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

ENTERED

6 APR 1994

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Mr. William Honker
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Dear Mr. Honker

XIII

Attached please find the final RCRA Facility Investigation (RFI) Report for the Appendix II Solid Waste Management Units (SWMUs) - Phase I at Cannon AFB. This report is a compilation of the draft report and our responses to your agency's December 20, 1993 Notice of Deficiency (NOD) and is being submitted per your requirement in a February 16, 1994 letter. This report consists of the following six volumes:

1. VOLUME 1 Appendix II RCRA Facility Investigation (RFI) Report
2. VOLUME 2 Appendix II RFI, Risk Assessment
3. VOLUME 3 Appendix II RFI, Data Validation Reports
4. VOLUME 4 Appendix II RFI, Data Validation Reports
5. VOLUME 5 Appendix II RFI, Validated Data
6. VOLUME 6 Appendix II RFI, Appendices B, C, D, E, F, G, and H

The Cannon AFB point of contact for this issue is Mr. John Ekhoff (505) 784-2739.

Sincerely

WILLIAM M. GUTH
Brigadier General, USAF
Commander

Attachment:
Appendix II, Phase I Final Report

Volume
3-4-5+6
Storage

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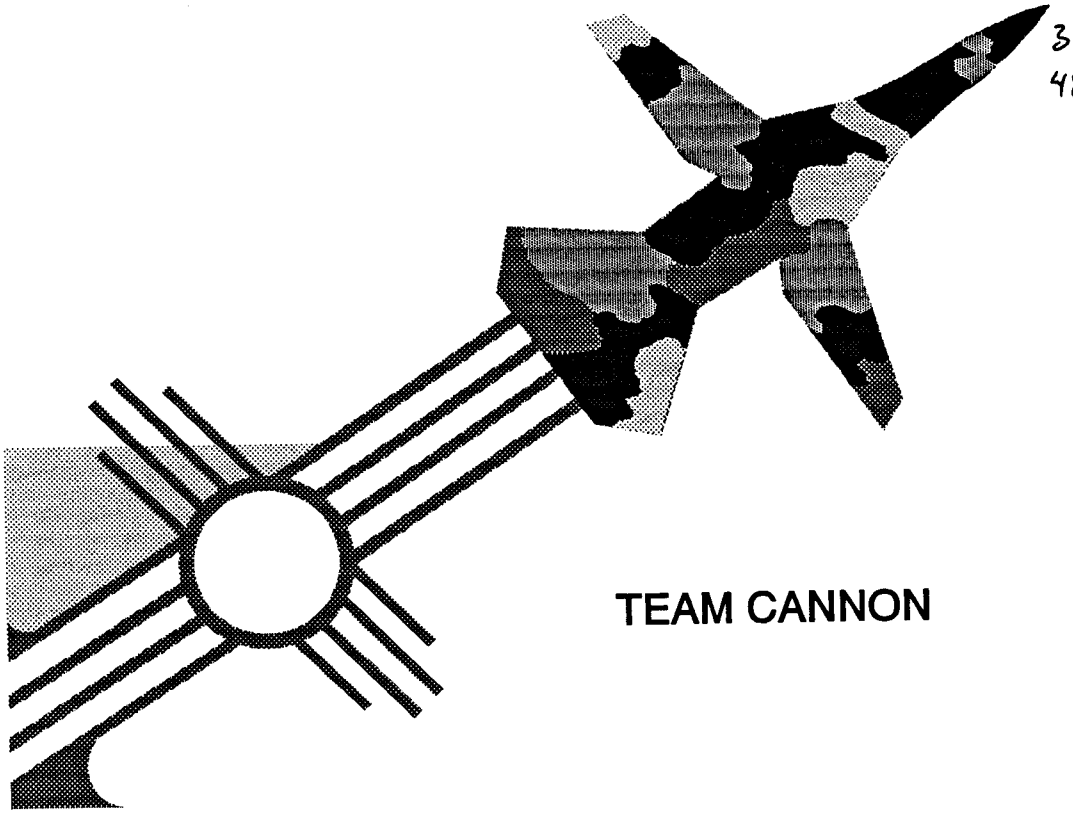
June 1991
APP II
PHASE

27th FIGHTER WING

SWMUs: 1, 3, 5, 7, 8, 9, 11, 16, 32a
33b, 38, 39, 48a
48b, 83, 108



TEAM CANNON

APPENDIX II
RCRA FACILITY INVESTIGATION

RFI REPORT
VOLUME 1

Project No. CZQZ 909012

CANNON AFB, NEW MEXICO

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UNITED STATES ARMY
CORPS OF ENGINEERS
ALBUQUERQUE DISTRICT

OGDEN ENVIRONMENTAL AND ENERGY SERVICES

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LIST OF ACRONYMS

AA	Atomic Absorption
AB	Analytical Batch
AFB	Air Force Base
BFB	Bromofluorobenzene - volatile instrument performance check compound.
CCB	Continuing Calibration Blank
CCV	Continuing Calibration Verification
CRDL	Contract Required Detection Limit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
COC	Contaminant of Concern
COE	U.S. Army Corps of Engineers
CRQL	Contract Required Quantitation Limit
CCV	Continuing Calibration Verification
CRA	AA Standard at the CRDL or IDL, whichever is greater.
CUZ	Compatible Use Zone
CVAA	Cold Vapor Atomic Absorption
%D	Percent Difference
DMP	Data Management Plan
EPA	U.S. Environmental Protection Agency
ER	Equipment Rinsate
ERA	Ecological risk Assessment
FB	Field Blank

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LIST OF ACRONYMS (Continued)

FSP	Field Sampling Plan
GC/EC	Gas Chromatography/Electron Capture Detector
GC/MS	Gas Chromatography/Mass Spectrometry
GFAA	Graphite Furnace Atomic Absorption
HRA	Health Risk Assessment
HSP	Health and Safety Plan
ICP	Inductively Coupled Plasma
ICS	Interference Check Sample
ICV	Initial Calibration Verification
IDL	Instrument Detection Limit
IS	Internal Standards - Compounds added to every VOA and BNA standard, blank, matrix spike duplicate, and sample extract at a known concentration, prior to instrumental analysis. Internal standards are used as the basis for quantitation of the target compounds.
LCS	Laboratory Control Sample
mg/kg	milligrams per killogram
MSA	Method of Standard Addition
MSL	Mean Sea Level
MS/MSD	Matrix Spike/Matrix Spike Duplicate
m/z	The ratio of mass (m) to charge (z) of ions measured by GC/MS.
PCB	Polychlorinated biphenyl (Arochlor is a trademark)
PE	Performance Evaluation
PID	Photoionization Detector
PPE	Personal Protective Equipment
QA	Quality Assurance - Total program for assuring the reliability of data.

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LIST OF ACRONYMS (Continued)

QAP	Quality Assurance Plan
QC	Quality Control - Routine application of procedures for controlling the monitoring process
%R	Percent Recovery
RAA	Risk Assessment Area
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RF	Response Factor
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
RPD	Relative Percent Difference (between matrix spike and matrix spike duplicate)
RRF	Relative Response Factor
$\overline{RRF}$	Average Relative Response Factor
RRT	Relative Retention Time (with retention to internal standard)
RSD	Relative Standard Deviation
RT	Retention Time
RW	Rinse Water
SDEV	Standard Deviation
SDG	Sample Delivery Group - Defined by one of the following, whichever occurs first: • Case of field samples • Each 20 field samples within a case • Each 14-day calendar period during which field samples in a Case are received beginning with receipt of the first sample in the SDG. (For VOA contracts, the calendar period is 7-day.)

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LIST OF ACRONYMS (Continued)

SMC	System Monitoring Compound - formerly surrogates for volatile analysis.
SMO	Sample Management Office
SOP	Standard Operating Procedure
SOW	Statement of Work
SV	Senivolatile analysis - Method based on analysis by GC/MS for BNA organic compounds.
SWDL	Southwest Division Laboratory
SWMU	Solid Waste Management Unit
TAC	Tactical Air Command
TCL	Target Compound List
TIC	Tentatively Identified Compound - A compound tentatively identified from search of the NIST mass spectral library that is not on the TCL.
TPH	Total Petroleum Hydrocarbons
TRPH	Total Recoverable Petroleum Hydrocarbons
μg/kg	micrograms per kilogram
VOA	Volatile Organic Analysis - Method based on the purge and trap technique for organic compound analysis.
VOC	Volatile Organic Compound
VTSR	Validated Time of Sample Receipt - Time of sample receipt at the laboratory as recorded on the shipper's delivery receipt and Sample Traffic Report.

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DATA QUALIFIER DEFINITIONS

The following definitions provide brief explanations of the national qualifiers assigned to results in the date review process. If the Regions choose to use additional qualifiers, a complete explanation of the qualifiers should accompany the data review.

U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

J - The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

N - The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".

NJ - The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.

UJ - The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

R - The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

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QUALIFICATION CODE REFERENCE TABLE

QUALIFIER	ORGANICS	INORGANICS
H	Holding times were exceeded.	Holding times were exceeded.
S	Surrogate recovery was outside QC limits.	The sequence or number of standards used for the calibration was incorrect.
C	Calibration %RSD or %D were noncompliant.	Correlation coefficient is <0.995.
R	Calibration RRF was <0.05.	%R for calibration is not within control limits.
B	Presumed contamination from preparation (method) blank.	Presumed contamination from preparation (method) or calibration blank.
L	Not applicable.	Laboratory Control Sample %R were not within control limits.
Q	MS/MSD recovery was poor or RPH high.	MS recovery was poor.
E	Not applicable.	Duplicates showed poor agreement.
I	Internal standard performance was unsatisfactory.	ICP ICS results were unsatisfactory.
A	Not applicable.	ICP Serial Dilution %D were not within control limits.
M	Tuning (BFB) was noncompliant.	Not applicable.
T	Presumed contamination from trip blank.	No applicable.
+	False positive - reported compound was not present.	Not applicable.
-	False negative - compound was present but not reported.	Not applicable.
F	Presumed contamination from FB or ER.	Presumed contamination from FB or ER.

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QUALIFICATION CODE REFERENCE TABLE (Concluded)

QUALIFIER	ORGANICS	INORGANICS
$	Reported result or other information incorrect.	Reported result or other information was incorrect.
?	TIC identity or reported retention time has been changed.	No applicable.
D	The analysis with this flag should not be used because another more technically sound analysis is available.	The analysis with this flag should not be used because another more technically sound analysis is available.
P	Instrument performance for pesticides was poor.	Post Digestion Spike recovery was not within control limits.
*#	Unusual problems found with the data that have been described in Section 2, "Data Validation Findings." The number following the asterisk (*) will indicate the subsection where a description of the problem can be found.	Unusual problems found with the data that have been described in Section 2, "Data Validatio Findings." The number following the asterisk (*) will indicate the subsection where a description of the problem can be found.

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Definitions Of Acronyms Used

QC	Quality Control
%RSD	Percent Relative Standard Deviation
RRF	Relative Response Factor
%R	Percent Recovery
MS/MSD	Matrix Spike/Matrix Spike Duplicate
RPD	Relative Percent Difference
ICP ICS	Inductively Coupled Plasma Interference Check Sample
BFB	Bromofluorobenzine
FB	Field Blank
ER	Equipment Rinsate
TIC	Tentatively Identified Compound

EXECUTIVE SUMMARY

A Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) was conducted to evaluate the nature and extent of potential contamination from 15 solid waste management units (SWMUs) at Cannon Air Force Base, New Mexico. The following requirements taken from the RCRA Facility Investigation (RFI) Data Management Plan, Cannon AFB, New Mexico, June 1991, presents a description of the regulatory framework under which this project was conducted.

