the maximum exposed off-base individual is approximately 1250 feet to the northeast of the landfill. The distance to the nearest residence is estimated to be approximately 3,500 feet. However, land within two miles of the site is not zoned and commercial land use (dairy and agricultural farming) occurs within 1000 feet of the site.

Emission rates of chemical compounds resulting from proposed construction activity at the north end of the landfill were evaluated independently to predict the average annual chemical concentrations in the atmosphere at the construction site. An area of approximately 17,000 square feet (Base Natural Resources Environmental Group, 1993) is proposed for construction purposes. Construction activity is a source of dust emissions and may have a temporary impact on construction workers in the area. The quantity of dust emissions from construction operation is directly proportional to the area of land being worked, the level of construction activity, the silt content of the soil, and is inversely proportional to the square of the soil moisture. The AP-42 emission factor for construction operations presented in Appendix J was used to calculate the total dust emissions at the construction site. The "box model" approach was used to predict concentrations at the construction site because the ISCST2 dispersion model does not compute a concentration for any receptor physically located on an area

source being modeled. Appendix J presents a detailed discussion of the calculations and air modeling results.

The estimated average and reasonable maximum concentrations in air are presented in Table 6-6. The predicted concentrations were then used to estimate health risks to the exposed populations. The maximum annual average contaminant concentrations predicted at the site (landfill) perimeter and CAFB perimeter were used to assess risks associated with the present occupational and present residential inhalation exposure scenarios, respectively. Predicted concentrations at the construction site were used to estimate health risks to construction workers.

The area source algorithm was used to estimate emission rates. The area source algorithm is based on the equation for a finite crosswind line source and requires that each individual area source have the same north-south and east-west dimensions. Since the landfill is irregularly shaped, it was modeled as several area sources by dividing the area into multiple squares that approximate the geometry of the land. The concentrations at the construction site were calculated by dividing the mass emission rate by the air flow through the cross section of the source. The flow was the product of the length of the area source, height of the air column above the source through which the pollutant disperses, and the average wind speed. A height of 6 feet, representative of an average man, was assumed. Contaminants with a Henry's Law constant of 1×10^5 atm-m^3/mole or greater and molecular weight less than 200 g/mole were considered volatile. These compounds were evaluated for various volatilization emission mechanisms. The remaining compounds were considered to be non-volatile and were evaluated for various entrained dust emission mechanisms. For volatile emissions, the mass emission rate from the landfill was considered. The mass emission rate due to construction activity and wind erosion of the landfill were considered for non-volatile emissions.

USEPA recommends comparing the concentrations of chemicals in ambient air with a reference concentration (RfC) rather than a reference dose (RfD) for

assessing inhalation exposure (USEPA, 1990a). The estimated concentrations and the effective air concentrations (EAC) were equivalent for the residential exposure scenario because RfCs assume 24-hour exposure and an inhalation rate of 20 m^3/day for adults and 16 to 24 m^3/day for children. For the occupational exposure, an EAC is derived by normalizing the exposure duration on site, at the moderate inhalation rate, to a 24-hour day at the average daily inhalation rate. This EAC is then compared to the RfC when available for a chemical. Refer to Appendix M, Table M-11, for the equation used to estimate the EAC.

6.3.5.2 Indoor Air from Residential Water Use

Use of contaminated water for bathing/showering may contribute concentrations of volatile chemicals to indoor air. The method used to estimate concentrations in air while showering is based on results of shower volatilization experiments (Andelman, 1986; Andelman, 1989). The experiments involved pumping a tracer chemical (aqueous trichloroethane) solution through an experimental shower chamber and measuring resulting concentrations of the tracer in the air.

Experimental data on percent volatilization in showers are not available for the chemicals of potential concern for this assessment. By considering the relative volatility of a specific chemical compared to the volatility of trichloroethane, the volatilization transfer coefficient can be estimated for the chemicals of potential concern. This approach is applicable to chemicals with vapor pressures lower than the vapor pressure of trichloroethane as well as chemicals with vapor pressures higher than the vapor pressure of trichloroethane but less than or equal to 400 mm. The model utilizes the following assumptions:

1. Water flow rate = 20 L/min [based on a U.S. Department of Housing and Urban Development survey which found the mean and maximum value for water flow rate in showers to be between 10 L/min and 30 L/min (Andelman, 1989)];

2. Air exchange rate = 1 per hour [a conservative value suggested by Andelman et. al., 1989 (Andelman, 1989)];

3. Dimensions of the shower stall = 5.5 × 3 × 8 feet (volume = 3.736 m^3); and

4. Shower duration = 7 minutes for the average shower duration and 15 minutes for the reasonable maximum (USEPA, 1989a).

A detailed discussion of the calculations is presented in Appendix M. Table 6-6 summarizes the estimated average and reasonable maximum concentrations in the shower stall used in the risk assessment to estimate indoor inhalation exposures from residential groundwater use.

EPA recommends comparing the concentrations of chemicals in the shower stall with a reference concentration (RfC) rather than a reference dose (RfD) for assessing inhalation exposure (EPA, 1990a). Because RfCs assume 24-hour exposure, and an adult inhalation rate of 20 m^3/day, a direct comparison of inhalation in the shower to an RfC is inappropriate. Instead, an EAC was derived by normalizing the short-duration exposure received in the shower, at the shower inhalation rate, to a 24-hour day at the average daily inhalation rate. This EAC was then compared to the RfC when available for a chemical. Table M-11, presented in Appendix M, summarizes the assumptions and algorithms used to estimate exposure to volatile chemicals while showering.

6.3.5.3 Groundwater

A series of mathematical models was used to estimate the transport and fate of groundwater contaminants migrating from Landfill No. 25 at CAFB. The objective of the analysis was to provide conservative estimates of the maximum concentrations of chemicals of potential concern that would be expected at targeted receptor sites. Appendix K presents a detailed discussion of calculations.

Migration of soil moisture and contaminants in the vadose zone beneath Landfill No. 25 was analyzed using analytical solutions for steady state unsaturated flow. Groundwater flow and contaminant transport in the unconfined aquifer were analyzed with a separate analytical model. From a hydraulic perspective, two categories of receptors were considered to represent the potential for human exposure to contaminants originating at Landfill No. 25. These are hydraulically active and hydraulically passive receptors.

Hydraulically active receptors are defined as those that impact the nature of the groundwater flow field and therefore the contaminant concentrations at the receptor as well. The ten potable water wells located on-base fall into this category. Hydraulically, the wells draw groundwater towards them by creating a cone of depression that does not exist naturally. A hypothetical well was positioned to capture groundwater and contaminants migrating from site.

Initially, the time of travel of unsaturated soil moisture from the bottom of the landfill to the water table was estimated (see Appendix K). The time of travel was estimated to be 173 years. The fate and movement of organic materials in subsurface environments are governed largely by sorption and biodegradation. Sorption affects the rate of travel of organic material, relative to that of water through subsurface systems (McCarty et. al., 1981). Solutes which may be sorbed/desorbed on soil, such as metals and pesticides, are expected to migrate at a slower velocity than the soil moisture, and will require a longer period of time to reach the water table. However, 173 years was used as a conservative estimate of the time required for contaminants to reach the groundwater.

The ultimate fate of organic compounds in the subsurface system depends upon biodegradative processes. The attenuation of organic species from biological, chemical, and physical degradation was estimated assuming a first-order decay mechanism. Fate and transport data were obtained from the *Soil Transport and Fate*

Database (Sims et. al., 1991). In addition to attenuation by first-order decay, a physical dilution of groundwater contaminants can be expected to take place as groundwater is pumped from the aquifer. For the purposes of this risk assessment, a hypothetical agricultural well was placed downgradient of the landfill.

Given the extended time of travel, even the most persistent species for which data were available is expected to be attenuated and diluted to 0.0002 or less than its original concentration. Less persistent species are expected to be attenuated to a greater degree. Therefore, organic chemicals of potential concern are predicted to be reduced to near zero concentrations in the water table.

The fate of metals in the unsaturated zone was modeled using estimated distribution coefficients (K_d's) to partition them between the sorbed, solid phase and the mobile, liquid phase. Under actual field conditions, the concentration of metals in soil water reaching the water table is likely to be less than the values estimated in this manner due to the use of highly conservative assumptions. Table 6-6 summarizes the estimated concentrations in groundwater used in this risk assessment to estimate exposures from future residential and agricultural groundwater use. However, at the present rate of pumping, the Ogallala Formation is being mined faster than downward metal migration. Therefore, it is unlikely that the Ogallala aquifer will be serving as a source for domestic water in 173 years, making this an incomplete exposure pathway.

6.3.5.4 Surface Water

Surface water modeling was completed using the guidelines set forth in the *Superfund Exposure Assessment Manual* (USEPA, 1988b). The Soil Conservation Service "curve number" rainfall/runoff hydrograph model (Mockus, 1972) was used to calculate runoff from several different storm events (see Appendix L). Hydrographs from storm events were then imported into a model that uses the Modified Universal Soil Loss Equation (MUSLE). The Universal Soil Loss Equation (USLE) was used to determine

sediment loss from a watershed and MUSLE was used to determine sediment yield to a downgradient location (Playa Lake). Once the runoff and sediment yield values were calculated, the dissolved and sorbed fractions of the contaminants were determined using the compounds sorption partition coefficient. Mass loading was divided by the calculated volume of Playa Lake to determine the estimated concentration in Playa Lake water. The estimated concentrations are presented in Table 6-6 and were used to estimate the average and reasonable maximum concentrations of chemicals in fruits, vegetables, meat and dairy products for the future exposure scenarios for off-base residents. Appendix L presents a detailed discussion of the calculations.

6.3.5.5 Fruits and Vegetables

Potentially contaminated surface water in the vicinity of Landfill No. 25 (Playa Lake) is used by a local farmer for irrigation purposes. In addition, many agricultural wells are located in the vicinity of CAFB. For this risk assessment, it was assumed that the use of contaminated water for irrigating farm crops contributes to concentrations of contaminants in edible portions of plants. The concentration of chemicals in plants irrigated with contaminated water depends on the concentration of the chemical in the irrigation water, subsequent concentration of the chemical in the soil, the plant type, and other factors.

To derive a concentration in soil from irrigation with water containing contaminants, an irrigation rate of 3,000 L/m^2/year was assumed (an average of approximately 39 inches of water applied over a six-month growing period in this geographic region) (Baes, et. al., 1984; Base Natural Resources Environmental Group, 1992). Irrigation was assumed to continue for 30 years for evaluation of long-term exposures because soil concentration of inorganic chemicals may build up over time. Degradation, chemical transformation, or other soil removal processes were not considered, although these processes likely occur. It was further assumed that the total mass of contaminants resides in the top 15 cm of soil and the soil bulk density was 1333

kg/m^3. Volatile organic chemicals (benzene, diesel fuel, hydrocarbons, methylene chloride and toluene) were not evaluated for this pathway because these chemicals can be largely expected to volatilize from the irrigation water and soil surface before significant plant uptake can occur.

Appendix M provides the algorithm and spreadsheet calculations for quantifying concentrations in soil as a result of irrigation and subsequent uptake into fruits and vegetables. The estimated average and reasonable maximum contaminant concentrations in vegetables resulting from irrigation of farm crops with potentially contaminated surface and groundwater are listed in Tables 6-7 and 6-8.

6.3.5.6 Meat and Dairy Products

The use of potentially contaminated groundwater for stock water is assumed to contribute to concentrations of contaminants in the edible meat of beef cattle and in milk and dairy products. However, there is no evidence to suggest that surface water (Playa Lake) is currently being used or will be used in the future for stock water (Base Natural Resources Environmental Group, 1992). While grazing, cattle also ingest surface soil, which can build up contaminant concentrations if the pasture is irrigated with contaminated water sources. As cattle ingest contaminated feed, water, and soil, some chemicals may be absorbed in the animals' gastrointestinal tract. The more lipophilic chemicals may then accumulate in meat.

To estimate the chemical concentration in meat and dairy products, an equation derived from the *Multi-Pathway Health Risk Assessment Input Parameters Guidance Document* (Clement, 1988) was used. Appendix M provides the algorithm and spreadsheet calculations for quantifying concentrations in meat and dairy products as a result of contaminated stock water and feed crops irrigated with contaminated water.

Contaminated food sources included in the evaluation are stock water from potentially contaminated groundwater, feed crops irrigated with surface water drawn from the Playa Lake or groundwater, and incidentally ingested soil. The fraction of feed from a contaminated source was assumed to be 100% for water (groundwater scenario), feed, and soil. One-hundred percent of all contaminants in the water, feed, and soil was assumed to be bioavailable. While these assumptions are not necessarily realistic and tend to be overly conservative, they allow assessment of a worst-case scenario. A cattle water ingestion rate of 150 kg/day, and a consumption rate of 16 kg/day for lactating cows and 8 kg/day for nonlactating cows and cattle (Base Natural Resources Environmental Group, 1992), and a soil ingestion rate of 0.6 kg/day, or 4% of the feed consumption rate (Clement, 1988), per head of cattle was assumed.

The estimated average and reasonable maximum concentrations in beef and dairy products, assuming the cattle feed on corn, milo, and alfalfa irrigated with potentially contaminated surface water drawn from the Playa Lake and potentially contaminated groundwater, are presented in Table 6-7 and 6-8.

6.3.6 Task 6: Estimation of Chemical Intakes for Individual Pathways

Exposure is defined as the contact rate of an organism with a chemical or physical agent. Intake is defined as exposure normalized for time and body weight and is expressed in units of mg chemical/kg body weight-day (USEPA, 1989a).

There are three categories of variables that are used to estimate intake:

1. Chemical-related variables (exposure concentration);
2. Variables that describe the exposed population (contact rate, exposure frequency and duration, and body weight); and
3. Assessment-related variables (averaging time).