The Hazardous and Solid Waste Amendments (HSWA) to the RCRA were enacted into law on November 8, 1984. One of the major provisions (Section 3004(u)) of these amendments requires corrective action for releases of hazardous waste or constituents from solid waste management units (SWMUs) at hazardous waste treatment, storage, or disposal facilities. Under this provision, any facility applying for a RCRA hazardous waste management facility permit will be subject to a RCRA Facility Assessment (RFA). The RFA is conducted by the regulatory agency and is designed to identify SWMUs which are, or are suspected to be, the source of a release to the environment. If any such units are identified, the owner or operator of the facility will be directed to perform a RCRA Facility Investigation (RFI) to obtain information on the nature and extent of the release so that the need for interim corrective measures or a Corrective Measures Study can be determined. Information collected during the RFI can also be used by the owner or operator to aid in formulating and implementing appropriate corrective measures. Such corrective measures may range from stopping the release through the application of a source control technique to a full-scale cleanup of the affected area. In cases where releases are sufficiently characterized, the regulatory agency may require the owner or operator to collect specific information needed to implement corrective measures during the RFI.

The RFI Work Plan consists of six documents prepared concurrently:

- Data Collection Quality Assurance Plan
- Data Management Plan
- Health and Safety Plan
- Community Relations Plan
- Field Sampling Plan
- Project Management Plan

A Risk Assessment was also performed as part of this RFI project.

LRL Sciences, Inc. (LRL), was contracted by the U.S. Army Corps of Engineers (COE), Albuquerque District, to perform the RFI. Responsibilities included preparation of supplements to the RCRA Facility Investigation Work Plan prepared by Lee Wan and Associates (1990) and the General Plans for Cannon AFB RFIs (1991) prepared by the Environmental Management Branch, Civil Engineering Squadron, Cannon AFB, NM. The supplements prepared by LRL were the Field Sampling Plan, the Safety and Health Plan, and the Quality Assurance Plan. These plans were approved by the COE and Cannon AFB. These supplemental plans were necessary to perform specific requirements and tasks in the COE Scope of Services.

The RFI field activities were conducted during April 1993. The field activities included auger drilling and sampling of surface and subsurface soils in the vicinity of each SWMU.

The following is a list of the SWMUs investigated during this RFI. The work was done under Air Force Project No. CZQZ 909012 and COE Contract No. DACA47-93-C-0009.

SWMU	Unit	Building
1	Oil/Water Separator	119
3	Oil/Water Separator	108(125)
5	Oil/Water Separator	121(126)
7	Oil/Water Separator	129
8	Oil/Water Separator	165
9	Aircraft Washrack Drain System	165
11	Oil/Water Separator	170
16	Oil/Water Separator	680
32A	Oil/Water Separator	186-1
33B	Oil/Water Separator	186-2
38	Oil/Water Separator	194
39	Oil/Water Separator	195
48A	Underground Waste Oil Tank (IRP Site)	
48B	Above Ground Overflow Capacity Tank (IRP Site)	
83	Sump (IRP Site)	
108	Explosive Ordnance Disposal Activities Area	

These SWMUs were identified during a RCRA Facility Assessment conducted by the U.S. EPA in 1987.

Environmental samples were analyzed by NDRC Laboratories, Inc., located in Richardson, Texas, Eureka Laboratories, located in Sacramento, California, and Aquatec. These laboratories were under contract with the Army Corps of Engineers Southwest Division Laboratory, located in Dallas, Texas.

RCRA SW-846 protocol was followed for soil analysis. The analytical parameter list included:

- Target Compound List Volatile Organic Compounds (TCL VOC)
- BTEX (Benzene, Toluene, Ethyl Benzene, Xylene)
- Priority Metals (TCLP List and Nickel)
- Target Analyte List (TAL) Metals
- Total Recoverable Petroleum Hydrocarbons (TRPH)
- Cyanide
- Reactives
- Sulfides

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Not all of the parameters listed above were analyzed at every SWMU.

Laboratory analytical data was validated by LRL Sciences, Inc., and Ogden Environmental according to the USEPA CLP National Functional Guidelines for data validation. Validated data was then used to present the nature and extent of potential contamination and to develop a risk assessment.

Following is a summary of the nature and extent of contamination for each SWMU.

SWMU No. 1 - Oil/Water Separator No. 119

Toluene and chromium were the only analytes detected (or detected above background) in the surface samples of all three boreholes. The highest concentration of toluene found in the surface was 36 μg/kg. The highest concentration of chromium detected at the surface was 34.6 mg/kg. Borehole 2 contained the most subsurface analytes including acetone at 24 μg/kg, mercury at 0.15 mg/kg, and nickel at 9.2 mg/kg. Borehole 3 contained only nickel in the subsurface at 9.6 mg/kg.

SWMU No. 3 - Oil/Water Separator No. 108

In borehole 1, both organics and metals were detected at the surface and at depth. Toluene and acetone were detected below the contract required quantitation limit (CRQL). Chromium was detected at 17.8 mg/kg. The QA duplicate contained nickel at 10.3 mg/kg and mercury at 0.15 mg/kg. In boreholes 2 and 3, no organics were detected. Metals detected included nickel at 9.6 mg/kg, barium at 816 mg/kg, and chromium at 16.4 mg/kg.

SWMU No. 5 - Oil/Water Separator No. 121

No analytes were detected (or detected above background) in any of the surface samples for the three boreholes. Nickel was detected in all the boreholes at 2.5 feet with the highest concentration at 12.7 mg/kg. Boreholes 2 and 3 contained two or more of the following compounds at 10 feet: acetone (16 μg/kg), nickel (10.1 mg/kg), and barium (749 mg/kg) or mercury (0.2 mg/kg).

SWMU No. 7 - Oil/Water Separator No. 129

Chromium was the only metal detected at the surface of all three boreholes with the highest concentration of 38.7 mg/kg. Arsenic (31.8 mg/kg), toluene (20 μg/kg), and several other organic compounds detected below the CRQL were also found at the surface. At 5 feet, borehole 1 contained mercury (0.2 mg/kg), borehole 2 contained nickel at 98 mg/kg, and borehole 3 contained acetone at 24 μg/kg.

SWMU No. 8 - Oil/Water Separator No. 165

No analytes were detected (or detected above background) in the surface samples in any of the boreholes. All three boreholes contained subsurface metals including nickel (31.6 mg/kg), chromium (13.2 mg/kg), and barium (812 mg/kg). Only borehole 3 contained subsurface BTEX (xylenes at 2.4 μg/kg).

SWMU No. 9 - Aircraft Washrack Drain

Several organics and metals occur in one or more of the surface samples of all four boreholes. These include : acetone at 250 μg/kg, tetrachloroethane at 14 μg/kg, toluene and xylene below the CRQL of 58 mg/kg, chromium at 26.9 mg/kg, nickel at 10.5 mg/kg, and barium at 840 mg/kg. In the subsurface samples, barium was detected at 1380 mg/kg, chromium at 31.1 mg/kg and acetone at 16.0 μg/kg.

SWMU No. 11 - Oil/Water Separator No. 170

The only target analyte organics detected at the surface were methylene chloride, detected below the CRQL of 11 μg/kg, and toluene at 13 μg/kg. No metals were detected above background at the surface. Nickel occurred at 2.5 feet in all three boreholes with the highest concentration at 10.6 mg/kg. Mercury (0.26 mg/kg) and methylene chloride (< CRQL of 10 μg/kg) occurred at 10 feet.

SWMU No. 16 - Oil/Water Separator No. 680

No organic compounds were detected in any of the boreholes. Nickel was detected at 5 feet in all three boreholes with the highest concentration at 9.6 mg/kg. Lead at 41.3 mg/kg and mercury at 0.24 mg/kg were detected in borehole 3 at the surface and at 2.5 feet, respectively.

SWMU No. 32A - Oil/Water Separator No. 186, #1-East

The only analyte detected at the surface was xylene at 34.0 μg/kg in borehole 2. Nickel (10.3 mg/kg) and mercury (0.27 mg/kg) were detected in the subsurface of borehole 1. Barium (1480 mg/kg) was detected at 10 feet in Borehole 3.

SWMU No. 33B

Acetone was detected in the surface sample of all three boreholes and at 10 feet in boreholes 1 and 3. The highest concentration detected was 15 μg/kg. Borehole 3 contained the most metals with chromium (41.3 mg/kg) and nickel (9.4 mg/kg) at the surface and arsenic (32.4 mg/kg) at 2.5 feet and barium (654 mg/kg) at 10 feet.

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SWMU No. 38 - Oil/Water Separator No. 194

From the surface to 2.5 feet, several organic compounds were detected in one or more boreholes: acetone at 17.0 μg/kg, 1,1,1-trichloroethane (<CRQL of 10 μg/kg), and toluene (<CRQL or 10 μg/kg). Borehole 1 contained nickel (10.6 mg/kg) and chromium (13.9 mg/kg) at 2.5 feet. All three boreholes contained nickel (11.0 mg/kg) at 5 feet.

SWMU No. 39 - Oil/Water Separator No. 195

At the surface and at 5 feet, toluene was detected at 12.0 μg/kg and acetone was detected at 38.0 μg/kg. In boreholes 2 and 3, nickel (9.7 mg/kg) occurred at 2.5 feet. All three boreholes contained metals at 5 feet, including: nickel (11.8 mg/kg), lead (52.0 mg/kg), and chromium (14.9 mg/kg). Borehole 3 contained barium (2200 mg/kg) at 10 feet.

SWMU No. 48A and 48B - Above Ground and Underground Storage Tanks

At the surface, only borehole 5 contained target analyte organics including acetone (110 μg/kg), xylene (75 μg/kg), and methylene chloride (150 μg/kg). Subsurface organic detections included: methylene chloride at 37 μg/kg and acetone at 39 μg/kg. Metals detected in the surface and subsurface samples include: barium (1760 mg/kg), nickel (12.9 mg/kg), beryllium (0.77 mg/kg), cobalt (4.6 mg/kg), and vanadium (28.9 mg/kg) (see Table 14-6).

SWMU No. 83 - Sump

Volatile organic analysis occurred only at 5 feet. None were detected. TRPH was detected in all three boreholes with the highest concentrations at 2.5 feet (5000 mg/kg). Metals were detected above background at the surface and at depth (see Table 15-4). Metals include: silver (3.4 mg/kg), nickel (11.4 mg/kg), barium (2170 mg/kg), zinc (231 mg/kg), copper (18.0 mg/kg), beryllium (0.81 mg/kg), cobalt (5.0 mg/kg), manganese (271 mg/kg), mercury (0.15 mg/kg), lead (36.8 mg/kg), and chromium (13.2 mg/kg).

SWMU No. 108 - Explosive Ordnance Disposal Training Area

Nickel was detected in the surface samples of three out of five boreholes. The highest concentration detected was 11.4 mg/kg. No other priority metals were detected above background at this SWMU. Analysis for sulfide resulted in no detections.

Human Health Risk Assessment

A human health risk assessment (HRA) was performed using the site investigation data obtained for 15 SWMUs. The objectives of the HRS included assessing the carcinogenic risk and noncarcinogenic hazard posed by contaminated soil at the various SWMUs to potential human receptors. The information from the HRA can then be used to assist in determining if there should be further investigation, remedial action, or no further action for each of the SWMUs.

The HRA was conducted using the standard principles and approaches identified in "Risk Assessment Guidance for Superfund: Volume I: Human health Evaluation Manual, Part A" (RAGS), (EPA 1989). RAGS, which is the Superfund guidance document for human health risk assessment, was used instead of RFI guidance for human health risk assessment due to its more comprehensive nature. Assumptions made throughout this risk assessment were generally conservative, and therefore tend to overestimate the actual risk.

Based on the validated data, chemicals of concern (COCs) were identified for each SWMU, and the 15 SWMUs were grouped into four Risk Assessment Areas (RAAs) including the following: RAA #1 including SWMUs 1, 3, 5, 7, 8, 9, 11, 16, 32A, 33B, 38, and 39; RAA #2 including SWMU 48A and 48B; RAA #3 including SWMU 83; and RAA #4 including SWMU 108. An RAA is a group of SWMUs that are geographically close and have similar chemical release sources. Grouping the SWMUs into RAAs allows the identification of chemicals and pathways that result in significant contributions to risk and the assessment of whether potential human health impacts are related to a particular RAA or contamination source. A site-specific risk assessment was then performed for each of the four RAAs.