The chemical-related variables (exposure concentrations) are presented in Tables 6-6, 6-7, and 6-8. Tables M-11 through M-19 presented in Appendix M, summarize the assumptions and algorithms used to estimate exposure for each exposure pathway. The rationale for selecting individual values is explained in footnotes to the tables. The tables in Appendix M also document the equations used for calculating pathway-specific intakes.

Site-specific and chemical-specific values were used when available data justified their use; otherwise conservative default values were substituted. Exposure assumptions recommended in the *Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors* (USEPA, 1991a), the *Risk Assessment Guidance for Superfund* (USEPA, 1989a), and the *Exposure Factors Handbook* (USEPA, 1989b) were used when available and applicable.

6.3.7 Exposure Assessment Uncertainties

The critical factor in assessing the effect of uncertainty on the exposure assessment is not that uncertainty exists, but rather that the risk assessor is able to qualify or quantify the uncertainty so that the decision-maker can make informed decisions. Major sources of uncertainty associated with the exposure assessment include:

1. The initial characterization of the physical setting that defines the risk assessment involves professional judgment and assumptions;

2. The possibility of false negatives or false positives associated with environmental sampling and analysis;

3. The ability of fate and transport models to realistically simulate the behavior of chemicals in the environment; and

4. The accuracy of exposure assumptions in representing the degree and way in which individuals are exposed.

Uncertainty is addressed in this risk assessment by:

1. Providing information related to the likelihood that assumed conditions will occur to allow interpretation of conditional risk estimates in the proper context;

2. Providing toxicity profiles for chemicals with known health effects that were eliminated from the quantitative risk assessment on the basis of the concentration/toxicity screen and a discussion of possible consequences of the exclusion of these chemicals from the quantitative risk assessment;

3. Having the data and documentation supplied to the risk assessor(s) reviewed according to a previously specified level or plan (see QCSR, Radian, 1993) by professionals with a knowledge of analytical procedures;

4. Incorporating both average and reasonable maximum values to provide a range of results rather than single values;

5. Using conservative estimates when defining reasonable maximum exposure assumptions in order to protect human health and the environment; and

6. Identifying and discussing the major sources of uncertainty and their effects on the exposure estimates in order that the results can be properly interpreted and used for estimation of risks.

6.3.7.1 Definition of Physical Setting

Identification of current and future land uses and exposure pathways as well as selection of chemicals detected at the site for inclusion in the quantitative risk assessment involves professional judgment and significantly affects the results of the risk assessment. A concerted effort has been made to provide information related to the likelihood that the assumed conditions will occur in order to allow interpretation of the risk estimates provided in Section 6.5 in the proper context. It should be noted that the risk estimates provided in this document are conditional upon the assumptions made throughout the risk assessment process.

Two of the most important factors when determining the potential effect of including a chemical in the risk assessment are its measured concentrations at the site and its toxicity. After carefully considering concentration and toxicity, several chemicals were eliminated from the quantitative risk assessment. This decision was based on the assumption that chemicals which were detected relatively infrequently (< 10%) and contributed less than 1% of the total risk factor for the site are unlikely to contribute significantly to the risks calculated in subsequent stages of the risk assessment. Use of this screening procedure involved considerable use of professional judgement. However, it greatly reduced the number of chemicals carried through the risk assessment and allowed the risk assessment to focus on the chemicals and media that are the greatest contributors to the overall risk. While this approach could potentially underestimate risks, it was considered appropriate because in most risk assessments the total risk for a particular medium is typically contributed by only a few chemicals. A total of 40 chemicals were eliminated from the risk assessment, representing approximately 0.2% and 0.6% of the total carcinogenic and noncarcinogenic risk factors, respectively.

6.3.7.2 Fate and Transport Modeling

There is always uncertainty as to how well fate and transport or exposure models approximate the true relationships between site-specific environmental conditions. Therefore, it is important to identify key model assumptions and their potential impacts on the risk estimates. Release rates to the air, groundwater, and surface water were based on analytical data from soils collected during this investigation. Estimated releases to all media with the exception of surface water were assumed to be steady state, indicating that they will not increase or decrease over the assumed periods of time for the exposure duration. Therefore, the estimated release rates are biased toward conservatism and most likely are overestimated because contaminant concentrations in the soil should decrease over time as chemicals volatilize to the air, degrade in the soil, and are flushed from the site.

Modeling the fate and transport of contaminants in air and water requires the use of overly simplistic assumptions that do not simulate the environment. Realistically, migration of contaminants from the source to receiving media involves numerous complex processes that are not necessarily addressed by the available models.

In many cases, conservative values were used for model input parameters. No pollutant removal processes were considered and a decay coefficient of 0 was used in the ISCST2 dispersion model for calculating ambient air concentrations. Therefore, concentrations predicted at each receptor are conservative estimates. These conservative assumptions result in higher ground level concentration estimates. In addition, subsurface contamination was assumed to be uniformly mixed. This assumption may or may not be overly conservative. The model used for transport of contaminants in groundwater and surface water uses conservative modeling assumptions to provide estimates of the maximum concentrations at the receptor sites. Modeling results were based on time of travel calculations for soil moisture. Solutes, which may sorb/desorb on soil, would be expected to migrate at a slower velocity than soil moisture and, therefore, would require a longer period of time to reach the water table. In addition, there are insufficient data to estimate the degree to which metals will be attenuated in the soil column. The fate of metals in the unsaturated zone was modeled using estimated distribution coefficients (K_d) to portion them between the sorbed, solid phase and the mobile, liquid phase. However, K_d values are extremely variable and may range from one to many orders of magnitude, depending on site-specific solute and soil characteristics. Because of the inherent uncertainties associated with the estimated K_d values, the estimated surface and groundwater concentrations could be over- or underestimated by several orders of magnitude.

6.3.7.3 Exposure Parameter Estimation

The standard assumptions regarding body weight, exposure period, life expectancy, population characteristics, and lifestyle may not accurately represent site-

specific exposure situations. The assumptions used most likely overestimate human exposures but may underestimate them in some cases. The purpose of exposure parameter estimations are to reflect realistic, site-specific exposures. However, because exact current and future exposure that more accurately depict all scenarios cannot be determined, assumptions were made which most likely err on the conservative (safe) side to protect human health.

Assumptions regarding exposure parameters that are conservative and may overestimate exposures include:

1. The use of modeled concentrations to represent exposure point concentrations for most exposure scenarios.

2. The amount of media intake is assumed to be constant and representative of the exposed population.

3. Exposure is assumed to occur 350 days/year for chronic exposure scenarios for off-base residents involving inhalation of ambient air and consumption of locally produced agricultural, beef, and dairy products. Hypothetical on-site workers and construction workers are assumed to be exposed by inhalation of ambient air at the perimeter of Landfill No. 25 or at the construction site, where contaminant concentrations are expected to be highest, 100 or 250 days/year, respectively. It is conservative to assume that off-base residents would consume milk, meat, fruit, or vegetables that come from the contaminated source 350 days/year. It is even more conservative to assume that on-site workers would be at the site perimeter 100 days/year, since there are no known activities which take place at the site presently. Should the construction that has been proposed for Landfill No. 25 take place, it is highly unlikely that construction workers would be exposed to the high estimated airborne contaminant concentrations, which represent an upperbound estimate for occupational exposures, 8 hours a day, 250 days/year for two years. These assumptions may further overestimate exposures.

4. Ambient air concentrations predicted at the perimeter of CAFB (approximately 1250 feet from the site) were used to estimate risks associated with residential exposures. This assumption may be overly conservative because contaminant concentrations in the air

would be expected to be diluted at distant sites, such as off-base residences (closest residential land use is 3500 feet).

5. The use of feed-to-beef and feed-to-milk transfer coefficients that do not account for metabolism and/or disposition of chemicals may also lead to overestimation of exposure.

6. One hundred percent absorption of inhaled and ingested contaminants is assumed. One hundred percent bioavailability is assumed for all inhaled, ingested, and dermally absorbed contaminants. These assumptions are highly conservative.

7. Future off-site residential scenarios assume direct use of groundwater by residents. However, by the time the contaminants reach the groundwater, it is probable that the aquifer will be depleted and not available for residential use.

All of the above exposure assumptions tend to overestimate exposures. No assumptions that tend to underestimate exposures have been identified with respect to exposure parameter estimation.

Exposure parameters used in the assessment represent exposures that may occur considering both current and future land use. Future off-base land use is not expected to differ significantly from current land use practices. However, CAFB is an expanding base and, therefore, current land use at Landfill No. 25 may not reflect future uses.

6.4 Toxicity Assessment

Toxicity assessment involves determining whether exposure to an agent can increase the incidence of a particular adverse effect (e.g., cancer, birth defects) in humans, characterizing the nature and strength of evidence of causation, and if sufficient data are available, quantifying the relationship between the dose of the contaminant and the incidence of adverse health effects in the exposed population. Toxicity values are derived from the quantitative dose-response relationship. These values can be used to

estimate the incidence or potential for adverse effects as a function of human exposure to the contaminant. This section summarizes the toxicity values used for the risk assessment.

6.4.1 Background

USEPA has performed the toxicity assessment step for numerous chemicals, and the resulting toxicity information and toxicity values have undergone extensive internal peer review. Toxicity values used to evaluate noncarcinogenic effects (effects other than cancer) include:

- Reference dose (RfD) in units of mg/kg-day; and
- Reference concentration (RfC) in units of mg/m^3.

The RfD and RfC are estimates (with uncertainty spanning as much as an order of magnitude) of the daily exposure to the human population (including sensitive sub-groups) that is likely to be without an appreciable risk of deleterious effects during a portion of the lifetime, in the case of a subchronic RfC or RfD, or during the lifetime, in the case of a chronic RfC or RfD. The RfD is used to evaluate oral and dermal exposures and the RfC is used to evaluate inhalation exposures.

Toxicity values used to evaluate carcinogenic effects include:

- Weight of evidence classification;
- Slope factor (SF) in units of $(mg/kg\text{-}day)^{-1}$; and
- Unit risk for inhalation exposure in units of $(\mu g/m^3)^{-1}$.

The weight of evidence classification is a USEPA classification system for characterizing the extent to which the available data indicate that an agent is a human carcinogen. In assessing the carcinogenic potential of a chemical, USEPA classifies the chemical into

one of the following groups, according to the weight of evidence from epidemiological studies and animal studies:

Group A - Human Carcinogen (sufficient evidence of carcinogenicity in humans);

Group B - Probable Human Carcinogen (B1 - limited evidence of carcinogenicity in humans; B2 - sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans);

Group C - Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data);

Group D - Not Classifiable as to Human Carcinogenicity (inadequate or no evidence); or

Group E - Evidence of Noncarcinogenicity for Humans (no evidence of carcinogenicity in adequate studies).

USEPA performs quantitative carcinogenic risk assessments for chemicals in Groups A and B, and on a case-by-case basis for chemicals in Group C. Classification of a chemical as Group D or E precludes performance of quantitative risk assessment. Cancer slope factors are estimated through the use of mathematical extrapolation models, most commonly the linearized multistage model, for estimating the largest possible linear slope (within the 95% confidence limit) at low extrapolated doses that is consistent with the data. The slope factor is characterized as a plausible upper-bound estimate of the probability of a response per unit intake of a chemical over a lifetime. The slope factor is used to estimate an upper-bound probability of an individual developing cancer as a result of a lifetime of exposure to a particular level of a potential carcinogen. The unit risk for drinking water and inhalation is the risk per concentration unit in water (risk per $\mu g/L$) and air (risk per $\mu g/m^3$), respectively.

6.4.2 Sources of Information

The following sources of information, in order of priority, were consulted to identify toxicity values for chemicals of concern with potential for human exposure:

- USEPA's Integrated Risk Information System (IRIS) - IRIS is updated monthly, provides verified RfDs and slope factors, and is the Agency's preferred source of toxicity information;
- USEPA's Health Effects Assessment Summary Tables (HEAST) - HEAST provides information on interim (not yet verified by USEPA Workgroups) as well as verified RfDs and slope factors and is used only to obtain toxicity values for chemicals not listed in IRIS;
- Other USEPA documents, such as the Drinking Water Regulations and Health Advisories (USEPA, 1991b).

6.4.3 Toxicity Values Used in the Risk Assessment

This section summarizes the available toxicity information for each of the chemicals of concern with potential for human exposure. Chemicals of concern that were screened out during the chemical selection process (see Section 6.1) are not included in the toxicity assessment. The relevant information includes standard USEPA toxicity values and toxicity values derived for use in this risk assessment. The information in this section was used in determining the risks associated with noncarcinogenic effects (RfDs), carcinogenic potential (slope factors), and weight of evidence classification. These values are defined and discussed in Section 6.4.1 of this report.

6.4.3.1 Toxicity Values for Noncarcinogenic Effects

The RfD values for the chemicals of concern are presented in Table 6-9 and were obtained from an IRIS search dated 1 February 1993 or from the USEPA, HEAST, 1992. Oral RfD values were not available for aluminum, benzene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, β-BHC, 4,4'-DDD, 4,4'-

Table 6-9

Toxicity Values for Chemicals Specific to Landfill No. 25 CAFB, Clovis, New Mexico

Chemical	EPA Class	Chronic Oral RfD (mg/kg-day)	Subchronic Oral RfD (mg/kg-day)	Chronic Inhalation RfC (mg/m^3)	Subchronic Inhalation RfC (mg/m^3)	Oral Slope Factor (mg/kg-day)$^{-1}$	Inhalation Unit Risk 1/(µg/m^3)	Inhalation Slope Factor (mg/kg-day)$^{-1}$
Organics								
β-BHC	C	--	--	--	--	1.80E+00 [I]	5.3E-04 [I]	1.80E+00 [H]
Benzene	A	--	--	--	--	2.90E-02 [I]	8.30E-06 [I]	2.90E-02 [H]
Benzo(a)pyrene	B2	--	--	--	--	7.30E+00 [I]	1.70E-04 [H]	6.10E+00 [H]
Benzo(b)fluoranthene	B2	--	--	--	--	1.02E+00 [Comp]	--	--
Benzo(k)fluoranthene	B2	--	--	--	--	4.82E-01 [Comp]	--	--
4,4'-DDD	B2	--	--	--	--	2.40E-01 [I]	--	--
4,4'-DDE	B2	--	--	--	--	3.40E-01 [I]	--	--
4,4'-DDT	B2	5.00E-04 [I]	5.00E-04 [H]	--	--	3.40E-01 [I]	9.70E-05 [I]	3.40E-01 [H]
Diesel Fuel	D	8.00E-03 [EPA]	--	--	--	--	--	--
Fluoranthene	D	4.00E-02 [I]	4.00E-01 [H]	--	--	--	--	--
Heptachlor	B2	5.00E-04 [I]	5.00E-04 [H]	--	--	4.50E+00 [I]	1.30E-03 [I]	4.50E+00 [H]
Heptachlor epoxide	B2	1.30E-05 [I]	1.30E-05 [H]	--	--	9.10E+00 [I]	2.60E-03 [I]	9.10E+00 [H]
Hydrocarbons								
MCPP		1.00E-03	1.00E-02 [H]	--	--	--	--	--
Methylene chloride	B2	6.0E-02 [I]	6.00E-02 [H]	3.00E+00 [H]	3.00E+00 [H]	7.50E-03	4.70E-07	--
Pyrene	D	3.00E-02 [I]	3.00E-01 [H]	--	--	5.91E-01 [Comp]	--	--
Toluene	D	2.00E-01 [I]	2.00E+00 [H]	4.00E-01 [I]	2.00E+00 [H]	--	--	--

Table 6-9

(Continued)

Chemical	EPA Class	Chronic Oral RfD (mg/kg-day)	Subchronic Oral RfD (mg/kg-day)	Chronic Inhalation RfC (mg/m^3)	Subchronic Inhalation RfC (mg/m^3)	Oral Slope Factor (mg/kg-day)$^{-1}$	Inhalation Unit Risk 1/(µg/m^3)	Inhalation Slope Factor (mg/kg-day)$^{-1}$
Inorganics								
Aluminum		--	--	--	--	--	--	--
Arsenic	A	3.00E-04 [I]	3.00E-04 [H]	--	--	--	4.30E-03 [I]	5.0E+01 [H]
Manganese (Food)	D	1.50E-01 [I]	1.00E-02 [H]	4.00E-04 [I]	4.00E-04 [H]	--	--	--
Manganese (Water)	D	5.00E-03 [I]	1.00E-01 [H]	4.00E-04 [I]	4.00E-04 [H]	--	--	--
Thallium		8.00E-05 [I]	--	--	--	--	--	--
Vanadium		7.00E-03 [H]	7.00E-03 [H]	--	--	--	--	--
Zinc	D	3.00E-01 [I]	2.00E-01 [H]	--	--	--	--	--

H = Health Effects Assessment Summary Tables, 1992.
I = Integrated Risk Information System Database, Search dated February 1993.
Comp = Calculated using relative potency estimates in conjunction with the Benzo[a]Pyrene dose-response model.
Calc MCL = Calculated based on Maximum Contaminant Level (MCL).
EPA = USEPA memorandum in response to requests for toxicity values for fuels, 1992.

4,4'-DDE, or hydrocarbons. Unless a specific dermal RfD was listed by IRIS or HEAST, the RfD for dermal exposures was assumed to be the same as for oral exposures. When available, inhalation RfCs were included.

6.4.3.2 Toxicity Values for Carcinogenic Effects

The slope factors for chemicals of potential concern classified by USEPA as carcinogens are also presented in Table 6-9 and were obtained from an IRIS search dated 1 February 1993 or from HEAST, 1992. When available, inhalation unit risk factors were included.

6.4.4 Health Effects Summaries

Appendix N of this report summarizes the toxicity information available for the noncarcinogenic and carcinogenic effects associated with the chemicals of potential concern. Toxicity profiles have been provided for chemicals with known health effects that were screened out based on the concentration/toxicity screen as well as for those chemicals carried through the quantitative risk assessment. General information on the potential health effects of exposures to the chemicals of potential concern is provided. Toxicity information on noncarcinogenic effects is provided for each contaminant that has an RfD value and includes the data that formed the basis for the determination of the RfD. Information on the potential carcinogenic risk includes supporting data for the USEPA carcinogenic classification. Table 6-10 summarizes the available information on human health effects of exposure to the chemicals that have been carried through the quantitative risk assessment. Unless otherwise stated, the information presented below (and in Appendix N) on each of the chemicals of concern is summarized from the information available on IRIS as of 1 February 1993.

6.4.5 Uncertainties Associated with Toxicity Information

Toxicity information for some of the chemicals of concern for this risk assessment was limited. Therefore, varying degrees of uncertainty are associated with the toxicity values presented in this document. Sources of uncertainty associated with toxicity values used in this risk assessment arise from several sources.

A primary source of uncertainty results from the use of information obtained from alternate sources when USEPA-verified toxicity values are not available. It is difficult to assign a level of confidence to these values, although it is appropriate and necessary to use them. Greater uncertainty would result if chemicals that do not have published toxicity values were to be excluded from the assessment.

Physical and chemical descriptions of the exposure atmospheres, amounts to which individuals are exposed, and tissue retention patterns are generally not available for accidental human exposures. Therefore, studies conducted on laboratory animals (under controlled experimental conditions) must, of necessity, be used to provide the exposure, dose, and biological effects data needed to evaluate the toxicity of potentially hazardous materials to which humans may be exposed. However, there are striking differences between laboratory animals and humans in anatomy and physiology. These differences are sources for variation in the toxic responses exhibited between different species. Complicating extrapolations from animals to man are differences in life span, body size, metabolic routes, and routes of exposure. Occasionally adjustments are made, on a case-by-case basis, for species differences in the rate of metabolism or retention within tissues. However, comparisons between species are usually made by use of standardized sizes or weights. These dose terms do not scale-up identically and are in some cases sources of uncertainty themselves.

Table 6-10

Critical Effects of Chemicals of Concern
Landfill No. 25, CAFB, Clovis, New Mexico

Chemical	Noncarcinogenic Effect		Carcinogenic Effect	
	Target Organ	Critical Effect	Target Organ/ Tumor Type	EPA Class
Aluminum	Lung	Increased incidence of asthma, coughing, decreased pulmonary function, pulmonary fibrosis, and several types of cancer have been reported by workers in the aluminum industry.		Not Classified
Arsenic	Lung	Inhalation of inorganic arsenic has been reported to increase the risk of lung cancer. Inhalation of high levels usually results in sore throat and irritated lungs.	Lung-Lung cancer	A-Human Carcinogen
	Skin	Hyperpigmentation and keratosis are characteristic of long-term oral exposure		
	Central Nervous System	Impaired nerve function causing "pins and needles" sensation in hands and feet have been associated with ingestion of arsenic.		

Table 6-10

(Continued)

Chemical	Noncarcinogenic Effect		Carcinogenic Effect	
	Target Organ	Critical Effect	Target Organ/ Tumor Type	EPA Class
Arsenic (Continued)	Vascular System	Decreased production of red and white blood cells, blood vessel damage and abnormal heart function have been noted due to ingestion of arsenic.		
	Gastrointestinal System	Low levels of inorganic arsenic in food or water may result in irritation of the stomach and intestines, with symptoms such as pain, nausea, vomiting, and diarrhea.		
Benzene	CNS (central nervous system)	Exposure to lower levels of (700-3,000 ppm) benzene may cause drowsiness, dizziness, headaches, and unconsciousness. Ingestion of foods containing high levels of benzene may have similar effects.	Bone marrow - leukemia	A-Human Carcinogen

Table 6-10
(Continued)

Chemical	Noncarcinogenic Effect		Carcinogenic Effect	
	Target Organ	Critical Effect	Target Organ/ Tumor Type	EPA Class
Benzene (Continued)	Blood	Inhalation of benzene for long periods of time may have adverse effects on the tissues that form blood cells, particularly the bone marrow. This may result in anemia or excessive bleeding.		
	Reproductive System	Long-term inhalation exposure has been reported to cause irregular menstrual cycles, and reduced ovary size in female workers. Low birth weights, delayed bone formation and bone marrow damage have been reported in off-spring from animals fed benzene during pregnancy.		
	Immune System	Benzene exposure can enhance the probability of infection and may lower the body's defense against tumors.		

Table 6-10

(Continued)

Chemical	Noncarcinogenic Effect		Carcinogenic Effect	
	Target Organ	Critical Effect	Target Organ/ Tumor Type	EPA Class
Benzo(k) Fluoranthene Benzo(b) Fluoranthene	Glandular System	Benzo(a) anthracene has been shown to suppress the sebaceous glands following topical application to mice.	Stomach - stomach tumors Skin - malignant skin tumors Respiratory Tract - respiratory tract tumors	B2-Probable Human Carcinogen
	Reproductive System	Short-term exposure of mice to B(a)P in the diet caused birth defects.		
	Liver and Blood	Long-term (6 months) exposure of mice to B(a)P results in adverse effects on the liver and blood.		
Benzo(a) Pyrene [B(a)P]	Reproductive System	Offspring of animals fed B(a)P during pregnancy have lower birth rates than normal and developmental aberrations (alterations in gonadal development, decreased fertility, increased incidence of sterility).		B2-Probable Human Carcinogen

Table 6-10

(Continued)

Chemical	Noncarcinogenic Effect		Carcinogenic Effect	
	Target Organ	Critical Effect	Target Organ/ Tumor Type	EPA Class
Benzo(a) Pyrene (Continued)	Immune System	Short- and long-term exposures to B(a)P cause death when ingested by animals. Deaths appear to be due to bone marrow suppression.		
Beta-BHC	Liver	Hypertrophy has been reported in a chronic ingestion studies conducted in rats.	Lung - lung cancer Bone - Osteosarcoma	B2-Probable Human Carcinogen
	Kidney	Tubular degeneration, hyalin droplet formation, and interstitial nephritis has been observed in rates fed BHC in the diet.		
4,4'-DDE	Liver and Thyroid	Hypertrophy may result after chronic oral exposure of rodents.	Liver - hepatocellular carcinomas	B2-Probable Human Carcinogen
4,4'-DDD	Thyroid	Atrophy of the thymus has been observed following short-term exposure of mice to DDD in the diet.	Thyroid - tumors Lung - tumors	B2-Probable Human Carcinogen

Table 6-10

(Continued)

Chemical	Noncarcinogenic Effect		Carcinogenic Effect	
	Target Organ	Critical Effect	Target Organ/ Tumor Type	EPA Class
4,4'-DDT	Liver	Chronic exposure may result in changes in enzyme levels in rodents.	Liver - carcinomas	B2-Probable Human Carcinogen
	Reproductive System	Some evidence in laboratory animals indicates that DDT may decrease fertility and may adversely affect offspring.		
Diesel Fuel	Liver	Fatty changes in the livers of mice have been reported following subchronic inhalation exposure.		D - Not Classifiable as to Human Carcinogenicity
Fluoranthene	Liver	Adverse effects on the liver (increased SGPT levels, liver weights, microscopic liver lesions) have been noted in mice.		D - Not Classifiable as to Human Carcinogenicity
	Kidney	Kidney pathology has been noted among mice exposed to fluoranthene.		

Table 6-10

(Continued)

Chemical	Noncarcinogenic Effect		Carcinogenic Effect	
	Target Organ	Critical Effect	Target Organ/ Tumor Type	EPA Class
Heptachlor/Heptachlor Epoxide	CNS	Tremors and convulsions have been reported in animals exposed orally to heptachlor. Heptachlor epoxide is more toxic than heptachlor primarily because it is stored in the fat.	Liver - malignant liver tumors and liver carcinomas	B2-Probable Human Carcinogen
	Liver and Kidney	Animals fed heptachlor have been reported to have enlarged livers, liver damage and kidney damage.		
	Reproductive System	Evidence suggests an association between heptachlor and reproductive effects (infertility; improper development of offspring). Placental transfer of heptachlor epoxide has been reported following inhalation.		

Table 6-10

(Continued)

Chemical	Noncarcinogenic Effect		Carcinogenic Effect	
	Target Organ	Critical Effect	Target Organ/ Tumor Type	EPA Class
Manganese	Lung	Inhalation of manganese particulates can lead to an inflammatory response in the lungs of animals and humans.		D-Not Classifiable as to Human Carcinogenicity
	CNS	Inhalation of large amounts of manganese can lead to a disabling neurological syndrome accompanied by apathy, general weakness, dullness, anorexia, and muscle pain in humans. Loss of libido and impotence have also been reported in males exposed occupationally.		
MCPP (2-Methylchloro-phenoxy Propionic Acid)	Liver	Increased absolute and relative organ weight has been observed in rats exposed to MCPP in the diet.		Not Classified

Table 6-10
(Continued)

Chemical	Noncarcinogenic Effect		Carcinogenic Effect	
	Target Organ	Critical Effect	Target Organ/ Tumor Type	EPA Class
MCPP (Continued)	Kidney	Increased absolute and relative organ weight, increased creatinine and decreased fructose levels have been observed in rats exposed to MCPP in the diet.		Not Classified
Methylene Chloride	Liver	Histological alterations of the liver were noted in a chronic drinking water study conducted on rats.	Liver - hepatocellular neoplasms Lung - alveolar/bronchiolar neoplasms Hematopoietic System - leukemia	B2-Probable Human Carcinogen
Pyrene	Reproductive System	Short-term exposure of mice to B(a)P in the diet causes birth defects.		D - Not Classifiable as to Human Carcinogenicity
	Liver and Blood	Long-term (6 months) exposure of mice to B(a)P results in adverse effects on the liver and blood		

Table 6-10
(Continued)

Chemical	Noncarcinogenic Effect		Carcinogenic Effect	
	Target Organ	Critical Effect	Target Organ/ Tumor Type	EPA Class
Thallium	CNS, Lung, Liver, and Kidney	Thallium can affect the CNS, lung, liver or kidney if large amounts are ingested. Symptoms include temporary hair loss, vomiting, and diarrhea.		D-Not Classifiable as to Human Carcinogenicity
	Reproductive System	Animal reproductive organs, especially the testes have been damaged following thallium exposure in drinking water.		
Toluene	Skin	Irritation of the skin and eyes has been observed in humans.		D-Not Classifiable as to Human Carcinogenicity
	Liver and Kidney	Increased liver and kidney weights have been noted in subchronic studies conducted in rats.		