An HRA is based on an estimate of the reasonable maximum exposure (RME) expected to occur under current and future land use conditions. Although most of the SWMUs are currently covered by asphalt, it was conservatively assumed that the SWMUs are bare for the purposes of risk assessment. Current and future land uses were identified to be industrial/commercial use. The current and future scenarios under this land use include a baseline scenario and construction scenario. To quantify the risk with each scenario, exposure point concentrations for onsite soils for each COC were first calculated. Fate and transport modeling was then performed for the air pathway, the only transport mechanisms identified, for the baseline and construction scenario. Exposure dose estimations were then made for soil ingestion, dermal absorption, inhalation of vapors, and inhalation or airborne dusts from each scenario. These exposure dose estimations were compared with values from the toxicity assessment for carcinogenic and noncarcinogenic effects to arrive at a risk characterization for each RAA.

For noncarcinogenic effects, the EPA level of concern for hazard indexes is 1.0, that is, if the total exposure dose estimations for all COCs in an RAA is greater than the safe dose level determined by the toxicity assessment, then there could be the potential for adverse effects. In this case, the hazard quotients of the COCs for the RAA need to be further evaluated. If the hazard index is below 1.0, then it is expected that humans will not suffer harmful effects. The hazard indexes for all RAAs for the baseline scenario are all below 1.0. For the construction scenario, the hazard index for RAAs #1, #2, and #4 are below 1.0. The hazard index for the onsite construction worker and the onsite general duty worker under the construction scenario is 1.2 for RAA #3 (RAA #3 is comprised solely of SWMU #83). Because the total hazard index for this RAA under the construction scenario was above 1.0, an evaluation was made of each COC and whether the combination of the effects of the COCs is additive. The primary driver of risk for RAA #3 is manganese. It was determined that adverse effects from manganese do not interact additively with the other COCs, and thus the noncarcinogenic risks can be evaluated by individual COC. The hazard quotients for all of the COCs, including manganese, are below 1.0, thus indicating that there is not expected to be unacceptable noncarcinogenic risks.

For carcinogenic effects, the EPA's target risk range of acceptable levels of carcinogenic risk is 1×10^{-4} to 1×10^{-6}, that is, all estimates of carcinogenic risk below 1×10^{-4} are considered to be acceptable. For all RAAs under all scenarios, the carcinogenic risk is below 10^{-4}.

For effects from lead exposure, the EPA has set 10 μg-lead/dl-blood as the target blood lead concentration using the Biokinetic Model. For all RAAs under all scenarios, the estimated maximum blood lead concentration is below 10 μg-lead/dl-blood.

Based on the findings of the HRA, it was determined that the health effects to humans from the 15 SWMUs are not significant.

Ecological Risk Assessment

An ecological risk assessment (ERA) was conducted using the site investigation data obtained for 15 SWMUs at Cannon AFB. The objectives of the ERA were to evaluate the potential for adverse effects to the environment posed by contaminated soil to the environment. From the information gathered, a recommendation can be made for no further action or for futher study.

The ERA was performed using the guidelines presented in the "Risk Assessment Guidance for Superfund: Volume II: Environmental Evaluation Manual" (EPA, 1989). Assumptions made throughout the ERA were generally conservative, and therefore tend to overestimate the actual risk. The approach employed was similar to that used for the HRA. The identified COCs and associated onsite soil exposures were obtained from the HRA. An ecological receptor, the deer mouse, was selected as being the most representative of exposures to all potential ecological receptors. For the ERA, the only complete pathway of exposure identified was onsite soil ingestion, therefore no fate and transport modeling was performed. Calculations were performed to estimate the daily ingestion dose of each COC by the deer mouse. These exposure dose estimations were compared with values considered to be safe as determined by the toxicity assessment for each of the identified COCs.

If the hazard quotient for a COC is greater than 1.0, that is, if the estimated exposure dose is greater than the identified safe level, then there could be the potential for adverse effects to the deer mouse, and by extension, to the ecosystem in general. If the hazard quotient is less than 1.0, then it is expected that the deer mouse and the ecosystem in general will not suffer harmful effects from the SWMUs. The hazard quotients for all COCs in all RAAs were below 1.0.

Based on the findings of the ERA, it was determined that adverse effects to the ecosystem from the 15 SWMUs are not significant.

1.0 INTRODUCTION

1.1 Purpose and Scope of Report

The purpose of this Resource Conservation and Recovery Act (RCRA) Facility Investigation Report is to present the results of the field activities and laboratory analyses conducted to characterize the nature and extent of contamination at 15 solid waste management units (SWMUs) at Cannon Air Force Base (AFB), New Mexico. The results of the field investigation and the laboratory analyses were used to develop a baseline risk assessment completed as part of the overall RFI of the 15 SWMUs. The LRL Sciences/Ogden Team (LRL) was contracted by the U.S. Army Corps of Engineers (USACE) Albuquerque Office to execute the RCRA Facility Investigation (RFI) presented in this report.

The RFI was performed to satisfy the requirements of the Cannon AFB RCRA permit. The RFI activities were conducted in accordance with the requirements of the RCRA Facility Investigation Work Plan (Volumes I and II) prepared and submitted to the Air Force by Lee Wan and Associates (1990) and RCRA Facility Investigation Plans prepared by the Environmental Management Branch, Civil Engineering Squadron, Cannon AFB, NM (1991). A specific Field Sampling Plan, Health and Safety Plan, and a Quality Control/Quality Assurance Project Plan were developed by the LRL Team for this RFI in accordance with the requirements and format of the above referenced documents.

1.2 Regulatory Framework

Cannon AFB is a permitted RCRA facility. The RCRA permit requires the facility to investigate both newly-identified SWMUs and those identified at the time of permit issuance (Cannon AFB RCRA Permit, EPA I.D. #NM7572124454, 1989). This RFI was conducted as part of the ongoing investigation of these SWMUs as required by the Cannon AFB RCRA permit.

1.3 Report Organization

The following sections, subsections, and appendices present the information obtained during the RFI of 15 SWMUs at Cannon AFB.

Section 1.0 presents the general description of the scope of work, regulatory framework, investigative objectives, methodology used for sample collection and analyses. A general description of the physical and historical setting of Cannon AFB is also included in this section.

Section 2.0 through 16.0 presents specific information for each SWMU under investigation. Included in each SWMU description is a short discussion of the setting, history of use, past investigations, land use, and demography. Information concerning the field investigation, physical characteristics, and the nature and extent of contamination is also presented.

1.4 Cannon Air Force Base Setting and Information

1.4.1 Facility Setting

Cannon Air Force Base (AFB) is sited in Curry County, New Mexico (Figure 1-1). The base occupies approximately 4,320 acres of land south of U.S. Highway 84/68, and approximately seven miles west of Clovis, New Mexico. Clovis is the county seat for Curry County. Portales is located approximately 12 miles south of the base. Clovis and Portales are the largest cities in proximity to Cannon AFB (Figure 1-1).

Air Force Base operations, maintenance, and support facilities are located along the northwest side of the airfield. Base housing is located northwest of the operations, maintenance, and support facilities (Figure 1-2). The wastewater lagoons, explosive ordnance disposal site, fire department and training area, munitions and petroleum storage areas are located to the south and east of the airfield.

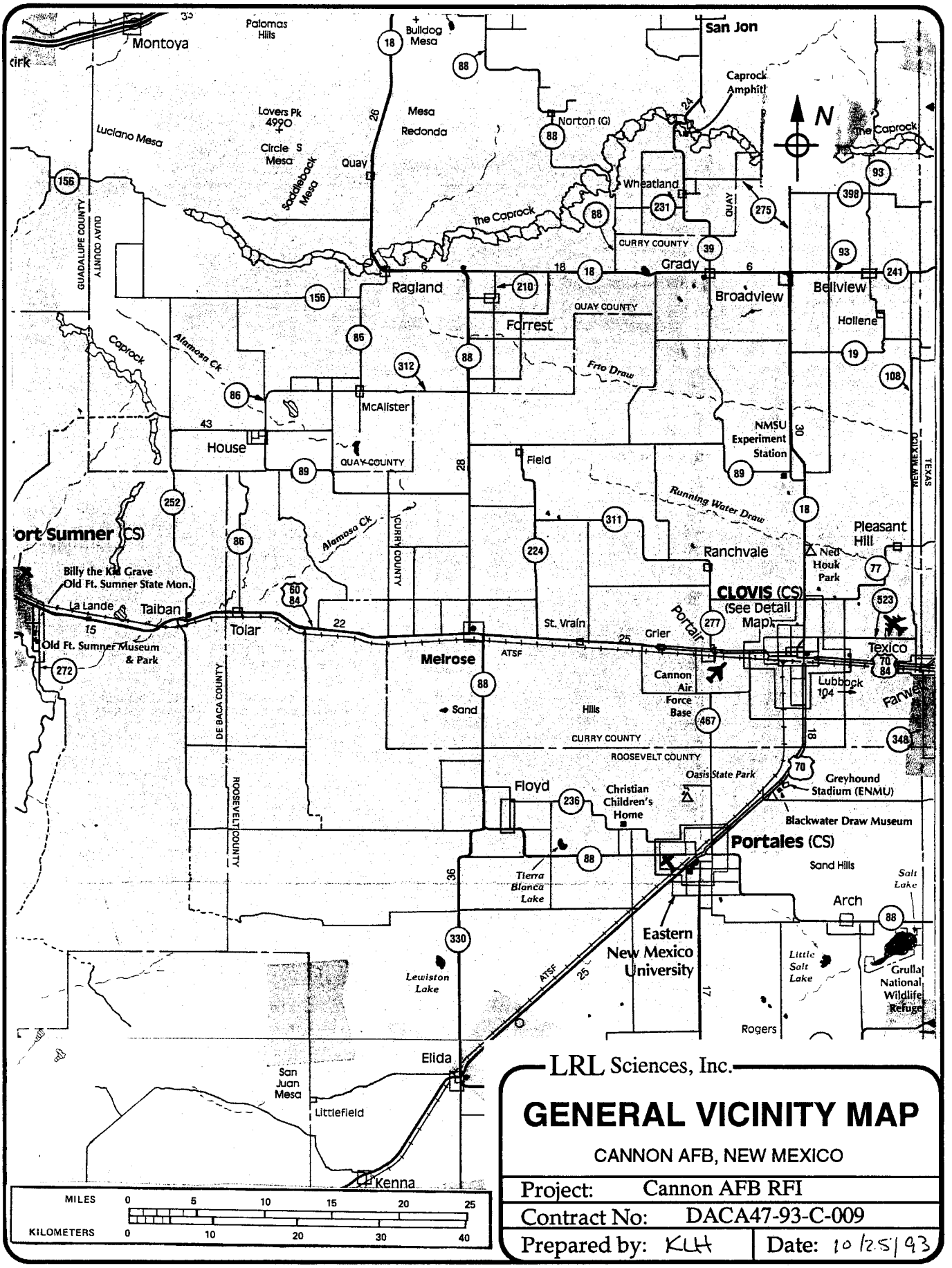
1.4.2 Base History

Cannon AFB occupies a site that was originally designated as Portair Field. Portair Field was established in 1929 as an air terminal for passengers during the initial era of commercial transcontinental flights. The commercial airport was renamed in the 1930s as Clovis Municipal Airport. The first military use of the airfield occurred in 1942 when the Army obtained the base for training bomber squadrons. The Clovis Municipal Airport became known as Clovis Army Air Base at that time. The military base was renamed Clovis Army Air Field in 1945. The Army deactivated the base in 1947. The base was assigned to the Tactical Air Command (TAC) and formally reactivated as Clovis Air Force Base in 1951. Pilots and support personnel trained on a variety of Air Force fighters and fighter-bombers. The base became a major training ground for F-86 Sabre pilots. It was renamed Cannon Air Force Base in honor of General John K. Cannon, a former Commander of TAC, in 1957. At this time, the F-100 Super Sabre became the principal aircraft on the base. The Super Sabre was replaced by the F-111 in 1969. The F-111s of the 27th FW have remained the principal aircraft at Cannon AFB since their assignment. Cannon AFB was reassigned to the Air Combat Command (ACC) on June 1, 1992.