Table 6-10

(Continued)

Chemical	Noncarcinogenic Effect		Carcinogenic Effect	
	Target Organ	Critical Effect	Target Organ/ Tumor Type	EPA Class
Vanadium	Lung	Chronic inhalation can cause mild respiratory distress (coughing, wheezing, chest pain). Studies suggest that vanadium is not very toxic by the oral route.		Not Classified
Zinc	Gastrointestinal System	Signs of zinc intoxication may include gastrointestinal distress, emesis, and decreased food consumption.		D-Not Classifiable as to Human Carcinogenicity
	Blood	Anemia and hemorrhage have been noted in several species following exposure to high zinc concentrations.		

Another source of uncertainty related to toxicity information is the use of dose-response information from effects observed at high doses to predict adverse health effects that may occur at the low levels to which humans are likely to be exposed in the environment. Sources of uncertainty occur in the USEPA potency estimates (slope factors) when they are applied to humans exposed to levels of putative carcinogens far below those administered to laboratory animals under experimental conditions. Many substances induce or enhance cancer in animals through processes for which a possible threshold can be identified. These effects usually only occur at very high doses and assuming that a lesser degree of the same effect occurs at lower doses is not necessarily an accurate portrayal of toxicity. This assumption may result in gross overestimation of the health risks associated with a particular chemical.

Two major factors that influence toxicity of chemicals are the duration and frequency of exposure. For many agents, the toxic effects following a single exposure are quite different from those produced by repeated and long-term exposures. In general, fractionation of the dose (or exposure) of a chemical reduces its toxicity. Therefore, a single exposure to a substance may produce an immediate severe effect and yet the same dose divided into multiple exposures may produce an attenuated response or no response at all. Such fractionation effects are generally the result of excretion between successive doses or to partial or full reversal of the injury produced by each exposure prior to the next exposure. Chronic (long-term) toxic effects occur if a chemical accumulates (absorption exceeds excretion), if it produces irreversible toxic effects, or if there is insufficient time for the individual to recover from the injury within the exposure interval. Therefore, use of information obtained from short-term exposure studies to predict health effects in humans exposed on a long-term basis may be a source of uncertainty.

Uncertainties arise when information gathered in studies using homogenous animal populations (inbred strains) or healthy human populations (occupational exposures) to predict the effects that are likely to occur in the general human population.

Human populations are a heterogenous group with variations in genetic constitution, diet, living environments (previous environmental exposures), activity patterns, and cultural patterns. All of these factors may influence metabolism, distribution of chemicals within the body, and susceptibility to the damaging effects of those chemicals. It is now well established that individuals exposed to several chemicals simultaneously or sequentially may exhibit altered pharmacologic or toxicologic responses. Interactions have been noted with respect to hepatotoxicity. For example, many of the chlorinated solvents induce enzymes in the liver that are involved in metabolism of chemicals. Therefore, an individual who is exposed to these chemicals may experience increased or decreased toxicity subsequent to exposure to other chemicals that undergo metabolism.

6.4.6 Summary of Toxicity Assessment

An understanding of the degree of uncertainty associated with toxicity information is an important part of interpreting and using that information to calculate toxicity values. The degree of confidence ascribed to toxicity values depends on both the quality of the critical study from which it was derived and the quantity of supporting data. USEPA-verified RfDs published in IRIS are accompanied by a statement of the confidence that the evaluators have in the RfD. A discussion of confidence ratings and USEPA's classification as to carcinogenicity are presented below.

Oral RfD values were available for 15 of the 24 individual contaminants of potential concern. Diesel fuel was the only chemical for which USEPA-derived toxicity values were available that was not published in IRIS or HEAST. USEPA has derived a provisional oral RfD for diesel fuel. This value was obtained from a USEPA memorandum in response to a request for oral systemic and carcinogenic toxicity values for JP-4, JP-5, diesel fuel, and gasoline (AVGAS) found to contaminate soils and groundwater at McChord AFB (Wash Rack/Treatment), Tacoma, WA. The level of confidence in the 14 RfDs given on IRIS ranged from low (nine chemicals) to medium (five chemicals). One RfD (vanadium) was obtained from HEAST, which does not

provide information regarding the level of confidence associated with RfDs. Confidence in the provisional RfD for diesel fuel developed by the USEPA was low. Low confidence indicates that the toxicity value may change if additional toxicity data become available. Oral RfDs were not available for 9 of the chemicals carried through the quantitative risk assessment.

Inhalation RfCs were available for toluene, manganese, and methylene chloride. A confidence rating of medium was assigned to both toluene and manganese. The RfC for methylene chloride was obtained from HEAST, which does not provide information regarding the level of confidence associated with RfCs.

Nineteen of the 24 contaminants carried through the quantitative risk assessment have been classified by the USEPA as to carcinogenic potential. Seven chemicals were classified as Group D (Not Classifiable as to Human Carcinogenicity), indicating inadequate or no evidence of carcinogenicity. One of the chemicals of concern (β-BHC) was classified as Group C (Possible Human Carcinogen) based on limited evidence of carcinogenicity in animals and inadequate or lack of human data. Nine chemicals were classified as Group B (Probable Human Carcinogen), indicating that there is sufficient evidence of the chemical's carcinogenicity in animals and inadequate or no evidence in humans. Two chemicals (benzene and arsenic) were classified as Group A (Human Carcinogen). No chemicals were classified as Group E (Evidence of Noncarcinogenicity for Humans).

USEPA-derived oral slope factors were available for most of the chemicals of potential concern that have been classified as Group A, B, or C carcinogens. However, oral slope factors were derived for benzo(b)fluoranthene, benzo(k)fluoranthene, and pyrene by multiplying the slope factor for benzo(a)pyrene by their respective comparative potency factors. Inhalation slope factors (USEPA-derived) were available for seven chemicals. Inhalation unit risk factors were available for eight chemicals.

6.5 Risk Characterization

Risk characterization involves integrating the possible exposure pathways and estimated chemical intakes with the appropriate toxicity values to form quantitative and qualitative expressions of potential health risk. Measured contaminant exposure levels, as well as those predicted by fate and transport modeling, are compared to chemical-specific toxicity information to determine if current or future levels of contamination, at or near the site, warrant concern for human health. The following subsections briefly describe the methodology used to characterize risk, present and future noncarcinogenic and carcinogenic risk estimates for each exposure scenario, uncertainties associated with predicting risk, and identify the key chemicals of potential concern and exposure pathways that drive the risk assessment.

6.5.1 Risk Characterization Methodology

6.5.1.1 Carcinogenic Effects

The cancer slope factor converts estimated daily intakes to an estimate of incremental risk. Because the slope factor is often an upper 95th percentile confidence limit of the probability of a response based on experimental animal data and an assumption of linearity in the low dose portion of a dose-response curve, the carcinogenic risk estimate is generally an upper-bound estimate. This means "true risk" probably does not exceed the risk estimates generated in this assessment and is likely to be less than the predicted risk (USEPA, 1991a).

For carcinogens, probabilities that an individual will develop cancer over a lifetime of exposure are estimated from projected exposure and the cancer slope factor. Exposure is quantified as the amount of a chemical available at the exchange boundary

(i.e., skin, lungs, etc.) and available for absorption. The carcinogenic risk is calculated for each exposure scenario using the following equation:

$$\text{Risk} = \text{Exposure} \times \text{Slope Factor.}$$

The USEPA Superfund site remediation goal set forth in the National Contingency Plan (NCP) allows a cancer risk of 1E-4 (1 in 10,000) to 1E-6 (1 in 1,000,000). This range is designed to be protective of human health.

6.5.1.2 Noncarcinogenic Effects

To characterize potential noncarcinogenic effects, comparisons are made between projected intakes of substances over a specified time period and toxicity values, primarily oral, dermal, and inhalation reference doses. The ratio of exposure to toxicity value is the hazard quotient (HQ) and the HQ is calculated for each exposure scenario using the following equation:

$$\text{HQ} = \text{Exposure/RfD or RfC}$$

Note that the HQ is not a statistical probability of a noncarcinogenic effect occurring and should not be interpreted as such. If the exposure level exceeds the appropriate toxicity value (i.e., the hazard quotient is greater than one), there may be cause for concern regarding the potential noncarcinogenic effects as set forth in the NCP.

6.5.2 Potential Exposure Scenarios

To ensure adequate characterization of risk that may be incurred at Landfill No. 25 presently or in the future, three chronic scenarios and two subchronic scenarios were identified for human exposure. The chronic exposure scenarios are: 1) present off-site residential; 2) future off-site residential; and 3) on-site worker. The subchronic exposure scenarios are: for 1) the present on-site worker; and 2) the future on-site construction worker.

6.5.3 Combining Risks Associated with Chemicals and Exposure Pathways

For each scenario addressed in this risk assessment, the estimated carcinogenic risk for potential carcinogens is generated on a chemical-specific basis for each relevant pathway of exposure. The estimated risk for each chemical associated with a specific pathway is summed to determine the total risk by pathway. To determine the total exposure scenario risk, total risks for all pathways are summed.

The total risk number assumes that different carcinogens affect the same target organ to produce a cancer response, ignoring potential antagonistic or synergistic effects or disparate effects on different target organs. It also assumes that the individual in the exposure scenario is exposed to site-related contaminants at estimated exposure concentrations by all pathways that compose the scenario. The scenarios were constructed to include all potential pathways of exposure and assume that it is possible for a single individual to be exposed by all pathways in a scenario. It is not likely, however, that a single individual will be exposed by each pathway at the conservatively estimated concentrations in the exposure media. For example, it is unlikely that an individual would be chronically exposed to maximum off-site groundwater concentrations and to maximum off-site concentrations predicted in agricultural products, because the sources of contamination are from different locales.

Likewise, the estimated hazard quotient for noncarcinogenic effects is generated on a chemical-by-chemical basis for each relevant pathway of exposure. The hazard quotients for each chemical associated with a specific pathway are summed to determine the hazard index by pathway. The hazard indices for all pathways are finally summed to determine the total hazard index for the exposure scenario.

6.5.4 Documentation of Risk Characterization Results

The exposure and risk calculations were performed by a risk model (Quantitative Site-Specific Multi-Media Assessment Risk Tool or QSMART) developed to automate the exposure quantification and risk characterization process. The model automates the equations for chemical intake and generates chemical-specific hazard indices for noncarcinogenic effects using RfDs and chemical-specific carcinogenic risk estimates using cancer slope factors. The model sums the resultant values for chemicals in each of the exposure pathways, and across pathways, to generate a total scenario hazard index for noncarcinogenic effects and a total scenario cancer risk for carcinogenic effects. The program also calculates the percentage of the total risk contributed by each individual chemical and pathway of exposure. Appendix O contains the exposure and risk model output.

6.5.5 Risk Characterization for the Present Off-Site Residential Exposure Scenario

This scenario addresses pathways of exposure considered to be complete for off-site residents at the present time based on current use of the land and water. It assumes that land and water use will not change significantly over the duration of exposure.

The present off-site residential scenario assumes exposure to site-related contaminants at off-base locations via three pathways of exposure: 1) ingestion of fruits and vegetables; 2) ingestion of meats and dairy products; and 3) inhalation of volatiles and

particulates in the ambient air. It is possible that contaminants detected in the soil at Landfill No. 25 could impact off-site soils due to deposition of wind-blown dusts. However, this migration pathway was not considered to be significant and was not assessed. Currently, one farmer uses surface water drawn from the Playa Lake for agricultural purposes. Widespread exposure resulting from dermal contact or inhalation of volatiles from Playa Lake water is unlikely because of the single user of this potentially contaminated source. Therefore, these pathways have not been included in this risk assessment.

Exposure concentrations were based on: 1) modeled on-site concentrations in surface water for purposes of predicting uptake and accumulation in fruits, vegetables, meat, and dairy products; and 2) modeled contaminant concentrations in ambient air, based on concentrations in on-site surficial and deep soil samples.

Many chemicals were detected in surficial soil samples and were therefore modeled to the Playa Lake in order to estimate the potential contribution of surface runoff from Landfill No. 25 to human exposure scenarios associated with the site. Based on modeled air emission results, several chemicals are predicted to enter the atmosphere above the landfill via volatilization or wind entrainment of contaminated dust.

Carcinogenic effects were estimated for adults only since risks are estimated as the probability of an individual developing cancer over a life-time. Chronic exposure was evaluated for 1) an average case, using average or 50th percentile values for exposure parameters (e.g., contaminant concentration, body weight, intake rates, exposure duration and frequency); and 2) a reasonable maximum case, using the 95th (occasionally 90th) percentile values for exposure parameters when available and appropriate. Noncarcinogenic effects were evaluated for adults and children with both average and reasonable maximum exposure parameters.

6.5.5.1 Carcinogenic Effects

Adults--Tables 6-11 and 6-12 characterize the average and reasonable maximum carcinogenic risk for adults, respectively. The total hazard indices for average and reasonable maximum exposure were 3E-8 and 1E-7, respectively. Both hazard indices are below the Superfund site remediation risk range goal of 1 in 1,000,000 (1E-6) cancer risk. Arsenic contributes 88% of both the average and reasonable maximum chemical-specific risk. The inhalation pathway contributes virtually all of the risk associated with the average and reasonable maximum exposure scenarios.