1.4.3 Natural Environment of Facility and Adjacent Areas

1.4.3.1 Physiography

Cannon AFB occupies an area of the Southern High Plains Physiographic Province known as the Llano Estacado. Elevations of the Llano Estacado Subprovince of the Southern High Plains range from 4,200 feet to 4,400 feet above mean sea level (MSL) in the vicinity of Cannon AFB. The topography of the Llano Estacado is very flat with a general slope to the east/southeast. Blowouts (broad shallow wind eroded depressions), broad valleys, and stabilized sand dunes characterize the area.



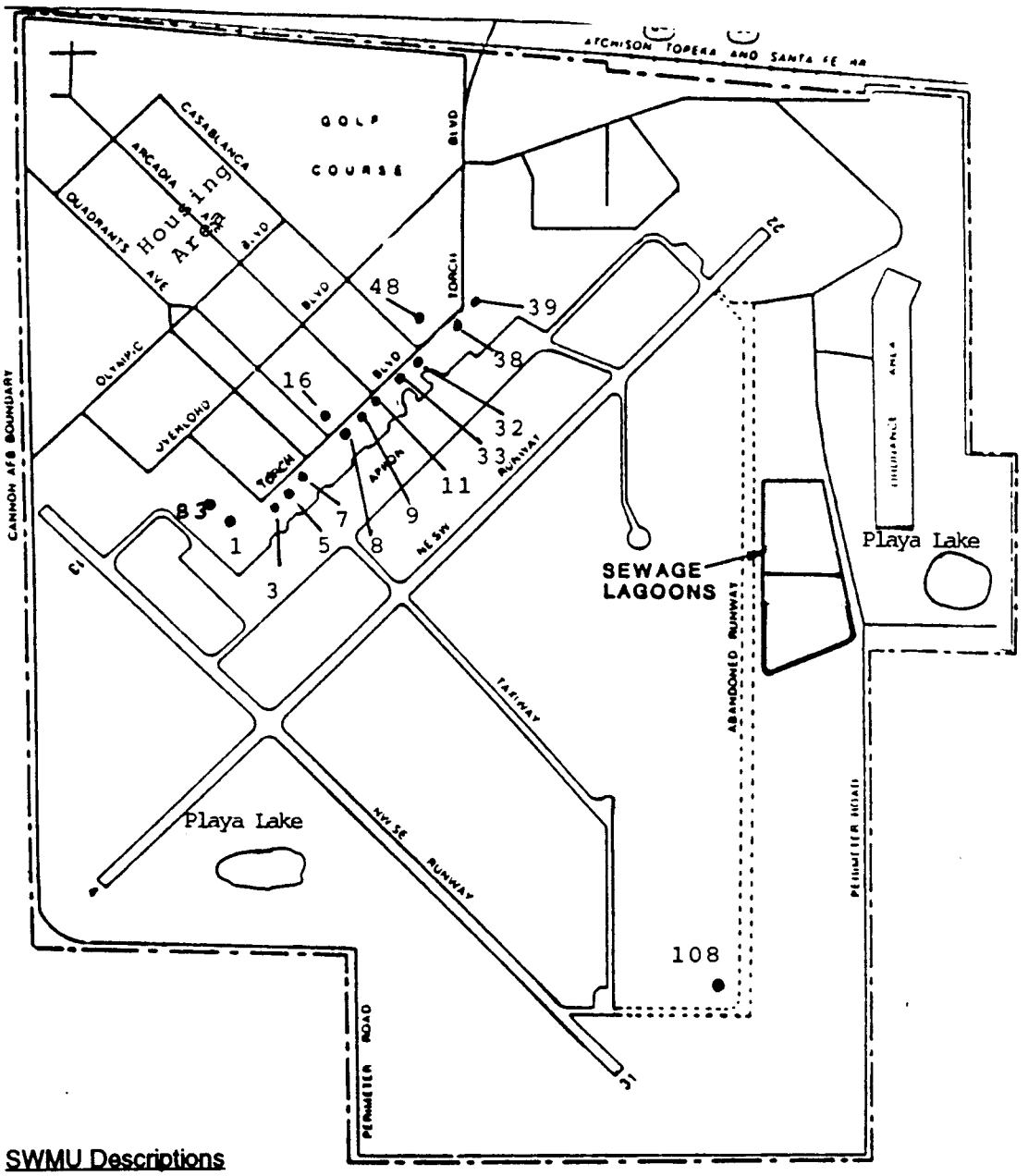
LRL Sciences, Inc.

GENERAL VICINITY MAP

CANNON AFB, NEW MEXICO

Project:	Cannon AFB RFI
Contract No:	DACA47-93-C-009
Prepared by: KLH	Date: 10/25/93

Fig. 1-1



SWMU Descriptions

1. Oil/Water Separator - bldg. 119
3. Oil/Water Separator - bldg. 108
5. Oil/Water Separator - bldg. 121
7. Oil/Water Separator - bldg. 129
8. Oil/Water Separator - bldg. 165
9. Aircraft Washrack Drain System - bldg. 165
11. Oil/Water Separator - bldg. 170
16. Oil/Water Separator - bldg. 680
32. Oil/Water Separator - bldg. 186-1
33. Oil/Water Separator - bldg. 186-2
38. Oil/Water Separator - bldg. 194
39. Oil/Water Separator - bldg. 195
48. A-Underground Waste Oil Tank
    B - Above ground overflow Capacity Tank
83. Sump
108. Explosive Ordinance Disposal Activities Area

N

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SWMU LOCATION MAP

CANNON AFB, NEW MEXICO

Project: Cannon AFB RFI	
Contract No: DACA47-93-C-009	
Prepared by: RLH	Date: 11-5-93

Fig. 1-2

Blowouts occupy small to very large areas, and may collect surface runoff. Larger blowouts that occur at a site with a relatively large drainage area form "playas." Playas are ephemeral lakes that do not have external drainage. The water collected in a playa is lost by evaporation and infiltration to the soil. Playa lakes usually contain water for short periods, such as days or weeks.

Streams or broad valleys do not occur on or near the base. The nearest drainages of this type are the second order streams, called Running Water Draw and Frio Draw. Both streams are ephemeral with poorly developed drainage patterns. These streams drain in a southeast direction conforming to the general drainage pattern of the area.

1.4.3.2 Climatology

Cannon AFB is located in a climatological region classified as semiarid (Figure 1-3). The average annual temperature is 57.4°F with a monthly average for January of 37°F and for July of 77.5°F (SPS, 1993). The annual average precipitation is 16.48 inches with 11.1 inches of snow in the winter months (SPS, 1993). Winds are primarily from the west. The average wind speed is 8 mph with gusts up to 73 mph (Table 1-1).

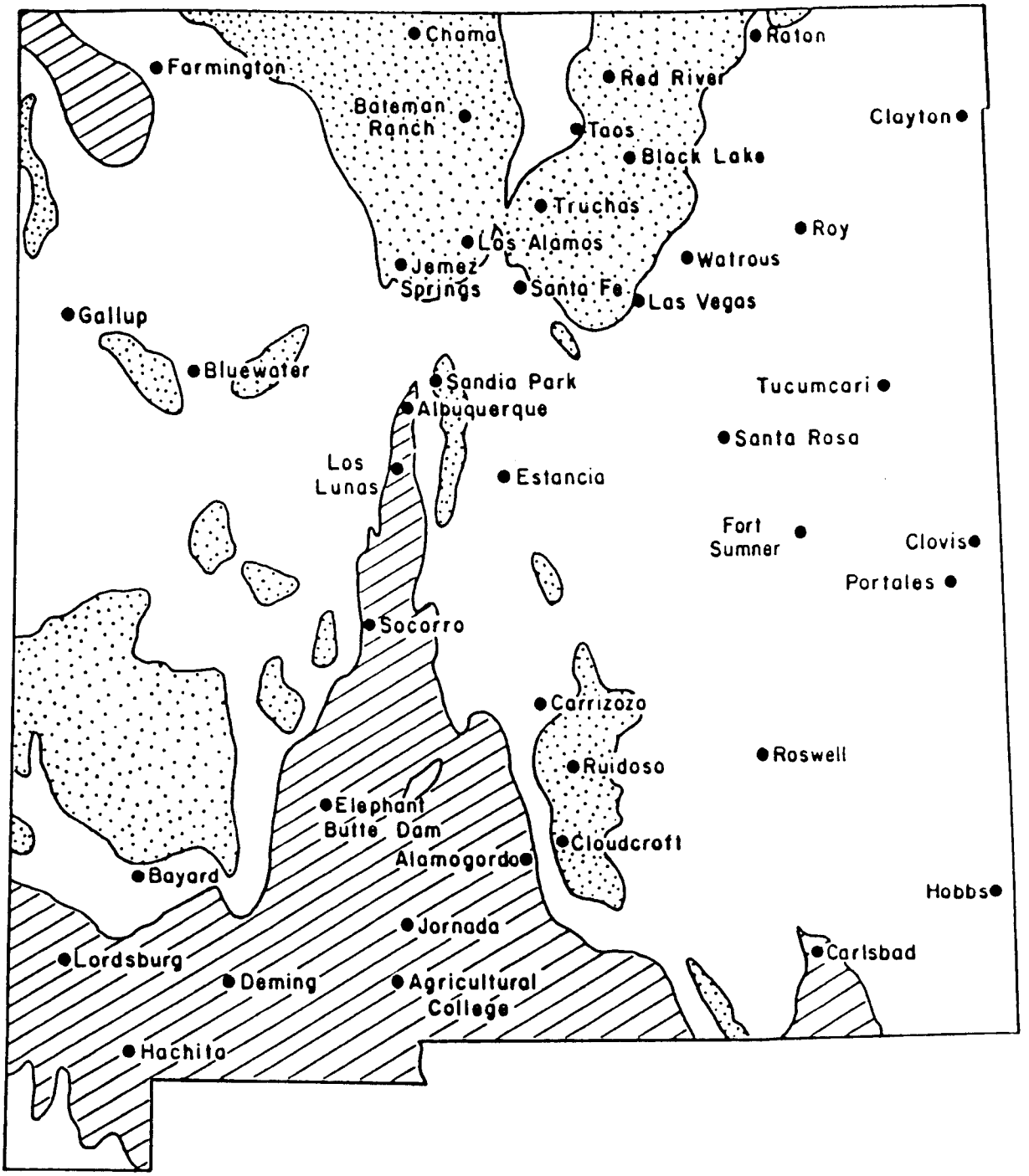
The air mass undergoes vertical mixing between 400 meters and 4,000 meters. The mixing occurs in response to temperature changes in the lower (near ground) portion of the air mass. The depth of mixing is less, in relative terms, during the winter and mornings than during summer and afternoons.

The strong winds of spring, with gusts over 40 mph, mix the air of the lower atmosphere. These gusty spring winds blowing across land with large and small areas of naturally exposed soil create frequent and sometimes severe dust storms in the area. The eastern New Mexico southern plains is part of an area recognized as having the most frequent and highest levels of windblown dust in the United States.

1.4.3.3 Soils

The distribution of soils in the vicinity of Cannon AFB are presently classified as SM (silty sand or silty gravelly sand) to SC (clayey sand or clayey gravelly sand) under the Unified Classification Systems of the USDA-Soil Conservation Service. The following descriptions are based on the draft "Soil Survey, Curry County, New Mexico" (USDA, 1993) and could be subject to minor changes. Figure 1-4 illustrates the various soil types mapped at Cannon AFB. A brief description of soil characteristics are included in the following paragraphs.

The most extensive soil association in Curry County, including Cannon AFB, are the Amarillo soils. The Amarillo series is characterized by three soil types: the Amarillo loam, Amarillo fine sandy loam, and Amarillo loamy fine sand. The Amarillo soils are formed by processes such as stream activity and constant reworking by wind, and generally consist of a loamy sand overlying a hard calcareous caliche layer. All of the Amarillo soils generally have well developed profiles.



LEGEND

Source: US Weather Bureau, Albuquerque office

Arid

Semi-Arid

Sub-humid/Humid (humid only in highest parts of mountains)

N

LRL Sciences, Inc.

CLIMATES OF NEW MEXICO

Project:	Cannon AFB RFI
Contract No:	DACA47-93-C-009
Prepared by: KLH	Date: 10-25-93

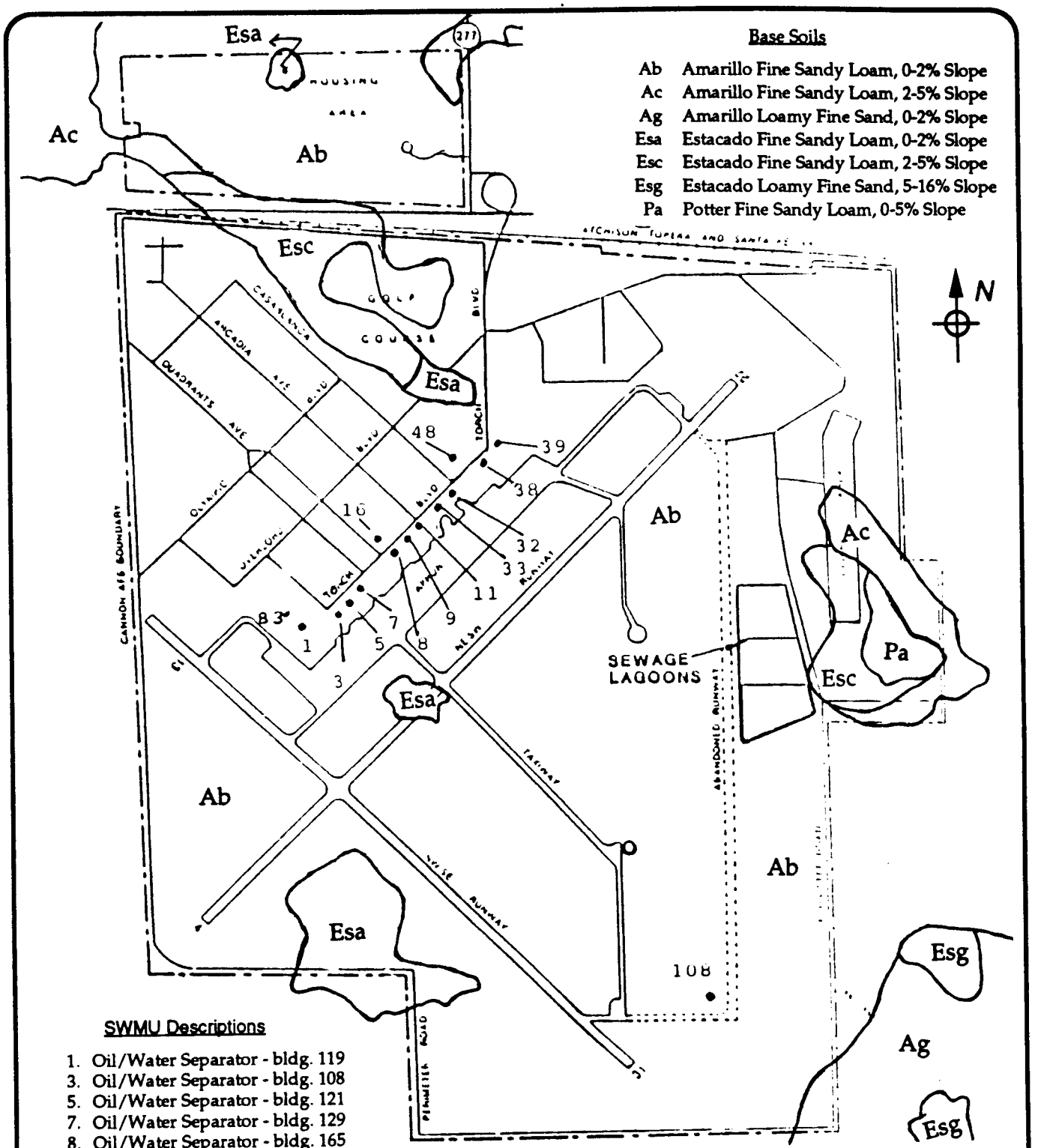
Fig. 1-3

Table 1-1. Monthly and Annual Surface Winds for Cannon AFB, New Mexico

MONTH	PREVAILING DIRECTION[1]	MEAN SCALAR SPEED (Knots)	MAX GUST (Knots)
January	W	8	60
February	W	8	61
March	W	9	73
April	W	9	59
May	W	8	65
June	S	7	64
July	S	6	66
August	S	5	69
September	S	6	70
October	W	7	64
November	W	7	59
December	W	8	67
Annual	W	7	73[2]
Period (yrs)	10	10	10

Source: Final EIS for Realignment of Cannon AFB
[1] Direction from which wind blows the greatest percentage of the time.
[2] Maximum annual wind gusts for 10-year sampling period.

DRAFT



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11. Oil/Water Separator - bldg. 170
16. Oil/Water Separator - bldg. 680
32. Oil/Water Separator - bldg. 186-1
33. Oil/Water Separator - bldg. 186-2
38. Oil/Water Separator - bldg. 194
39. Oil/Water Separator - bldg. 195
48. A-Underground Waste Oil Tank
    B - Above ground overflow Capacity Tank
83. Sump
108. Explosive Ordinance Disposal Activities Area

LRL Sciences, Inc.

SOILS DISTRIBUTION MAP

CANNON AFB, NEW MEXICO

Project: Cannon AFB RFI	
Contract No: DACA47-93-C-009	
Prepared by: KLH	Date: 11-5-93

Source: USDA-S.C.S., Soil Survey of Curry County NM, 1993

Fig. 1-4

The most predominate of these soil types is the Amarillo fine sandy loam, having an 0-2 percent slope phase (map symbol Ab). This soil consists of a thin sandy A horizon, well defined clayey B_{1-3} horizons, with a calcic B_3 horizon at depths below 40 inches. The calcic B_3 horizon lies on a calcic C horizon or on caliche. The color of the surface is brown (7.5YR 5/5, dry) and subsurface soils are reddish-brown (5YR 4/4, dry) to yellow-red (15YR 5/6,dry). The calcic C horizon underlying the Amarillo fine sandy loam is white in color. It occurs on relatively flat surfaces with slope phases of less than 2 percent. The Amarillo fine sandy loam, having an 2-5 percent slope phase (map symbol Ac), can also be found on Cannon AFB and is generally associated with playas. The Amarillo loamy fine sand, having an 0-2 percent slope phase (map symbol Ag), occurs along the southeast quadrant of the base. Amarillo soils typically have moderate hydraulic conductivity rates and range from $1x10^{-3}$ to $4x10^{-4}$ cm/sec (CH_2M Hill, 1983).

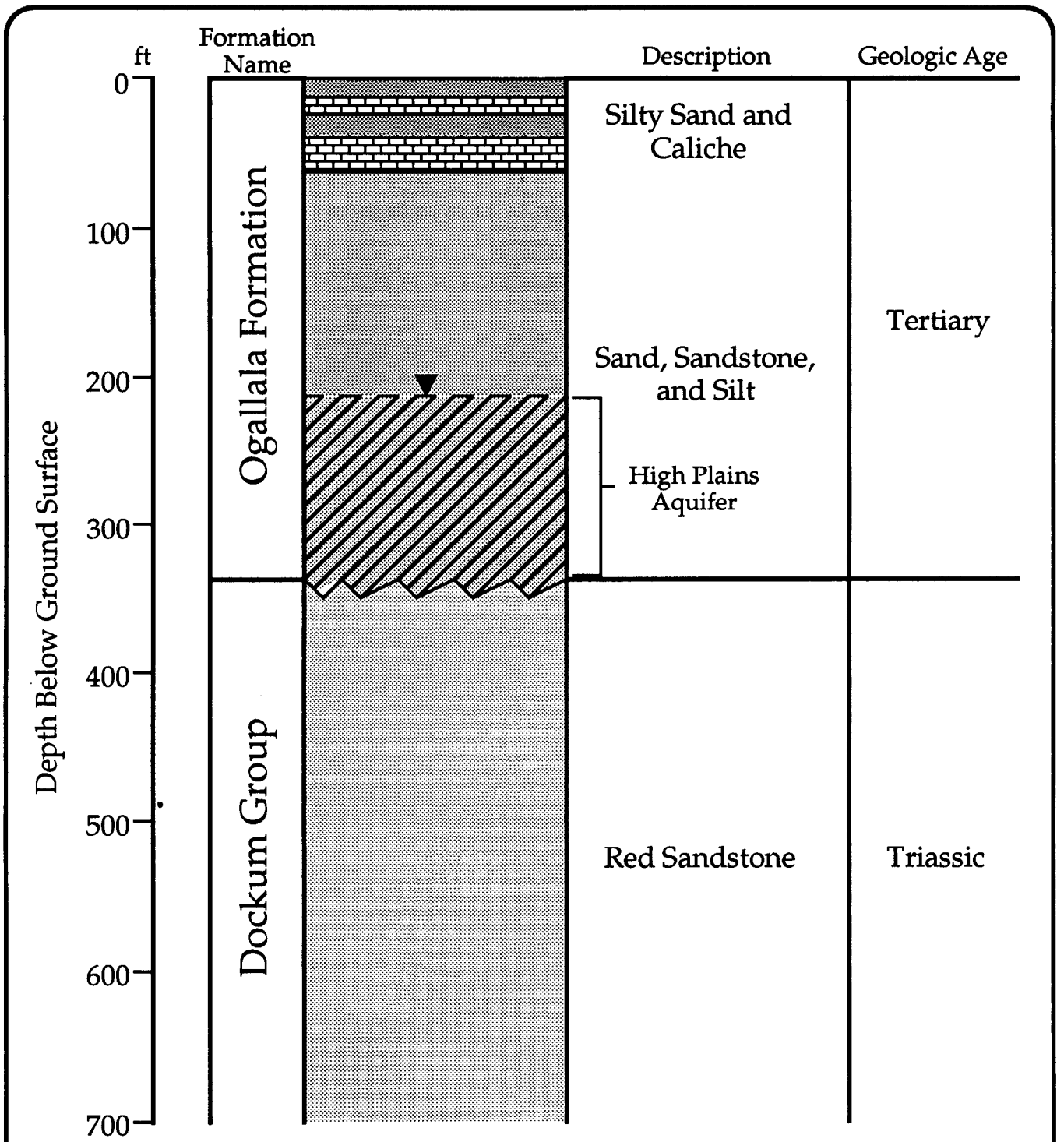
Other less extensive soil associations occurring at Cannon AFB include the Estacado soils, (formerly the Clovis and Mansker soils, USDA, 1993 Draft), and the Potter soils. Both soil types occur primarily in the areas of playa lakes. The USDA Soil Conservation Service describes the soils as follows.

The Estacado soils are extensive throughout Curry County, but only occur in a few areas on and around Cannon AFB. The Estacado soil series is represented by three soil types: the Estacado fine sandy loam (0-2 percent slope phase), the Estacado fine sandy loam (2-5 percent slope phase), and the Estacado loamy fine sand (map symbols Esa, Esc, Esg). The series consists of very deep, well drained, nearly level to moderately steep soils of uplands. The soil is formed from loamy, calcareous alluvial, or eolian materials. The surface layer is brown clay loam about 16 inches thick. The subsoil is calcareous clay loam with prominent accumulations of calcium carbonate. It is reddish brown in the next 32 inches, and reddish yellow below 60 inches and extending to depths greater than 80 inches. Slopes range from 0 to 16 percent. The individual soil profiles are generally poorly developed.

Potter soils occur in one location at Cannon AFB, but in many areas in Curry County they have a close association with the Estacado soils. They seem to have been formed from weathered caliche and other wind blown materials. They contain large amounts of calcium carbonate material, are shallow in depth and overlie a hard consolidated caliche layer. Potter soils (map symbol Pa) range in color from grayish brown at the surface to pale brown in the subsurface.