6.5.5.2 Noncarcinogenic Effects

Adults--Tables 6-13 and 6-14 characterize the average and reasonable maximum noncarcinogenic risks for adults, respectively. The total hazard index was 9E-3 for both average and reasonable maximum exposure. Manganese contributed 99% of both the average and reasonable maximum chemical-specific risks. The inhalation pathway contributed virtually all of the total average and reasonable maximum risk.

USEPA recommends comparing the concentrations of chemicals in ambient air with a reference concentration (RfC) rather than a reference dose (RfD) for assessing inhalation exposure (USEPA, 1990a). USEPA has been involved for the last several years in developing a method for derivation of inhalation RfCs. This decision was meant to clearly distinguish between oral and inhalation exposure. Currently, RfCs are available only for a limited number of compounds. Inhalation RfCs were not available for some contaminants predicted to enter the atmosphere via volatilization (benzene, diesel fuel, hydrocarbons,) or wind entrainment of contaminated surface soil (4,4'-DDD, 4,4'-DDE, 4,4'-DDT, aluminum, arsenic, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)-fluoranthene, beta-BHC, fluoranthene, heptachlor, heptachlor epoxide, MCPP, pyrene, thallium, vanadium, and zinc). Therefore, the contribution of these chemicals to the total noncarcinogenic risks associated with the inhalation pathway could not be assessed.

Table 6-11

Average Cancer Risk Off-Site Residential Adult - Present
Landfill No. 25, CAFB, Clovis, New Mexico

	Inhalation of Ambient Air	Ingestion of Fruits	Ingestion of Vegetables	Ingestion of Meat	Ingestion of Milk	Total	% Contribution
4,4'-DDD	0E+0	2E-18	3E-18	2E-17	1E-17	3E-17	< 1
4,4'-DDE	0E+0	2E-17	4E-17	7E-17	4E-17	2E-16	< 1
4,4'-DDT	4E-12	7E-18	1E-17	3E-16	2E-16	4E-12	< 1
Arsenic	3E-8	0E+0	0E+0	0E+0	0E+0	3E-8	88
Benzene	1E-9	0E+0	0E+0	5E-20	3E-20	1E-9	4
Benzo(a)pyrene	2E-9	7E-17	1E-16	3E-15	2E-15	2E-9	6
Benzo(b)fluoranthene	0E+0	2E-17	3E-17	2E-15	1E-15	3E-15	< 1
Benzo(k)fluoranthene	0E+0	6E-18	1E-17	1E-15	8E-16	2E-15	< 1
beta-BHC	2E-12	8E-16	1E-15	5E-18	4E-18	2E-12	< 1
Heptachlor	6E-12	2E-16	4E-16	3E-16	2E-16	6E-12	< 1
Heptachlor epoxide	1E-11	9E-17	2E-16	1E-16	7E-17	1E-11	< 1
Methylene chloride	9E-10	0E+0	0E+0	6E-21	4E-21	9E-10	3
Pyrene	0E+0	2E-16	4E-16	2E-20	8E-17	7E-16	< 1
Total by pathway	3E-8	1E-15	3E-15	6E-15	4E-15		
% Contribution by pathway	100	< 1	< 1	< 1	< 1		
Scenario Total						3E-8	

Table 6-12

Reasonable Maximum Cancer Risk Off-Site Residential Adult - Present
Landfill No. 25, CAFB, Clovis, New Mexico

	Inhalation of Ambient Air	Ingestion of Fruits	Ingestion of Vegetables	Ingestion of Meat	Ingestion of Milk	Total	% Contribution
4,4'-DDD	0E+0	1E-17	3E-17	4E-16	2E-16	7E-16	< 1
4,4'-DDE	0E+0	2E-16	3E-16	2E-15	9E-16	3E-15	< 1
4,4'-DDT	1E-11	6E-17	1E-16	6E-15	3E-15	1E-11	< 1
Arsenic	1E-7	0E+0	0E+0	0E+0	1E-7		88
Benzene	4E-9	0E+0	0E+0	1E-18	7E-19	4E-9	4
Benzo(a)pyrene	6E-9	6E-16	1E-15	7E-14	4E-14	6E-9	6
Benzo(b)fluoranthene	0E+0	2E-16	3E-16	4E-14	2E-14	6E-14	< 1
Benzo(k)fluoranthene	0E+0	5E-17	9E-17	3E-14	2E-14	5E-14	< 1
beta-BHC	8E-12	7E-15	1E-14	1E-16	9E-17	8E-12	< 1
Heptachlor	2E-11	2E-15	4E-15	7E-15	4E-15	2E-11	< 1
Heptachlor epoxide	5E-11	7E-16	1E-15	2E-15	1E-15	5E-11	< 1
Methylene chloride	3E-9	0E+0	0E+0	1E-19	8E-20	3E-9	3
Pyrene	0E+0	2E-15	4E-15	4E-19	2E-15	7E-15	< 1
Total by pathway	1E-7	1E-14	2E-14	2E-13	9E-14		
% Contribution by pathway	100	< 1	< 1	< 1	< 1		
Scenario Total						1E-7	

Table 6-13

Average Non-Cancer Hazard Index Summary Off-Site Residential Adult - Present
Landfill No. 25, CAFB, Clovis, New Mexico

	Inhalation of Ambient Air	Ingestion of Fruits	Ingestion of Vegetables	Ingestion of Meat	Ingestion of Milk	Total	% Contribution
4,4'-DDT	0E+0	3E-13	6E-13	1E-11	7E-12	2E-11	< 1
Arsenic	0E+0	9E-10	1E-8	2E-9	1E-10	1E-8	< 1
Fluoranthene	0E+0	1E-13	2E-13	2E-14	2E-14	4E-13	< 1
Heptachlor	0E+0	8E-13	1E-12	1E-12	7E-13	4E-12	< 1
Heptachlor epoxide	0E+0	6E-12	1E-11	6E-12	4E-12	3E-11	< 1
Manganese	9E-3	4E+10	8E-11	6E-13	1E-12	9E-3	99
Methylene chloride	5E-6	0E+0	0E+0	1E-16	6E-17	5E-6	< 1
Pyrene	0E+0	1E-13	2E-13	7E-18	4E-14	3E-13	< 1
Thallium	0E+0	7E-11	1E-9	4E-13	4E-9	5E-9	< 1
Toluene	4E-6	0E+0	0E+0	5E-17	1E-15	4E-6	< 1
Vanadium	0E+0	1E-9	4E-9	9E-13	7E-9	1E-8	< 1
Zinc	0E+0	1E-8	7E-9	6E-14	3E-9	2E-8	< 1
Total by pathway	9E-3	1E-8	2E-8	2E-9	1E-8		
% Contribution by pathway	100	< 1	< 1	< 1	< 1		
Scenario Total						9E-3	

Table 6-14

Reasonable Maximum Non-Cancer Hazard Index Summary
Off-Site Residential Adult - Present
Landfill No. 25, CAFB, Clovis, New Mexico

	Inhalation of Ambient Air	Ingestion of Fruits	Ingestion of Vegetables	Ingestion of Meat	Ingestion of Milk	Total	% Contribution
4,4'-DDT	0E+0	8E-13	2E-12	8E-11	5E-11	1E-10	< 1
Arsenic	0E+0	2E-9	3E-8	1E-8	6E-10	4E-8	< 1
Fluoranthene	0E+0	3E-13	5E-13	2E-13	1E-13	1E-12	< 1
Heptachlor	0E+0	2E-12	4E-12	8E-12	4E-12	2E-11	< 1
Heptachlor epoxide	0E+0	1E-11	3E-11	5E-11	3E-11	1E-10	< 1
Manganese	9E-3	6E+10	2E-10	4E-12	9E-12	9E-3	99
Methylene chloride	5E-6	0E+0	0E+0	7E-16	4E-16	5E-6	< 1
Pyrene	0E+0	3E-13	5E-13	5E-17	2E-13	1E-12	< 1
Thallium	0E+0	2E-10	3E-10	3E-12	2E-8	2E-8	< 1
Toluene	4E-6	0E+0	0E+0	4E-16	6E-15	4E-6	< 1
Vanadium	0E+0	3E-9	1E-8	7E-12	4E-8	6E-8	< 1
Zinc	0E+0	3E-8	2E-8	4E-13	2E-8	7E-8	< 1
Total by pathway	9E-3	3E-8	6E-8	1E-8	9E-8		
% Contribution by pathway	100	< 1	< 1	< 1	< 1		
Scenario Total						9E-3	

Children--Tables 6-15 and 6-16 illustrate the average and reasonable maximum noncarcinogenic risk for children, respectively. The hazard index was 9E-3 for both average and reasonable maximum exposure. Manganese contributed the majority (99% for both average and reasonable maximum) of the chemical-specific risk. Inhalation was responsible for virtually all of the pathway-specific risks.

6.5.6 Risk Characterization for the Present On-Site Worker Exposure Scenario

This scenario addresses pathways of exposure considered to be complete for an on-site worker at the present time. Surficial and deep soil samples were taken at the site. Laboratory analyses detected metals at depths ranging from 0 to 60 feet. Organics were also detected at the site, however, many of the results (all of those at depth) were below the RL or less than five times the RL, making the concentrations of these contaminants uncertain. There is little or no evidence of disturbances by humans in the area and there are currently no invasive activities at the site. In most cases, the contaminated soil was below the rubble pile. The rubble pile was not included in this assessment and, therefore, direct human contact with contaminants in the soil is currently unlikely.

The present on-site worker scenario assumes exposure to site-related contaminants via inhalation of contaminants emitted to the atmosphere above the site. Exposure concentrations were based on predicted concentrations at the site perimeter estimated from measured concentrations in surficial and deep soil samples taken from soil borings within the confines of the landfill. Concentrations of contaminants in the air are expected to be highest at this location.

On-site workers were assumed to be adults. Noncarcinogenic and carcinogenic effects were evaluated with both average and reasonable maximum exposure parameters. Noncarcinogenic effects were evaluated assuming both chronic (25 years) and subchronic (7 years) exposures.

Table 6-15

Average Non-Cancer Hazard Index Summary Off-Site Residential Child - Present
Landfill No. 25, CAFB, Clovis, New Mexico

	Inhalation of Ambient Air	Ingestion of Fruits	Ingestion of Vegetables	Ingestion of Meat	Ingestion of Milk	Total	% Contribution
4,4'-DDT	0E+0	2E-12	3E-12	3E-11	3E-11	7E-11	< 1
Arsenic	0E+0	4E-9	5E-8	4E-9	5E-10	6E-8	< 1
Fluoranthene	0E+0	5E-13	9E-13	5E-14	7E-14	2E-12	< 1
Heptachlor	0E+0	4E-12	7E-12	2E-12	3E-12	2E-11	< 1
Heptachlor epoxide	0E+0	3E-11	5E-11	2E-11	2E-11	1E-10	< 1
Manganese	9E-3	2E-9	4E-10	1E-12	6E-12	9E-3	99
Methylene chloride	5E-6	0E+0	0E+0	2E-16	3E-16	5E-6	< 1
Pyrene	0E+0	5E-13	8E-13	2E-17	2E-13	1E-12	< 1
Thallium	0E+0	3E-10	6E-9	1E-12	2E-8	2E-8	< 1
Toluene	4E-6	0E+0	0E+0	1E-16	5E-15	4E-6	< 1
Vanadium	0E+0	5E-9	2E-8	2E-12	3E-8	5E-8	< 1
Zinc	0E+0	5E-8	3E-8	1E-13	2E-8	1E-7	< 1
Total by pathway	9E-3	6E-8	1E-7	4E-9	7E-8		
% Contribution by pathway	100	< 1	< 1	< 1	< 1		
Scenario Total						9E-3	

Table 6-16

Reasonable Maximum Non-Cancer Hazard Index Summary Off-Site Residential Child - Present
Landfill No. 25, CAFB, Clovis, New Mexico

	Inhalation of Ambient Air	Ingestion of Fruits	Ingestion of Vegetables	Ingestion of Meat	Ingestion of Milk	Total	% Contribution
4,4'-DDT	0E+0	4E-12	7E-12	2E-10	2E-10	4E-10	< 1
Arsenic	0E+0	1E-8	1E-7	3E-8	3E-9	2E-7	< 1
Fluoranthene	0E+0	1E-12	3E-12	4E-13	5E-13	5E-12	< 1
Heptachlor	0E+0	9E-12	2E-11	2E-11	2E-11	6E-11	< 1
Heptachlor epoxide	0E+0	7E-11	1E-10	1E-10	1E-10	4E-10	< 1
Manganese	9E-3	3E-9	9E-10	1E-11	4E-11	9E-3	99
Methylene chloride	5E-6	0E+0	0E+0	2E-15	2E-15	5E-6	< 1
Pyrene	0E+0	1E-12	2E-12	1E-16	1E-12	4E-12	< 1
Thallium	0E+0	8E-10	2E-9	8E-12	1E-7	1E-7	< 1
Toluene	4E-6	0E+0	0E+0	9E-16	3E-14	4E-6	< 1
Vanadium	0E+0	1E-8	4E-8	2E-11	2E-7	3E-7	< 1
Zinc	0E+0	1E-7	9E-8	1E-12	1E-7	3E-7	< 1
Total by pathway	9E-3	1E-7	3E-7	3E-8	4E-7		
% Contribution by pathway	100	< 1	< 1	< 1	< 1		
Scenario Total						9E-3	

6.5.6.1 Carcinogenic Effects

Tables 6-17 and 6-18 show the carcinogenic risk resulting from average and reasonable maximum on-site worker exposure, respectively. For average exposure, the risk value was 7E-8. The risk value associated with reasonable maximum on-site worker exposure was 4E-8. Both of these risk values are below the Superfund site remediation goal. Inhalation of arsenic accounts for 96% of the chemical-specific risk for both average and reasonable maximum exposure scenarios.