1.4.3.4 Geology

Cannon AFB is situated in the Southern High Plains (Llano Estacado) section of the Great Plains of eastern New Mexico and western Texas. The stratigraphic units of concern consist of the Ogallala Formation of late Miocene to early Pliocene epoch, 24-2 million years ago, and the Dockum Group of the late Triassic period, 240-205 million years ago (Figure 1-5). The Ogallala Formation extends from eastern New Mexico to the Pecos Valley in Texas and northward to parts of Oklahoma, Kansas, Colorado, Nebraska, Wyoming, and South Dakota. The Ogallala Formation is the principle geologic unit in the High Plains aquifer and underlies the area currently under study. The contact between the Ogallala Formation and its underlying Triassic Formation is an unconformity. The surface of this unconformity is apparently undulating; therefore, the thickness of the Ogallala Formation can vary significantly over local



LEGEND

Lithologic Contact

Water Level

Unconformity

Source: USGS

LRL Sciences, Inc.

GENERALIZED GEOLOGIC COLUMN

CANNON AFB, NEW MEXICO

Project: Cannon AFB RFI	
Contract No: DACA47-93-C-0009	
Prepared by: KLH	Date: 10/25/93

Fig. 1-5

and regional distances. Recently completed studies in the Cannon area conclude that a minimum depth to the High Plains aquifer is about 250 feet below land surface.

The depositional history of the Ogallala Formation for the Southern High Plains section is complex. It involves the influences of eolian, fluvial, sandy alluvial and minor lacustrine deposits. The Ogallala Formation in the vicinity of Cannon AFB is composed of deposits which are unconsolidated, as well as poorly sorted sand, silt, clay, and gravel. Many of these deposits exist as lenticular beds or lenses of material cemented with varying degrees of calcium carbonate and are resistant to weathering. Studies in the area of Cannon have concluded that no faults or other dynamic geologic activity exist.

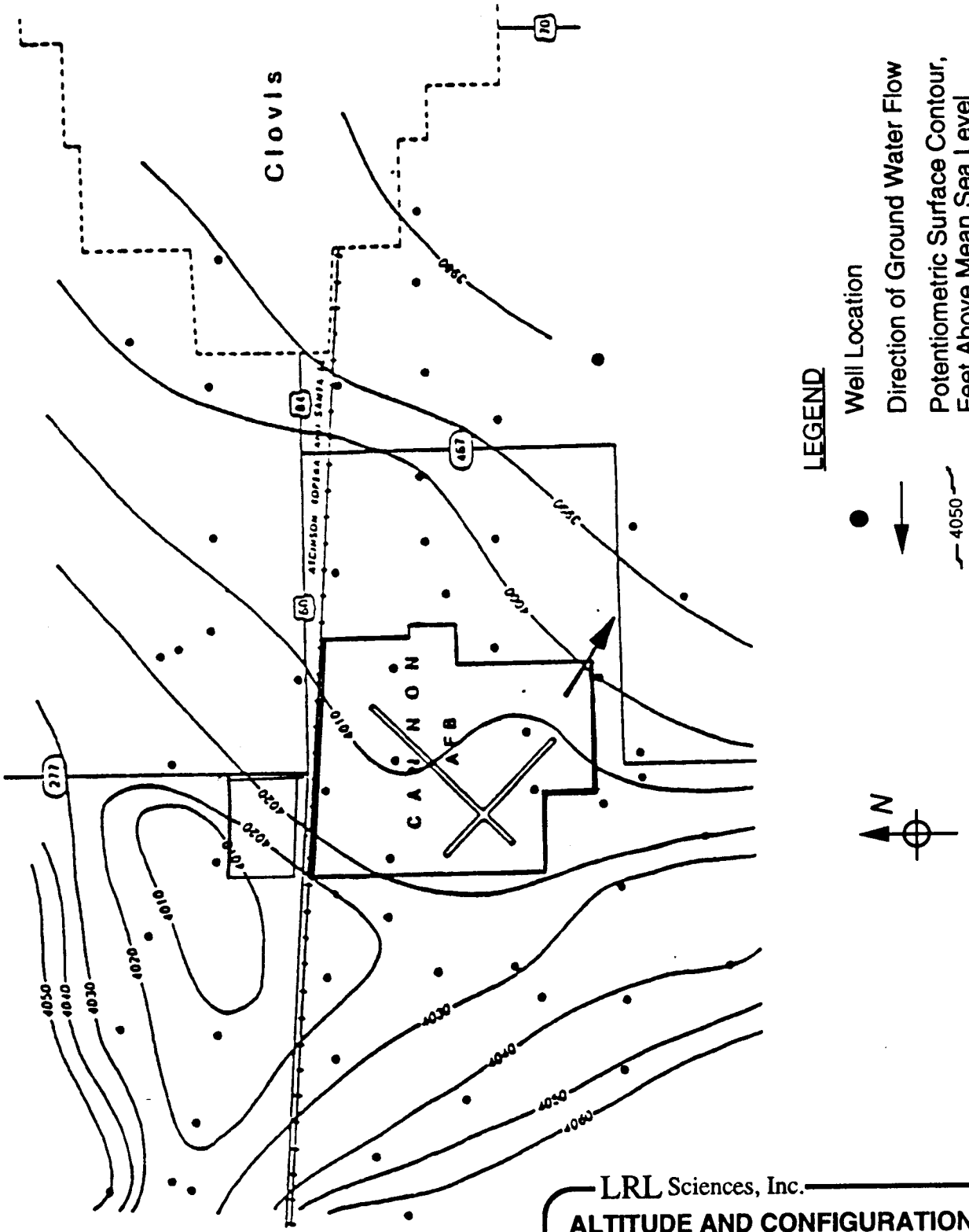
Caliche or calcium carbonate is another dominant characteristic in this area. It is hard, white to grey in color, and occurs in continuous or discontinuous layers throughout much of the uppermost part of the formation. Caliche layers in many instances consist of well developed accumulations of almost pure calcium carbonate material. The caliche material varies in thickness and depth over the areal extent of the base.

1.4.3.5 Hydrology

Cannon AFB lies over a small portion of the Ogallala Formation, which is the region's major water supply. The geographic extent of the Ogallala aquifer includes eastern New Mexico, western Texas, western Oklahoma, eastern Colorado, Nebraska, southwestern South Dakota and southeastern Wyoming, an area of 134,000 square miles (Gutentag et al., 1984). The aquifer is stratigraphically located above the Dockum group red beds. The aquifer is unconfined, with regional gradients of 10 to 15 ft/mile. Wells may yield up to 1600 gallons per minute (gpm) from the Ogallala sands and gravels (Woodward-Clyde, 1992). The overall water quality is good and is typically classified as "hard."

Ground water is the only water supply at Cannon AFB. Ground water is used for both irrigation and potable water. Water table elevation contours are shown in Figure 1-6 (Radian, 1986). The depth to the ground water table ranges from 300 feet in the northwest corner of the base to 260 feet in the southeast corner of the base (CH_2M Hill, 1983). Saturated thickness varies from 93-143 feet. The local ground water gradient is southeast at 7 to 15 feet/mile (CH_2M Hill, 1983). The well production on Cannon AFB varies from 205 to 1150 gpm.

Hydraulic conductivity of the Ogallala Formation was estimated from aquifer pump tests. These test results showed a range of 2.0×10^{-3} to 2.0×10^{-2} cm/sec (Woodward-Clyde, 1992). Hydraulic conductivity values were also estimated from empirical relationship of hydraulic conductivity and specific yield for various grain sizes in well logs; values for the hydraulic conductivity showed a range of 3.9×10^{-3} cm/sec to 7.1×10^{-2} cm/sec with an average of 2.1×10^{-2} cm/sec. Values for the specific yield showed a range of 0.05 to 0.20 with an average of 0.15 (USGS, 1985).



Source: Installation Restoration Program Phase II - Stage I Draft, Radian Corp., 1986

LRL Sciences, Inc.

ALTITUDE AND CONFIGURATION OF WATER TABLE, VICINITY OF

CANNON AFB, NEW MEXICO

Project: Cannon AFB RFI	
Contract No: DACA47-93-C-009	
Prepared by: KLH	Date: 10/25/93

Fig. 1-6

Recharge to the Ogallala aquifer is mainly from infiltration of rain water on the high plains (14-16 in/yr rainfall). The recharge of the Ogallala aquifer varies by two orders of magnitude on the southern high plains, varying from 0.01 in /yr to 1.6 in/yr (Nativ and Riggio, 1990). The estimate of the 1.0 in/yr local recharge falls within this range (Woodward-Clyde, 1992). The recharge on Amarillo soils is 0.03 in/yr and 0.48 in/yr on playas (Stone, 1990). An additional recharge of an unknown amount is from irrigation return flow from areas where the water is continuously ponded.

Well pumping has greatly depleted the aquifer; water levels in wells at Cannon AFB have declined an average of 1.2 feet per year (USAF, 1990). Springs along the eroded margins of the Ogallala Formation are also discharge areas. These type of springs occur near Portales south of Cannon AFB.

Potential for groundwater contamination is low because of low hydraulic conductivity units beneath the AFB. The hydraulic conductivity of the Amarillo soils, which range from 4×10^{-4} cm/sec to 1×10^{-3} cm/sec, is lower than the hydraulic conductivity range of the Ogallala aquifer (CH_2M Hill, 1983). The low recharge rate (USAF, 1990) and a relatively deep water table are also factors that indicate a low potential for groundwater contamination.

1.4.3.6 Land Use and Demography

Cannon AFB is located in Curry County, New Mexico. Clovis, the county seat, and Portales are the largest cities near the base. Clovis is approximately seven miles east of Cannon AFB and Portales lies approximately twelve miles to the south. Data presented in the Clovis-Curry County Chamber of Commerce (CCCCC, 1993) Community Survey shows the population of Curry County as 42,207. The population of Clovis is 30,954 and the population of Portales is 11,000. The population of Cannon AFB is 4,653 (CCCCC, 1993).

Major industries in Curry County include agriculture, retail trade, government, and services. Curry County consistently ranks second in New Mexico in agricultural production. A major share of the wheat, corn, peanuts, barley, cotton, milo, hay, and potatoes grown in New Mexico come from this county (CCCCC, 1993). In addition to crop production, dairy farming, cattle ranching, and livestock feeding are important to the area's economy. The importance of agriculture in Curry County is apparent when one realizes that of the 897,000 acres within the county, over 837,000 of these acres are designated as farmland (USAF, 1990). The land surrounding Cannon AFB is irrigated farmland.

The Santa Fe Railroad and Cannon AFB also provide a significant economic boost to the county. Cannon AFB's related employment is approximately 6,000 individuals, which includes 5,098 military personnel and 900 civilians (USAF, 1993). The total of the base personnel makes Cannon AFB the largest employer in Curry County.

The type or amount of development on the lands surrounding Cannon is not controlled by land use or zoning restrictions at the present time. The Air Force has identified and designated Compatible Use Zones (CUZs) around Cannon AFB which provide land use recommendations for areas subject to noise and hazards associated with aircraft accidents. Commercial and

residential land use that is incompatible with the Air Force CUZ designation has occurred to the northeast of the base because of the lack of zoning or land use controls.

Land use within the boundaries of Cannon AFB include base operation facilities (light industrial), businesses, offices, commissary, entertainment facilities (commercial), residential areas, water and sewage facilities (utilities), parks and playgrounds (recreational), and vacant land. There are 1,591 housing units on base with an additional 250 located off base. This housing consists of 830 on-base dormitory units for individual enlisted personnel, 1,011 on-base family units, and 250 off-base family units.

Educational facilities are available for Cannon AFB personnel and dependents through the Clovis Municipal School District, Portales Schools, other school systems in the local area, Eastern New Mexico University of Portales, and the Clovis Community College.

Portales is the home of Eastern New Mexico University, the third largest university in New Mexico. The enrollment is more than 3,800 students (CCCCC, 1993). Clovis Community College offers a two-year community college program with an enrollment of more than 3,800 (CCCCC, 1993).

Medical services for Cannon AFB personnel and their dependents are provided by the base hospital. Additional medical services are available locally at the Clovis High Plains Hospital, Roosevelt General Hospital in Portales, and the De Baca General Hospital in Fort Sumner.

1.4.3.7 Ecology

Cannon AFB is located on the Llano Estacado, a subprovince of the Southern High Plains Physiographic Province. Most of the High Plains is covered by a short-grass vegetation type. The short-grass vegetation type is dominated primarily by blue grama grass with galleta grass as a subdominant species. Areas with coarse soils or gravelly slopes also support sideoats grama, hairy grama, galleta grass, and little bluestem. Sand bluestem and sand dropseed are found growing on sandy soils. The heavier clay soil are occupied by big bluestem, buffalograss, and western wheatgrass. Meadows, valleys, and floodplains with alkali soil support alkali sacaton and desert saltgrass.

The short grass plains have numerous species of forbs and shrubs with few trees. The most common non-native forbs include kochia and russian thistle. Native species include asters, sunflowers, and cacti. Native shrubs found on the plains include soapweed yucca, four wing saltbush, winterfat, broom snakeweed, and mesquite. Trees are generally found growing in areas where water is more available. The trees growing on the plains include natives such as the plains cottonwood and introduced species such as russian olive and chinese elm.

The wildlife of the Llano Estacado consists of large and small mammals, waterfowl, shorebirds, raptor, and passerine birds. Reptiles and amphibians are also common in the area. The playa lakes are important to the area's wildlife because they provide drinking water, resting areas, and nesting sites with an increased food supply for migratory birds.

Table 1-2 presents a list of mammals that reside in the area of Cannon AFB.

Table 1-3 presents a listing of birds that occur in the Cannon AFB area.

Table 1-4 presents some of the common reptiles occurring in the vicinity of Cannon AFB.

Threatened and endangered species listed by the United States Fish and Wildlife Service (USFWS) are not known to exist on Cannon AFB. Threatened and endangered species listed by the USFWS for Curry and Roosevelt County in the vicinity of Cannon AFB are the Peregrine Falcon (Falco peregrinus) (USFWS, 1993), the Bald Eagle (Haliaectus leucocephalus), and the Black Footed Ferret (Mustela nigripes). Suitable nesting or roosting sites for the Bald Eagle and the Peregrine Falcon are not easily found on or adjacent to Cannon AFB. The Black-Footed Ferret has been reported in the past as occurring in Curry County. This ferret has not been identified in this area in recent history.

Baird's Sparrow (Ammodramus bairdii) is the only endangered species listed by the State of New Mexico known to occur in Curry County. It is found in the area mainly during autumn migration in the eastern plains and southern lowlands. Migrants appear as early as the first week of August and move farther south by November (USAF, 1990).

The Tall Plains Spurge (Euphorbia strictor) is listed as a Sensitive Species by the State of New Mexico. This species grows on sandy soils of the short grass plains. This species was not found during the recent vegetation survey of Cannon AFB (NMEMNRD, 1993).

1.4.4 Previous Investigations

The following discussion concerning previous investigations is modified from the Woodward-Clyde Remedial Investigation Report for 18 Solid Waste Management Units, Cannon AFB, Covis, NM (May 1992). This discussion also includes the Woodward-Clyde Investigation.

Prior to this RFI at Cannon AFB, past investigations had been performed for the majority of the SWMUs currently being investigated. These previous investigations were conducted under both the USAF IRP program and in relation to Cannon AFB's RCRA permit. The following is a brief description of the previous investigations which have been conducted at Cannon AFB. Additional information on previous investigations at the specific SWMUs investigated by this RFI is contained in Sections 2.0 through 16.0 of this RFI report.

In 1982-1983, CH_2M Hill conducted a records search in support of the USAF IRP program for Cannon AFB. The records search was conducted as Phase I of the IRP for Cannon AFB. This project included a detailed review of pertinent installation records, contact with government agencies, and a site visit. The purpose of this project was to identify and fully evaluate suspected problems associated with past hazardous material disposal sites, control the migration of hazardous contamination from such sites, and control hazards to health and welfare that may have resulted from these past operations. Results of this records search identified several sites on Cannon AFB which warranted further investigation (CH_2M Hill, 1983).

Table 1-2. Mammals in the Cannon AFB Area

GENUS-SPECIES	COMMON NAME
Antilocarpa americana	Pronghorn
Antrozous pallidus	Pallid Bat
Bassariscus astutus	Ringtail
Canis latrans	Coyote
Cynomys ludovicianus	Black-Tailed Prairie Dog
Dipodomys ordii	Ord's Kangaroo Rat
Dipodomys spectabilis	Banner-Tailed Kangaroo Rat
Erethizon dorsatum	Porcupine
Geomys bursarius	Plains Pocket Gopher
Lepus californicus	Black-Tailed Jack Rabbit
Mephitis mephitis	Striped Skunk
Mustela frenata	Long-Tailed Weasel
Neotoma micropus	Southern Plains Woodrat
Odocoileus hemionus	Mule Deer
Onychomys leucogaster	Northern Grasshopper Mouse
Perognathus hispidus	Hispid Pocket Mouse
Perognathus flavescens	Plains Pocket Mouse
Perognathus flavus	Silky Pocket Mouse
Peromyscus lucopus	White-Footed Mouse
Peromyscus maniculatus	Deer Mouse
Reithrodontomys megalotis	Western Harvest Mouse
Reithrodontomys montanus	Plains Harvest Mouse
Sigmodon hispidus	Hispid Cotton Rat
Spermophilus spilosoma	Spotted Ground Squirrel
Sylvilagus auduboni	Desert Cottontail
Tadarida brasiliensis	Brazilian Free-Tailed Bat
Taxidea taxus	Badger
Vulpes velox	Swift Fox

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Table 1-3. Birds of the Cannon AFB Area

GENUS-SPECIES	COMMON NAME
Accipiter cooperii	Cooper's Hawk
Accipiter striatus	Sharp-Shinned Hawk
Actitis macularia	Spotted Sandpiper
Agelaius phoeniceus	Red-Winged Blackbird
Aimophila cassinii	Cassin's Sparrow
Ammodrumus savannarum	Grasshopper Sparrow
Anas acuta	Pintail Duck
Anas carolinensis	Green-Winged Teal
Anas cyanoptera	Cinnamon Teal
Anas discors	Blue-Winged Teal
Anas platyrhynchos	Mallard Duck
Anthus spinoletta	Water Pipit
Aquila chrysaetos	Golden Eagle
Archilochus alexandri	Black-Chinned Hummingbirg
Ardea herodias	Great Blue Heron
Asio flammeus	Short-Eared Owl
Athene cunicularia	Burrowing Owl
Branta canadensis	Canada Goose
Bubo virginianus	Great Horned Owl
Buteo jamaicensis	Red-Tailed Hawk
Buteo lagopus	Rough-Legged Hawk
Buteo regalis	Ferruginous Hawk
Buteo swainsoni	Swainson's Hawk
Calamospiza melanocorys	Lark Bunting
Calcarius ornatus	Chestnut-Collard Longspur
Callipepla squamata	Scaled Quail
Capella gallinago	Common Snipe
Carpodacus mexicanus	House Finch

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Table 1-3. Birds of the Cannon AFB Area (continued)

GENUS-SPECIES	COMMON NAME
Casmerodius albus	Common Egret
Cathartes aura	Turkey Vulture
Charadrius vociferus	Killdeer
Chen hyperborea	Snow Goose
Chlidonias niger	Black Tern
Chondestes grammacus	Lark Sparrow
Chordeiles minor	Common Nighthawk
Colaptes cafer	Red-Shafted Flicker
Columba livia	Domestic Pigeon
Corvis brachyrhynchos	Common Crow
Corvis cryptoleucus	White-Necked Raven
Dendroica nigrescens	Black-Throated Gray Warbler
Eremophila alpestris	Horned Lark
Euphagus cyanocephalus	Brewer's Blackbird
Eupoda montana	Mountain Plover
Flaco mexicanus	Prairie Falcon
Falco sparverius	American Kestrel
Fulica americana	American Coot
Geococcyx californianus	Roadrunner
Grus canadensis	Sandhill Crane
Guiraca caerulea	Blue Grosbeak
Hesperiphona vespertina	Evening Grosbeak
Hirundo rustica	Barn Swallow
Hylocichla guttata	Hermit Thrush
Ictinia mississippiensis	Mississippi Kite
Lanius ludovicianus	Loggerhead Shrike
Limnodromus scholopaceus	Long-Billed Dowitcher
Megaceryle alcyon	Belted Kingfisher

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Table 1-3. Birds of the Cannon AFB Area (concluded)

GENUS-SPECIES	COMMON NAME
Melospiza melodia	Song Sparrow
Mergus merganser	Common Merganser
Mimus polyglottos	Mockingbird
Molothrus ater	Brown-Headed Cowbird
Muscivora forfic	Scissor-Tailed Flycatcher
Oporornis tolmiei	MacGillivray's Warbler
Passer domesticus	House Sparrow
Passerculus sandwichensis	Savannah Sparrow
Piranga rubra	Summer Tanager
Pooecetes gramineus	Vesper Sparrow
Recurvirostra americana	American Avocet
Spinus tristis	American Goldfinch
Spizella arborea	Tree Sparrow
Spizella passerina	Chipping Sparrow
Sturnella magna	Eastern Meadowlark
Sturnella neglecta	Western Meadowlark
Sturnus vulgaris	Starling
Totanus flavipes	Lesser Yellowlegs
Toxostoma rufum	Brown Thrasher
Tryngites subruficollis	Buff-Breasted Sandpiper
Turdus migratorius	Robin
Tympanuchus pallidicinctus	Lesser Prairie Chicken
Tyrannus verticalis	Western Kingbird
Tyto alba	Barn Owl
Wilsonia pusilla	Wilson's Warbler
Zenaidura macroura	Mourning Dove
Zonotrichia leucophrys	White-Crowned Sparrow

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Table 1-4. Reptiles in the Cannon AFB Area

GENUS-SPECIES	COMMON NAME
Ambystoms tigrinum	Tiger Salamander
Arizona elegans	Kansas Glossy Snake
Bufo cognatus	Great Plains Toad
Bufo debilis	Green Toad
Bufo punctatus	Red-Spotted Toad
Cnemidophorus sexlineatus	Six-Lined Racerunner
Crotalus viridis	Prairie Rattlesnake
Crotaphytus collaris	Collard Lizard
Diadophis punhctatus	Prairie Ringneck Snake
Elaphe guttata	Corn Snake
Eumeces obosoletus	Great Plains Skink
Hetrodon nasieus	Western Hognose Snake
Holbrookia maculata	Lesser Earless Lizard
Lampropeltis getulus	California Kingsnake
Lampropeltis triangulum	Central Plains Milk Snake
Leptotyphlops delcis	Texas Blind Snake
Masticophis flagellum	Western Coachwhip
Phyrnosoma cornutum	Texas Horned Lizard
Phyrnosoma modestum	Round-Tailed Horned Lizard
Pituophis melanoleucus	Bullsnake
Rhinocheilus lecontei	Texas Long-Nosed Snake
Scaphiopus bombifrons	Plains Spadefoot
Scaphiopus conchi	Conch's Spadefoot
Scaphiopus hammondi	Western Spadefoot
Sceloporus undulatus	Eastern Fence Lizard
Sistrurus caternatus	Massasauga
Sonora episcopa	Grand Snake
Tantilla migricejas	Plains Black-Headed Snake
Terapene ornata	Box Turtle
Thamnophis radix	Plains Garter Snake
Uta stansburiana	Side-Blotched Lizard

Based on the records search, Radian Corporation conducted a hydrogeological investigation of 16 sites on Cannon AFB to determine if environmental contamination resulted from past waste disposal and materials handling operations. The investigation was part of a Phase II of the IRP for Cannon AFB. The sites investigated during this 1984-1985 program included several landfills, fire training areas, fuel handling and spill areas. Results of this investigation documented the presence of oil and grease in the upper soil zone at several sites. Metals analyses indicated that metals were generally at background levels except for barium and selenium at several sites (Radian 1986). No groundwater contamination was found as a result of this investigation.

As a result of the investigation performed by Radian in 1984-1985, a follow up investigation was performed by Radian at the AGE Drainage Ditch - Site 15, (SWMU 34/IRP No. SD-11). This investigation was conducted to determine whether toxic soils existed and if so, to assist Cannon AFB personnel in disposing the soils in a proper manner in compliance with applicable hazardous waste regulations. Results of this investigation indicated that the AGE Drainage Ditch contained visibly discolored but nonhazardous soils (as defined by 40 CFR 261, Subpart D) (Radian, 1987). Recommendations for site restoration were provided to the USACE, Omaha District and Cannon AFB as a result of this investigation.