6.5.6.2 Noncarcinogenic Effects

Tables 6-19 and 6-20 illustrate the noncarcinogenic risks resulting from average and reasonable maximum on-site worker chronic exposure scenarios, respectively. Tables 6-21 and 6-22 characterize the noncarcinogenic risks resulting from average and reasonable maximum on-site worker subchronic exposure scenarios, respectively. The hazard index for both the average chronic and subchronic exposure scenarios was 7E-3. The hazard index associated with the reasonable maximum chronic and subchronic exposure scenarios 4E-2. Inhalation of manganese was responsible for 99% of the total risk associated with average and reasonable maximum chronic and subchronic exposures.

6.5.7 Risk Characterization for the Future Off-Site Residential Exposure Scenario

This scenario addresses pathways of exposure considered to be complete for off-site residents at a point in the future, assuming that contaminants originating from Landfill No. 25 migrate to the groundwater. Although groundwater samples were not taken during the 1992 sampling event, groundwater modeling based on soil contaminant concentrations found at Landfill No. 25 indicate that future contamination of the groundwater with contaminants from Landfill No. 25 is possible. The time estimated for contaminants to leach into the groundwater is 173 years, and based on current pumping rates, the aquifer is unlikely to be serving as a source of groundwater at that time.

Table 6-17

Average Cancer Risk On-Site Worker - Present
Landfill No. 25, CAFB, Clovis, New Mexico

	Inhalation of Ambient Air	Total	% Contribution
4,4'-DDT	8E-12	8E-12	< 1
Arsenic	6E-8	6E-8	96
Benzene	3E-10	3E-10	< 1
Benzo(a)pyrene	4E-10	4E-10	< 1
beta-BHC	5E-12	5E-12	< 1
Heptachlor	1E-11	1E-11	< 1
Heptachlor epoxide	3E-11	3E-11	< 1
Methylene chloride	2E-9	2E-9	3
Total by pathway	7E-8		
% Contribution by pathway	100		
Scenario Total		7E-8	

Table 6-18

Reasonable Maximum Cancer Risk On-Site Worker - Present
Landfill No. 25, CAFB, Clovis, New Mexico

	Inhalation of Ambient Air	Total	% Contribution
4,4'-DDT	4E-11	4E-11	< 1
Arsenic	4E-7	4E-7	96
Benzene	2E-9	2E-9	< 1
Benzo(a)pyrene	2E-9	2E-9	< 1
beta-BHC	3E-11	3E-11	< 1
Heptachlor	7E-11	7E-11	< 1
Heptachlor epoxide	2E-10	2E-10	< 1
Methylene chloride	1E-8	1E-8	3
Total by pathway	4E-7		
% Contribution by pathway	100		
Scenario Total		4E-7	

Table 6-19

Average Non-Cancer Hazard Index Summary On-Site Worker - Chronic Landfill No. 25 CAFB, Clovis, New Mexico

	Inhalation of Ambient Air	Total	% Contribution
Manganese	7E-3	7E-3	99
Methylene chloride	4E-6	4E-6	< 1
Toluene	3E-6	3E-6	< 1
Total by pathway	7E-3		
% Contribution by pathway	100		
Scenario Total		7E-3	

Table 6-20

Reasonable Maximum Non-Cancer Hazard Index Summary
On-Site Worker - Chronic
Landfill No. 25, CAFB, Clovis, New Mexico

	Inhalation of Ambient Air	Total	% Contribution
Manganese	4E-2	4E-2	99
Methylene chloride	2E-5	2E-5	< 1
Toluene	2E-5	2E-5	< 1
Total by pathway	4E-2		
% Contribution by pathway	100		
Scenario Total		4E-2	

Table 6-21

Average Non-Cancer Hazard Index Summary
On-Site Worker - Subchronic
Landfill No. 25, CAFB, Clovis, New Mexico

	Inhalation of Ambient Air	Total	% Contribution
Manganese	7E-3	7E-3	99
Methylene chloride	4E-6	4E-6	< 1
Toluene	6E-7	6E-7	< 1
Total by pathway	7E-3		
% Contribution by pathway	100		
Scenario Total		7E-3	

Table 6-22

Reasonable Maximum Non-Cancer Hazard Index Summary
On-Site Worker - Subchronic
Landfill No. 25, CAFB, Clovis, New Mexico

	Inhalation of Ambient Air	Total	% Contribution
Manganese	4E-2	4E-2	99
Methylene chloride	2E-5	2E-5	< 1
Toluene	4E-6	4E-6	< 1
Total by pathway	4E-2		
% Contribution by pathway	100		
Scenario Total		4E-2	

However, groundwater ingestion, as well as dermal contact and inhalation of vapor phase chemicals during domestic water use pathways were included in this assessment in order to reflect the limited potential for future exposure to contaminants present at Landfill No. 25 via groundwater. The scenario is based on predicted future lifetime exposures using current on-site contaminant concentrations in the soil and assuming that the release of contaminants will remain constant over time.

The future off-site residential scenario assumes exposure to contaminants via five exposure pathways: 1) ingestion of contaminated drinking water; 2) inhalation of vapor phase chemicals while showering; 3) dermal contact with residential water; 4) ingestion of fruits and vegetables irrigated with contaminated groundwater; and 5) ingestion of meat and milk from farm animals exposed to contaminants in the groundwater and contaminated feed crops.

Exposure concentrations are based on: 1) predicted contaminant concentrations in groundwater (off-site) based on measured concentrations in deep soils and sediments and assuming steady state conditions; 2) predicted concentrations in the shower, based on predicted groundwater concentrations; 3) calculated uptake and accumulation in fruits, vegetables, meat, and milk, based on predicted groundwater concentrations; and 4) predicted contaminant concentrations in ambient air, based on soil concentrations.

Carcinogenic effects were estimated for adults only, using average and reasonable maximum exposure parameters. Noncarcinogenic effects were estimated for both adults and children, assuming average and reasonable maximum exposure parameters.

6.5.7.1 Carcinogenic Effects

Adults--The average and reasonable maximum carcinogenic risks for future off-site residential adults are presented in Tables 6-23 and 6-24, respectively. The total cancer risk for average exposure was 2E-9. The reasonable maximum cancer risk for this scenario was 1E-8. The cancer risks for average and reasonable maximum exposure are below the Superfund site remediation risk range goal for carcinogens. Dermal contact with benzo(a)pyrene while showering is responsible for the majority (83%) of the pathway- and (100%) chemical-specific risk for both average and reasonable maximum exposure.

6.5.7.2 Noncarcinogenic Effects

Adults--Tables 6-25 and 6-26 characterize the average and reasonable maximum noncarcinogenic risks for future off-site adults, respectively. The total hazard index is 2E-1 for average exposure and 3E-1 for reasonable maximum exposure. Both values are below the Superfund site remediation goal of 1 for noncarcinogens. These hazard indices indicate that the noncarcinogenic risks for future off-site residential adults are acceptable. Arsenic is responsible for the majority of the chemical-specific risks for the average and reasonable maximum exposures (80% and 81%, respectively). Manganese contributed 19% and 18% of the chemical-specific risk for the average and reasonable maximum exposure scenarios, respectively. The groundwater ingestion pathway contributed most of the pathway-specific risk for both average and reasonable maximum exposure (99% and 96%, respectively).

Children--The average and reasonable maximum noncarcinogenic risk for children living off-site under future exposure conditions are presented in Tables 6-27 and 6-28, respectively. The hazard indices for both the average and reasonable maximum exposure scenarios were 6E-1. Again, arsenic caused the majority of the chemical-specific risk (80% and 81% of the average and reasonable maximum exposure, respectively). Manganese was responsible for 19% and 18% of the chemical-specific risks for the

Table 6-23

Average Cancer Risk Off-Site Residential Adult - Future
Landfill No. 25, CAFB, Clovis, New Mexico

	Ingestion of Groundwater	Inhalation while Showering	Dermal Contact while Showering	Ingestion of Fruits	Ingestion of Vegetables	Ingestion of Meat	Ingestion of Milk	Total	% Contribution
4,4'-DDD	2E-23	0E+0	4E-23	2E-29	4E-29	2E-24	9E-25	6E-23	< 1
4,4'-DDE	1E-22	0E+0	4E-22	2E-28	4E-28	5E-24	3E-24	5E-22	< 1
4,4'-DDT	2E-19	3E-25	2E-18	1E-25	2E-25	3E-20	2E-20	2E-18	< 1
Benzo(a)pyrene	2E-10	3E-16	1E-9	2E-16	3E-16	5E-11	3E-11	2E-9	100
Benzo(b)fluoranthene	6E-36	0E+0	1E-35	4E-42	7E-42	2E-36	1E-36	2E-35	< 1
Benzo(k)fluoranthene	2E-88	0E+0	3E-91	1E-94	2E-94	1E-88	8E-89	4E-88	< 1
Heptachlor	3E-22	7E-28	3E-23	1E-27	2E-27	1E-27	9E-28	4E-22	< 1
Heptachlor epoxide	8E-22	2E-27	8E-23	2E-27	4E-27	3E-27	2E-27	9E-22	< 1
Methylene chloride	3E-44	1E-50	3E-45	0E+0	0E+0	8E-54	5E-54	4E-44	< 1
Pyrene	2E-43	0E+0	2E-46	6E-49	1E-48	3E-49	2E-49	1E-43	< 1
Total by pathway	2E-10	3E-16	1E-9	2E-16	3E-16	5E-11	3E-11		
% Contribution by pathway	12	< 1	83	< 1	< 1	3	2		
Scenario Total								2E-9	

Table 6-24

Reasonable Maximum Cancer Risk Off-Site Residential Adult - Future
Landfill No. 25, CAFB, Clovis, New Mexico

	Ingestion of Groundwater	Inhalation while Showering	Dermal Contact while Showering	Ingestion of Fruits	Ingestion of Vegetables	Ingestion of Meat	Ingestion of Milk	Total	% Contribution
4,4'-DDD	8E-23	0E+0	3E-22	1E-28	2E-28	2E-23	1E-23	4E-22	< 1
4,4'-DDE	5E-22	0E+0	3E-21	1E-27	2E-27	7E-23	4E-23	3E-21	< 1
4,4'-DDT	7E-19	4E-24	1E-17	7E-25	1E-24	5E-19	2E-19	1E-17	< 1
Benzo(a)pyrene	9E-10	4E-15	9E-9	8E-16	2E-15	7E-10	4E-10	1E-8	100
Benzo(b)fluoranthene	3E-35	0E+0	1E-34	2E-41	4E-41	3E-35	2E-35	2E-34	< 1
Benzo(k)fluoranthene	1E-87	0E+0	2E-90	5E-94	9E-94	2E-87	1E-87	4E-87	< 1
Heptachlor	2E-21	9E-27	2E-22	5E-27	1E-26	2E-26	1E-26	2E-21	< 1
Heptachlor epoxide	4E-21	2E-26	5E-22	1E-26	2E-26	4E-26	2E-26	4E-21	< 1
Methylene chloride	2E-43	2E-49	2E-44	0E+0	0E+0	1E-52	7E-53	2E-43	< 1
Pyrene	7E-43	0E+0	1E-45	3E-48	6E-48	5E-48	3E-48	7E-43	< 1
Total by pathway	9E-10	4E-15	9E-9	8E-16	1E-15	7E-10	4E-10		
% Contribution by pathway	8	< 1	83	< 1	< 1	6	3		
Scenario Total								1E-8	

Table 6-25

Average Non-Cancer Hazard Index Summary Off-Site Residential Adult - Future
Landfill No. 25, CAFB, Clovis, New Mexico

	Ingestion of Groundwater	Inhalation while Showering	Dermal Contact while Showering	Ingestion of Fruits	Ingestion of Vegetables	Ingestion of Meat	Ingestion of Milk	Total	% Contribution
4,4'-DDT	7E-15	0E+0	8E-14	6E-21	1E-20	1E-15	9E-16	9E-14	< 1
Arsenic	1E-1	0E+0	8E-05	2E-8	2E-7	2E-3	1E-4	1E-1	80
Fluoranthene	2E-25	0E+0	1E-25	1E-30	3E-30	3E-5	2E-5	5E-5	< 1
Heptachlor	1E-18	0E+0	1E-19	4E-24	6E-24	4E-24	3E-24	1E-18	< 1
Heptachlor epoxide	5E-17	0E+0	5E-18	2E-22	3E-22	2E-22	2E-22	6E-17	< 1
Manganese (food)	0E+0	0E+0	0E+0	7E-9	6E-8	5E-8	8E-8	2E-7	< 1
Manganese (water)	4E-2	0E+0	5E-5	0E+0	0E+0	0E+0	0E+0	4E-2	19
Methylene chloride	6E-40	8E-47	5E-41	0E+0	0E+0	1E-49	9E-50	6E-40	< 1
Pyrene	7E-41	0E+0	9E-44	3E-46	5E-46	1E-46	1E-46	7E-41	< 1
Thallium	3E-4	0E+0	4E-7	1E-11	2E-10	8E-6	8E-7	3E-4	< 1
Vanadium	7E-4	0E+0	9E-7	2E-10	7E-10	9E-7	1E-6	7E-4	< 1
Zinc	6E-4	0E+0	3E-7	6E-8	4E-8	6E-8	2E-8	6E-4	< 1
Total by pathway	2E-1	8E-47	1E-4	9E-8	3E-7	2E-3	2E-4		
% Contribution by pathway	99	< 1	< 1	< 1	< 1	1	< 1		
Scenario Total								2E-1	

Table 6-26

Reasonable Maximum Non-Cancer Hazard Index Summary Off-Site Residential Adult - Future Landfill No. 25, CAFB, Clovis, New Mexico

	Ingestion of Groundwater	Inhalation while Showering	Dermal Contact while Showering	Ingestion of Fruits	Ingestion of Vegetables	Ingestion of Meat	Ingestion of Milk	Total	% Contribution
4,4'-DDT	1E-14	0E+0	2E-13	9E-21	2E-20	6E-15	3E-15	2E-13	< 1
Arsenic	2E-1	0E+00	2E-4	3E-8	4E-7	1E-2	5E-4	2E-1	81
Fluoranthene	3E-25	0E+0	2E-25	2E-30	4E-30	1E-4	7E-5	2E-4	< 1
Heptachlor	2E-18	0E+0	2E-19	5E-24	1E-23	2E-23	1E-23	2E-18	< 1
Heptachlor epoxide	7E-17	0E+0	1E-17	2E-22	5E-22	8E-22	5E-22	8E-17	< 1
Manganese (food)	0E+0	0E+0	0E+0	1E-8	9E-8	2E-7	3E-7	6E-7	1
Manganese (water)	5E-2	0E+0	1E-4	0E+0	0E+0	0E+0	0E+0	5E-2	18
Methylene chloride	8E-40	3E-46	1E-40	0E+0	0E+0	6E-49	3E-49	9E-40	< 1
Pyrene	9E-41	0E+0	2E-43	4E-46	8E-46	6E-46	4E-46	9E-41	< 1
Thallium	4E-4	0E+0	8E-7	2E-11	3E-10	4E-5	3E-6	4E-4	< 1
Vanadium	1E-03	0E+0	2E-6	3E-10	1E-9	4E-6	5E-6	1E-3	< 1
Zinc	9E-4	0E+0	7E-7	9E-8	6E-8	3E-7	2E-8	9E-4	< 1
Total by pathway	3E-1	3E-46	3E-4	2E-7	6E-7	1E-2	6E-4		
% Contribution by pathway	96	< 1	< 1	< 1	< 1	4	< 1		
Scenario Total								3E-1	

Table 6-27

Average Non-Cancer Hazard Index Summary Off-Site Residential Child - Future
Landfill No. 25, CAFB, Clovis, New Mexico

	Ingestion of Groundwater	Inhalation while Showering	Dermal Contact while Showering	Ingestion of Fruits	Ingestion of Vegetables	Ingestion of Meat	Ingestion of Milk	Total	% Contribution
4,4'-DDT	2E-14	0E+0	3E-13	3E-20	5E-20	3E-15	4E-15	3E-13	< 1
Arsenic	5E-1	0E+0	3E-4	1E-7	1E-6	5E-3	6E-4	5E-1	80
Fluoranthene	8E-25	0E+0	4E-25	7E-30	1E-29	7E-5	9E-5	2E-4	< 1
Heptachlor	4E-18	0E+0	4E-19	2E-23	3E-23	1E-23	1E-23	4E-18	< 1
Heptachlor epoxide	2E-16	0E+0	2E-17	8E-22	1E-21	4E-22	6E-22	2E-16	< 1
Manganese (food)	0E+0	0E+0	0E+0	3E-8	3E-7	1E-7	4E-7	8E-7	< 1
Manganese (water)	1E-1	0E+0	2E-4	0E+0	0E+0	0E+0	0E+0	1E-1	19
Methylene chloride	2E-39	2E-46	2E-40	0E+0	0E+0	3E-49	4E-49	2E-39	< 1
Pyrene	2E-40	0E+0	3E-43	1E-45	2E-45	3E-46	5E-46	2E-40	< 1
Thallium	9E-4	0E+0	1E-6	5E-11	9E-10	2E-5	4E-6	9E-4	< 1
Vanadium	2E-3	0E+0	3E-6	1E-9	3E-9	2E-6	7E-6	2E-3	< 1
Zinc	2E-3	0E+0	1E-6	3E-7	2E-7	1E-7	9E-8	2E-3	< 1
Total by pathway	6E-1	2E-46	5E-4	4E-7	2E-6	5E-3	7E-4		
% Contribution by pathway	99	< 1	< 1	< 1	< 1	< 1	< 1		
Scenario Total								6E-1	

Table 6-28

Reasonable Maximum Non-Cancer Hazard Index Summary Off-Site Residential Child - Future Landfill No. 25, CAFB, Clovis, New Mexico

	Ingestion of Groundwater	Inhalation while Showering	Dermal Contact while Showering	Ingestion of Fruits	Ingestion of Vegetables	Ingestion of Meat	Ingestion of Milk	Total	% Contribution
4,4'-DDT	2E-14	0E+0	3E-13	4E-20	8E-20	1E-14	2E-14	4E-13	< 1
Arsenic	5E-1	0E+0	3E-4	2E-7	2E-6	2E-2	2E-3	5E-1	81
Fluoranthene	8E-25	0E+0	4E-25	1E-29	2E-29	3E-4	3E-24	6E-4	< 1
Heptachlor	4E-18	0E+0	4E-19	2E-23	5E-23	4E-23	5E-23	4E-18	< 1
Heptachlor epoxide	2E-16	0E+0	2E-17	1E-21	2E-21	2E-21	2E-21	2E-16	< 1
Manganese (food)	0E+0	0E+0	0E+0	5E-8	5E-7	5E-7	1E-6	2E-6	< 1
Manganese (water)	1E-1	0E+0	2E-4	0E+0	0E+0	0E+0	0E+0	1E-1	18
Methylene chloride	2E-39	3E-46	2E-40	0E+0	0E+0	1E-48	2E-48	2E-39	< 1
Pyrene	2E-40	0E+0	3E-43	2E-45	4E-45	1E-45	2E-45	2E-40	< 1
Thallium	9E-4	0E+0	1E-6	8E-11	1E-9	8E-5	1E-5	1E-3	< 1
Vanadium	2E-3	0E+0	3E-6	1E-9	5E-9	9E-6	2E-5	2E-3	< 1
Zinc	2E-3	0E+0	1E-6	4E-7	3E-7	6E-7	3E-7	2E-3	< 1
Total by pathway	6E-1	3E-46	5E-4	6E-6	3E-6	2E-2	3E-3		
% Contribution by pathway	96	< 1	< 1	< 1	< 1	4	< 1		
Scenario Total								6E-1	

average and reasonable maximum exposures, respectively. Ingestion of groundwater contributed the majority of the pathway-specific risks for average (99%) and reasonable maximum (96%) exposure scenarios.

6.5.8 Risk Characterization for the Future On-Site Construction Worker Exposure Scenario

This scenario addresses pathways of exposure considered to be complete for an on-site construction worker at some time in the future. It was assumed that on-site contamination will not increase. Currently, there are no on-going invasive activities being conducted at the site. However, CAFB is an expanding base and it is possible that land use at the site will change significantly in the future. In addition, expansion of the existing munitions facility onto the northern portion of Landfill No. 25 has been proposed. The future on-site construction worker scenario assumes exposure to site-related contaminants via three pathways: 1) inhalation of contaminants in the air (volatilized chemicals or fugitive dust generation); 2) incidental ingestion of contaminated soil; and 3) dermal contact with contaminated soil.

Carcinogenic effects were not evaluated for this scenario because the construction activity will be of subchronic duration (seven years or less). The hypothetical construction was assumed to take place over a two year period. Noncarcinogenic effects were evaluated with both average and reasonable maximum exposure parameters.

6.5.8.1 Noncarcinogenic Effects

Tables 6-29 and 6-30 illustrate the noncarcinogenic risks resulting from average and reasonable maximum on-site construction worker chronic exposure scenarios, respectively. The hazard indices for the average and reasonable maximum exposure scenarios were 4E-2 and 3E-1, respectively. Manganese was responsible for the majority

Table 6-29

Average Non-Cancer Hazard Index Summary On-Site Construction Worker - Future
Landfill No. 25, CAFB, Clovis, New Mexico

	Inhalation of Volatiles In Ambient Air	Ingestion of Soil	Dermal Contact with Soil	Total	% Contribution
4,4'-DDT	0E+0	3E-6	3E-5	4E-5	< 1
Arsenic	0E+0	4E-3	4E-4	5E-3	12
Diesel	0E+0	5E-4	5E-3	6E-3	14
Fluoranthene	0E+0	3E-10	8E-10	1E-9	< 1
Heptachlor	0E+0	5E-7	5E-6	5E-6	< 1
Heptachlor epoxide	0E+0	2E-5	2E-4	2E-4	< 1
Manganese	2E-02	4E-4	4E-4	2E-2	62
MCPP	0E+0	2E-4	2E-3	2E-3	5
Methylene chloride	3E-6	5E-8	5E-7	4E-6	< 1
Pyrene	0E+0	3E-10	1E-9	1E-9	< 1
Toluene	6E-7	2E-9	2E-8	6E-7	< 1
Vanadium	0E+0	1E-3	1E-3	2E-3	6
Zinc	0E+0	4E-5	4E-5	8E-5	< 1
Total by pathway	2E-02	7E-3	9E-3		
% Contribution by pathway	60	17	23		
Scenario Total				4E-2	

Table 6-30

Reasonable Maximum Non-Cancer Hazard Index Summary On-Site Construction Worker - Future Landfill No. 25, CAFB, Clovis, New Mexico

	Inhalation of Volatiles in Ambient Air	Ingestion of Soil	Dermal Contact with Soil	Total	% Contribution
4,4'-DDT	0E+0	3E-5	8E-5	1E-4	< 1
Arsenic	0E+0	4E-02	1E-03	4E-02	17
Diesel	0E+0	5E-3	1E-2	2E-2	7
Fluoranthene	0E+0	3E-9	2E-9	5E-9	< 1
Heptachlor	0E+0	5E-6	1E-5	2E-5	< 1
Heptachlor epoxide	0E+0	2E-4	5E-4	7E-4	< 1
Manganese	2E-1	4E-3	1E-3	2E-1	67
MCPP	0E+0	2E-3	4E-3	6E-3	2
Methylene chloride	2E-5	5E-7	1E-6	3E-5	< 1
Pyrene	0E+0	3E-9	3E-9	6E-9	< 1
Toluene	4E-6	2E-8	4E-8	4E-6	< 1
Vanadium	0E+0	1E-2	3E-3	1E-2	5
Zinc	0E+0	4E-4	1E-4	5E-4	< 1
Total by pathway	2E-1	7E-2	2E-2		
% Contribution by pathway	65	26	9		
Scenario Total				3E-1	

of the chemical-specific risks for both the average (62%) and reasonable maximum (67%) exposure scenarios. The inhalation pathway caused most of the pathway-specific risks (60% and 65% for average and reasonable maximum, respectively).

6.5.9 Major Factors Driving Risks

The results of this baseline risk assessment should not be interpreted as a characterization of absolute risk. The hazard index estimates discussed below highlight potential sources of risk at the site. This risk assessment was based on conservative exposure assumptions and modeling parameters and may, therefore, overestimate the magnitude of risk associated with Landfill No. 25. None of the estimated cancer risks for the various exposure pathways exceed the Superfund site remediation goal of a cancer risk of 10^{-4} (1 in 10,000) to 10^{-6} (1 in 1,000,000). These results indicate that, based on currently available information and the assumptions used in this risk assessment, contaminants below the rubble pile at Landfill No. 25 pose negligible carcinogenic health risks presently and in the future. The results also indicate that the risk of noncarcinogenic effects are within acceptable limits as well. Tables 6-31 and 6-32 identify the key chemicals and exposure pathways that drive the carcinogenic and noncarcinogenic risk, respectively. Discussions of the magnitude and nature of risks that potentially exist at Landfill No. 25 and the major sources of uncertainty affecting the risk estimates are presented below.

6.5.9.1 Carcinogenic Effects

All estimated cancer risks are below the Superfund site remediation cancer risk goal of 1 in 1,000,000 (1E-6) considered to be the de minimus value. The risk associated with inhalation of arsenic in the form of fugitive dust drives the present residential adult and on-site worker cancer risks. Dermal contact with benzo(a)pyrene while showering drives the future residential adult cancer risk. These results indicate that based on currently available information and the assumptions used in this risk assessment,

Table 6-31

Identification of Key Chemicals and Exposure Pathways that Drive the Carcinogenic Risk Assessment for Landfill No. 25, CAFB, Clovis, New Mexico

Scenario	Total Scenario Risk	Chemicals that Contribute Chemical-Specific Risk (% Contribution)	Exposure Pathways that Contribute Pathway-Specific Risk (% Contribution)
Off-Site Residential (Present)			
- Adult, Average	3E-8	Arsenic (88)	Inhaltion of fugitive dust (100)
- Adult, Reasonable Maximum	1E-7	Arsenic (88)	Inhalation of fugitive dust (100)
On-Site Worker (Present)			
- Adult, Average	7E-8	Arsenic (96)	Inhalation of fugitive dust (100)
- Adult, Reasonable Maximum	4E-7	Arsenic (96)	Inhalation of fugitive dust (100)
Off-Site Residential (Future)			
- Adult, Average	2E-9	Benzo(a)pyrene (100)	Dermal contact while showering (83)
- Adult, Reasonable Maximum	1E-8	Benzo(a)pyrene (100)	Dermal contact while showering (83)

Table 6-32

Identification of Key Chemicals and Exposure Pathways that Drive the Noncarcinogenic Risk Assessment for Landfill No. 25, CAFB, Clovis, New Mexico

Scenario	Total Scenario Risk	Chemicals that Contribute Chemical-Specific Risk (% Contribution)		Exposure Pathways that Contribute Pathway-Specific Risk (% Contribution)	
Off-Site Residential (Present)					
- Adult, Average	9E-3	Manganese	(99)	Inhalation of fugitive dust	(100)
- Adult, Reasonable Maximum	9E-3	Manganese	(99)	Inhalation of fugitive dust	(100)
- Child, Average	9E-3	Manganese	(99)	Inhalation of fugitive dust	(100)
- Child, Reasonable Maximum	9E-3	Manganese	(99)	Inhalation of fugitive dust	(100)
On-Site Worker (Present)					
- Adult, Average					
Chronic	7E-3	Manganese	(99)	Inhalation of fugitive dust	(100)
Subchronic	7E-3	Manganese	(99)	Inhalation of fugitive dust	(100)
- Adult, Reasonable Maximum					
Chronic	4E-2	Manganese	(99)	Inhalation of fugitive dust	(100)
Subchronic	4E-2	Manganese	(99)	Inhalation of fugitive dust	(100)

Table 6-32

(Continued)

Scenario	Total Scenario Risk	Chemicals that Contribute Chemical-Specific Risk (% Contribution)		Exposure Pathways that Contribute Pathway-Specific Risk (% Contribution)	
Off-Site Residential (Future)					
- Adult, Average	2E-1	Arsenic	(80)	Ingestion of groundwater	(99)
- Adult, Reasonable Maximum	3E-1	Arsenic	(81)	Ingestion of groundwater	(96)
- Child, Average	6E-1	Arsenic	(80)	Ingestion of groundwater	(99)
- Child, Reasonable Maximum	6E-1	Arsenic	(81)	Ingestion of groundwater	(96)
On-Site Construction Worker (Future)					
- Adult, Average Subchronic	4E-2	Manganese	(62)	Inhalation of fugitive dust	(60)
- Adult, Reasonable Maximum Subchronic	3E-1	Manganese	(67)	Inhalation of fugitive dust	(65)

the contaminants below the rubble pile at Landfill No. 25 pose negligible carcinogenic health risks to human populations that may be exposed. It should be noted that the risk assessment was based on subsurface contamination and not the rubble pile itself.

6.5.9.2 Noncarcinogenic Effects

All of the estimated noncarcinogenic hazard indices, were below the Superfund site remediation goal of 1.0 for noncarcinogens. The risk associated with the average and reasonable maximum future residential adult scenarios were 2E-1 and 3E-1, respectively. Arsenic is responsible for the majority of the chemical-specific risk for both the average (80%) and the reasonable maximum (81%) exposure scenarios. Ingestion of groundwater was responsible for 99% and 96% of the average and reasonable maximum pathway-specific risks, respectively. The average and reasonable maximum future residential child scenarios both have associated risks of 6E-1. Again, ingestion of arsenic in the groundwater was responsible for the majority of the risk (approximately 80% of the average and reasonable maximum exposure scenarios). These results indicate that, based on currently available information and the assumptions used in this risk assessment, the contaminants below the rubble pile at Landfill No. 25 pose negligible noncarcinogenic health risks to human populations that may be exposed. Again, the risk assessment was based on subsurface contamination and not on the contaminants or concentrations found within the rubble pile itself.

6.5.9.3 Nature of Potential Risks at Landfill No. 25

All of the carcinogenic and noncarcinogenic health risks estimated in this risk assessment were below the de minimis values (1 for noncarcinogens and 1E-6 for carcinogens) set forth by the NCP for use in making risk management decisions and as Superfund site remediation goals. These results indicate that, based on currently available information and the assumptions used in the risk assessment, the contaminants below the rubble pile at Landfill No. 25 pose negligible human health risks.

6.5.10 Uncertainties Associated with Risk Characterization

Risk characterization results are not actual representations of risk but rather conditional estimates of risk which should be interpreted in light of the considerable number of assumptions required to quantify exposure, intake, and dose-response. Uncertainties associated with identification of chemicals of potential concern, exposure assessment, and toxicity assessment all contribute to the level of confidence that can be placed on the risk characterization results. The uncertainties associated with these steps are discussed in previous sections of the report and are summarized in Table 6-33 to facilitate interpretation of the risk characterization.

The most significant uncertainties associated with risk characterization are the limitations of analytical methods and fate and transport models in addition to the lack of verifiable toxicity values. The majority of the tasks performed during risk assessment utilize conservative assumptions which tend to overestimate risk. However, the limitations associated with analytical methods and the lack of USEPA-verified toxicity values for some chemicals could result in underestimation of risks. Alternately, many of the uncertainties associated with risk assessment have the potential to either over- or underestimate the risk associated with exposure. Table 6-33 summarizes the uncertainties associated with the risk characterization and their potential impact.

6.6 Environmental Evaluation

This section presents a qualitative evaluation of potential adverse impacts of contamination from Landfill No. 25 on critical habitats and endangered species in the area. A description of the site and the nature and extent of the contaminants of concern were presented earlier in this report. Information for this qualitative evaluation was adapted from an ecological risk assessment of CAFB prepared by Woodward-Clyde and Consultants (Woodward-Clyde, 1992b).

Table 6-33

Uncertainties Associated with Risk Assessment and Potential Impact on Risk Characterization Landfill No. 25, CAFB, Clovis, New Mexico

Uncertainty	Effect on Risk Characterization		
	Potential for Overestimation	Potential for Underestimation	Potential for Over- or Underestimation
Environmental Sampling/Analysis			
• Sufficient samples may not have been taken to fully characterize the rubble and the lateral landfill boundaries	Moderate		Moderate
• Sufficient background samples may not have been taken to adequately define background concentrations of inorganics			
• Systematic or random errors in chemical analyses may yield erroneous data			Low
Fate/Transport Modeling			
• Use of ISCST2 to estimate contaminant concentrations in the air for on-site workers and off-site residents	Moderate/High		
• Use of a box model to estimate contaminant concentrations in the air for on-site construction workers	Moderate/High		
• Use of estimated K_d values as opposed to site-specific data for groundwater modeling			Moderate/High

Table 6-33
(Continued)

Uncertainty	Effect on Risk Characterization		
	Potential for Overestimation	Potential for Underestimation	Potential for Over- or Underestimation
Exposure Assumptions			
• Standard assumptions regarding body weight, period exposed, life expectancy, population characteristics, and lifestyle may not be representative actual exposure conditions			Moderate
• Amount of media intake is assumed to be constant and representative of the exposed population			Moderate
• Assumption of daily lifetime exposure for residents			Moderate/High
• Use of modeled concentrations to represent exposure point concentrations	Moderate/High		
• Assumption that metals are 100% bioavailable	Moderate/High		
• Assumption that the groundwater will be available for domestic use 173 years in the future.	Moderate		

Table 6-33
(Continued)

Uncertainty	Effect on Risk Characterization		
	Potential for Overestimation	Potential for Underestimation	Potential for Over- or Underestimation
Toxicity Information			
• Lack of verified toxicity values for some chemicals and/or routes of exposure		Moderate	
• Inability to assess synergistic/antagonistic effects of simultaneous exposure to multiple contaminants			Moderate/High
• Use of toxicity values developed from studies conducted on animals at high doses	High		

6.6.1 Local Ecology

CAFB and surrounding areas are part of the High Plains physiographic province. Much of the province is natural grasslands, that have been disrupted by agricultural practices. Small trees and large shrubs are located around riparian areas and playa lakes. The areas surrounding CAFB are used for crops and livestock. Common agriculture crops grown in the area include wheat, sorghum, and alfalfa.

Landfill No. 25 is situated on the northeast end of CAFB. Landfill No. 25 is bordered on the west by Perimeter Road and immediately on the east by the CAFB ordinance area. Agricultural land lies approximately 1250 feet both east and south of the landfill. Playa Lake is located approximately 500 feet to the southeast.

A visual survey of the vegetative cover was completed during the field investigation of this project. The relatively unconsolidated debris above the firmer Ogallala sediments gives the site a somewhat different cover than adjacent parts of CAFB. Chinese Elms along with other deciduous trees are found on the northern half of the site. Their presence may be the result of increased infiltration due to the poorly consolidated debris. These trees may tap the boundary between the debris and the native soils where water infiltration is slowed. Yucca is present over the entire site. Sage and rabbitbrush are the most common shrubs. Indian rice grass, foxtail barley, and blue gramma are the most common grasses.

6.6.2 Threatened and Endangered Species

Table 6-34 lists threatened and endangered species and species of high federal concern historically inhabiting areas within CAFB and surrounding Curry County. The Baird's sparrow and the ferruginous hawk are known to inhabit this area. However, both birds are infrequent visitors in the area. The Baird's sparrow may be found in the

Table 6-34

Federal- and State-Protected Animals Potentially Occurring in the Vicinity of CAFB (Curry County), New Mexico for Landfill No. 25 CAFB, Clovis, New Mexico

Common Name	Scientific Name	Federal Status	State Status
Birds			
Baird's sparrow	*Ammodramus bairdii*		Endangered (group 2)
Bald eagle	*Haliaeetus leucocephalus*	Endangered	Endangered (group 2)
Peregrine falcon	*Falco perigrinus*	Endangered	Endangered (group 1)
Long-billed curlew	*Numenius americnus*		Endangered (group 2)
Western snowy plover	*Charadrius aleandrus nivosis*		Endangered (group 2)
Mammals			
Black-footed ferret	*Mustela nigripes*	Endangered	Possibly Extinct
Swift fox	*Vulpes velox*		Endangered (group 2)
Reptiles			
Texas horned lizard	*Phrynosoma cornutum*		Endangered (group 2)

Endangered (group 1): Species whose prospects of survival or recruitment within the state are in jeopardy.

Endangered (group 2): Species whose prospects of survival or recruitment within the state are likely to become jeopardized in the foreseeable future.

Possibly Extinct: Potentially no longer in existence in the state.

Source: Woodward-Clyde, 1992.

area from early August and departs by November. The ferruginous hawk may occasionally feed at CAFB, but does not reside there because of lack of suitable nesting habitat.

6.6.3 Other Species

Small amphibians and reptiles are known to occupy areas in and around CAFB. The pocket gopher and the deer mouse are two common small mammals found at CAFB. Both animals inhabit areas covered with small shrubs and grasses similar to those found near Landfill No. 25. Pheasant, quail, and migratory waterfowl feed on waste grains in the fields near the landfill. Waterfowl, mostly dabbler ducks, utilize the Playa Lake as a resting and feeding area during migration. The primary predators in the area are several species of raptors. Mated pairs of Mississippi kite, recently removed from New Mexico's protected species list, have been spotted on CAFB defending territory near the golf course. Occasionally, a big game animal such as the longhorn antelope has been spotted in the vicinity.

6.6.4 Selection of Indicator Species

Animals that inhabit Landfill No. 25 and utilize nearby areas such as the Playa Lake are potentially exposed to chemicals originating from the Landfill. It is not possible to assess effects on all species potentially impacted by exposure to chemicals of concern at Landfill No. 25. Ducks have been chosen as the indicator species to represent potential impacts of chemicals at the landfill on wildlife in the area. Dabbler ducks, which include gadwalls, mallards, pintails, shovelers and widgeons, make up the majority of wildlife found at CAFB. The ducks are not usually found at Landfill No. 25; however, they spend a majority of their time resting at the nearby Playa Lake and feeding in the adjacent grain fields.

6.6.5 Qualitative Risk Assessment for Potential Exposure to Wildlife

Potential exposure of ducks to contaminants originating at Landfill No. 25 is via surface water flowing downgradient to the nearby Playa Lake. Mean annual precipitation for the area is 15 inches with a low monthly average of 0.4 inches during the winter months. Contaminants of concern were detected in the surface soil. Therefore, movement of chemicals towards the Playa Lake via runoff is possible. However, due to low annual precipitation, few chemicals are likely to be carried from the landfill to the lake.

Ducks typically begin migrating through the Clovis area by late October and reach their highest numbers by mid-November. The majority of the ducks have continued southward migration by the time the lakes are frozen which is usually in the beginning of January. During mild winters, ducks can remain in the vicinity until mid-March. The average amount of time ducks spend in the area is between 1.5 to 3 months.

Considering the low precipitation and the amount of time the ducks are found in the area, the level of exposure due to contaminants found at Landfill No. 25 is likely to be low.

6.7 Conclusions

All estimated cancer risks are below the Superfund site remediation cancer risk goal of 1 in 1,000,000 (1E-6), considered to be the de minimis value used in making risk management decisions. Estimated noncarcinogenic hazard indices were below the Superfund site remediation goal of 1 for noncarcinogenic effects as well. These results indicate that, based on currently available information and the assumptions used in this risk assessment, the contaminants in the native soil at Landfill No. 25 pose negligible human health risks to populations that may be exposed currently or in the future.

Results from the qualitative evaluation of potential adverse impacts of contaminants from Landfill No. 25 on critical habitats and endangered species in the area indicate that deleterious ecological effects from site contaminants are unlikely.

7.0 CONCLUSIONS/RECOMMENDATIONS

This section highlights the results of the RFI and the Risk Assessment, makes conclusions from these results, and outlines the important considerations for determining appropriate courses of action.

7.1 Conclusions

Landfill No. 25 contains a mix of surface and subsurface rubble. The site is underlain by the Ogallala Formation that changes with depth from a well cemented sandstone with abundant caliche to an unconsolidated sand.

A total of 139 field samples were collected and analyzed. One surface sample (CAN97-17-S) was found to exceed the proposed noncarcinogenic soil action level for lead. Beryllium in background samples, as well as in some landfill samples, exceeds the proposed carcinogenic soil action level. The presence of beryllium in the background indicates that the proposed level is not appropriate for this site. One sample (CAN97-15-S) exceeded the proposed carcinogenic soil action levels for benzo(a)pyrene and benzo(b)fluoranthene. All organic results were below the proposed noncarcinogenic soil action levels.

With the exception of TICs which were detected at all depth intervals, the vertical extent of contamination has been delineated at the site. Because of the uncertainty with identification and the relatively low concentrations, TICs should not necessitate the need to drill deeper. The lateral extent of contamination is not well defined. All borings, other than one background boring, were completed within the landfill. The perimeter of the contaminated zone cannot be determined from this investigation. However, such delineation may not be necessary given the relatively minor contamination that is associated with the soil.

None of the estimated cancer risks exceed the Superfund site remediation cancer risk goal of 1 in 1,000,000 (1E-6), considered to be the de minimus value used in making risk management decisions. In addition, all of the estimated noncarcinogenic hazard indices are below the Superfund site remediation goal of 1 for noncarcinogenic effects. These results indicate that, based on currently available information and the assumptions used in the risk assessment for Landfill No. 25, the native soil below the rubble pile poses no notable human health risks.

7.2 Recommendations

The results of this investigation suggest that the native soil below the rubble at Landfill No. 25 is not contaminated. No further action is recommended for the soil.