In 1987, A.T. Kearney, Inc. performed a Preliminary Review and Visual Site Inspection of Cannon AFB for the USEPA Region VI to identify and evaluate solid waste management units (SWMU) and other areas of concern. During that investigation, the potential for releases of hazardous wastes or constitutents to the environment was assessed, and where appropriate, the need for further action was identified. That investigation identified 128 SWMUs and 51 other areas of concern (Kearney, 1987).

Walk, Haydel & Associates conducted a remedial investigation at four sites (Underground Storage Tank Runoff Area at Fire Department Training Area No. 4, Engine Test Cell Overflow Pit and Leach Field, South Stormwater Collection Point, and Northeast Stormwater Collection Point) at Cannon AFB in 1987. The sites investigated during that investigation were selected for additional investigation based on the results of IRP Phase I and Phase II investigations. Results of that investigation suggested that no adverse impact to public health or the environment is expected based on conditions at each of the four sites (Walk, Haydel & Associates, 1990).

In 1988, an Environmental Assessment and Remedial Action Plan was prepared for the Old Entomology Rinse Area - Site 17 (SWMU 78/IRP No. SD-17) by Walk, Haydel & Associates. Their investigation was prompted by findings during the hydrogeologic investigation conducted previously by Radian Corporation. Results of that Environmental Assessment suggested that the site does not pose a significant impact to the environment and that no remedial action should be required at the Old Entomology Rinse Area (Walk, Haydel & Associates, 1988).

A Remedial Investigation (RI) was conducted in 1991-1992 by Woodward-Clyde Consultants. The RI was conducted to evaluate the nature and extent of potential contamination of 18 Solid Waste Management Units (SWMUs) located on Cannon AFB (Woodward-Clyde, 1992). Woodward-Clyde performed a Baseline Risk Assessment as part of the RI work. The RI work consisted of drilling and sampling. Sampling of surface and subsurface soil, groundwater,

surface water, and sediment was conducted. The following SWMUs were investigated by Woodward-Clyde:

- No. 34 AGE Drainage Ditch (IRP SD-15)
- No. 76 Sludge Weathering Pit (IRP WP-14)
- No. 78 Fire Training Area No. 1 (IRP FT-6)
- No. 81 Solvent Disposal Area (IRP DP-16)
- No. 86-90 Engine Test Cell (IRP SD-11)
- No. 95 NE Stormwater Drainage (IRP SD-20)
- No. 96 Old Entomology Ravine (IRP SD-17)
- No. 98 Sanitary Sewer Line
- No. 101, 102 Wastewater Lagoons
- No. 106 Fire Training Area No. 2 (IRP FT-7)
- No. 107 Fire Training Area No. 3 (IRP FT-8)
- No. 109 Fire Training Area No. 4
- No. 113 Landfill No. 5 (IRP LF-5)

These SWMUs were identified during the RCRA Facility Assessment (RFA) performed by USEPA in 1987.

Petroleum products, metals, and pesticides were identified from the Woodward-Clyde RI. The risk assessment concluded that "potential health impacts to humans from the 18 SWMUs investigated during the RI are not significant" (Woodward-Clyde, 1992). The ecological risk assessment recommendations were "no action" for all the SWMUs except SWMU 109. Further investigation was recommended for this site.

1.5 Field Investigation Objectives and Methods

1.5.1 Field Investigation Objectives

The approach for investigating 15 SWMUs at Cannon AFB was to review the results of past investigations, identify data needs and then formulate a sampling plan to collect the necessary data required to evaluate each SWMU. Data collection activities were designed to evaluate the nature and extent of contamination, if any, identify properties that control contaminant migration and perform a baseline risk assessment. If necessary, these data may be used to support the selection of remedial alternatives.

The SWMU-specific sampling programs were designed to sample all potentially affected media specific to each SWMU in a safe, efficient, and quality-controlled manner. Data collection activities were designed to be comparable and compatible with previous site investigations.

The rationale for selection of sampling locations, number of samples and analytical parameters is detailed in the Field Sampling Plan (FSP), RCRA Facility Investigation, Cannon AFB, New Mexico (LRL, 1993). In general, however, sample locations, frequencies and analyses were selected to find any hazardous or otherwise regulated waste constituents, if present, and characterize their nature and extent.

1.5.2 Field Investigation Methods

This section provides a discussion of the samples collected and the investigation methods used during sampling activities conducted at Cannon AFB in April of 1993. This includes: sampling equipment and procedures, sample designation, sample handling, documentation, and analysis.

The sampling activities at Cannon, as outlined in the FSP (LRL, 1993), consisted of drilling 3 to 5 boreholes in the vicinity of each SWMU and collecting surface and subsurface samples for chemical analysis (Table 1-5).

Table 1-5. Summary of Boreholes and Samples

Number of Boreholes	Number of Surface Soil Samples	Number of Subsurface Soil Samples (including duplicates)
50	100	395

For some SWMUs, actual borehole locations differ slightly from the FSP. Borehole locations were moved in response to obstacles to the drilling equipment or improved information on SWMU location. In all cases the distances moved were marginal and were considered either similar to original locations or better for characterizing the SWMU.

In accordance with the Quality Assurance Plan (QAP) (LRL, 1993), QA/QC samples (duplicate soil samples, ambient blanks, rinsate blanks, trip blanks, and decontamination water blanks) were collected and submitted to Southwest Division Laboratory (SWDL). SWDL sorted the samples and sent them to their contract analytical laboratory for analyses. A second laboratory received duplicate samples to provide a means to assess the quality of the data from the field sampling program (Table 1-6).

Table 1-6. Summary of QA/QC Samples

QC Duplicates (analyzed at same laboratory as normal samples)	QA Duplicates (analyzed at different laboratory from normal samples)	Ambient Blanks	Rinsate Blanks	Trip Blanks	Decontamination Water Blanks
41	41	15	31	14	31

A summary of the QA/QC sampling program conducted at each of the SWMUs is presented in the sections that describe individual SWMUs at Cannon AFB. Fewer trip blanks were required than originally specified in the FSP since in many cases all the samples from a particular site were sent to the laboratories in a single cooler.

1.5.2.1 Sample Equipment and Procedures

The specific procedures employed for sample collection were consistant with the RCRA Facility Investigation, Field Sampling Plan, Cannon AFB, June 1991 which specifies the use of the following Standard Operating Procedures (SOP):

SOP 1.3 Sample Control and Documentation
SOP 1.4 Sample Containers and Preservation
SOP 1.5 Guide to the Handling, Packaging and Shipping of Samples
SOP 1.6 General Equipment Decontamination
SOP 1.8 Personal Decontamination - Level D Protection
SOP 4.1 Soil Boring
SOP 5.1 Soil and Rock Borehole Logging and Sampling

At each site, prior to drilling and sampling, as specified by the QAP, a daily tailgate health and safety meeting was conducted. In addition, the following quality control forms and check lists were completed for each SWMU:

- Site Safety Briefing Form
- Site Safety Inspection Report
- Sample Identification QA Field Checklist
- Chain of Custodies
- Borehole Logs (Soil) Form
- Site Monitoring Data (HNU Meter)
- SWMU Site QAP Report (Field QC Checklist for Each)

Issues covered at meetings and on the safety form and report include:

- Review of site Health and Safety Plan
- Potential chemical hazards
- Emergency response procedures
- Persons in attendance
- Drilling and safety equipment - type and condition
- Personal Protective Equipment (PPE) required

The SWMU Site QAP Report was completed for each SWMU as an accounting method for data collection quality control. QA Field Checklist topics included:

- Predrilling and sampling requirements
- Equipment decontamination procedures
- Sample collection, identification, and shipping procedures
- Field logbook entry requirements
- Cuttings management and borehole closure

Chain of Custody forms (Appendix D) were completed for each sample and submitted, with the samples, to the laboratory.

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1.5.2.1.1 *Surface Soil Sample Collection.* Surface soil samples were collected using a stainless steel trowel at each location. VOC samples were placed in narrow mouth, 60 ml, amber vials. Metal samples were placed in wide mouth, 500 ml, clear glass containers. Samples were collected, containerized, labeled, sealed, and placed on ice in a cooler. All containers were pre-preserved by the laboratory. Surface samples were collected to a maximum of 6" below ground level. At some locations asphalt removal was required to obtain surface soils.

1.5.2.1.2 *Subsurface Sample Collection.* All soil borings were drilled, sampled, lithologically logged and grouted with cement in accordance with SOPs 4.1 and 5.1. Drilling was conducted by Pool Environmental Drilling Company of Roswell, NM. Drilling was conducted with a CME-75 drill rig, using an 8" diameter hollow auger drill stem with an integrated continuous sampler. At SWMUs where boreholes were deepest, a split spoon sampler was also used. Where space limitations occurred, a hand auger was sometimes employed. At SWMU #s 1, 3, 5, 7, 8, 11, 16, 32A, 33B, 38, 39, and 83, three boreholes were drilled, at SWMU 9, four boreholes were drilled, and at SWMUs 48A&B and 108, five boreholes were drilled. For the purpose of worker protection, monitoring data was collected and documented at the drill stem and in ambient air with an HNU meter. Sample collection from the five foot long split spoon barrel sampler was conducted by placing the split barrel sampler onto a dry surface. Sample containers for VOCs, BTEX, and TRPH samples were placed adjacent to the interval from which the sample was to be collected. The sampler was then opened and sliced lengthwise with a stainless steel spatula into three sections. BTEX, VOCs, and/or TRPH were collected from the center slice, four inches from either end, containerized, sealed, labeled and placed on ice in a cooler. The remaining soil at each discrete sampling interval was mixed with a stainless steel spoon. Metals samples were taken from this mixture, containerized, labeled, sealed, and placed on ice in a cooler.

Borehole logs were generated for all boreholes. Information taken on these logs includes:

- Facility code and SWMU number
- Boring number and location
- Well diameter, depth and construction method
- Completion date
- Closure comments
- Depth, sample method, and lithologic description
- Technician and technical reviewer signatures

1.5.2.2 Sample Designation

The sample designation system for all field and QA/QC samples was also taken from the RCRA Facility Investigation, Field Sampling Plan, Cannon AFB, June 1991. This system involved a three letter and eleven digit/letter unique identification for each sample (CANXXX-YYYY-ZZZZ). CANXXX is the facility identifier with CAN identifying Cannon AFB and XXX identifying the specific SWMU. The next four digits/letters (YYYY) identify the specific sampled location i.e. the site number and borehole number. The last four digits (ZZZZ) were the sample identifier. The first number corresponds to the type of sample collected (i.e. 0 =

normal analytical sample, 2 = ambient blank, 4 = trip blank, etc.). The second number corresponds to the analytical test type (i.e. BTEX, priority metals etc.). The third number corresponds to the sample number for each test type and the fourth number/letter corresponds to sample depth. Figure 1-7 shows the sample identification codes.

1.5.2.3 Sample Handling, Documentation and Analysis

All labeling, preservation, handling, shipping, documentation and tracking for sam,ples collected were performed in accordance with SOPs 1.3 Sample Control and Documentation, 1.4 Sample Containers and Preservation and 1.5 Guide to Handling, Packaging, and Shipping of Samples (Cannon AFB, 1991).

All sample containers and coolers were supplied by the Army Corp of Engineers Southwest Division Laboratory. All sample labels were filled out with waterproof ink. After sample collection, the containers were placed into styrofoam packing material also provided by the lab and placed into the coolers. A completed and signed Chain-of-Custody was placed in each cooler. A custody seal was placed on each individual container and on the lid of each cooler. Southwest Division Laboratory submitted the QA duplicates to a second laboratory.

Table 1-7 presents a list of analyses performed and the analytical methods employed in this investigation. Tables of the specific analyses performed on each sample are presented in each SWMU chapter.

1.6 Data Validation

All data validation quality control criteria and quality control limits utilized in the data validation process for this investigation may be found in USEPA CLP National Gunctional Guidelines, 1991.

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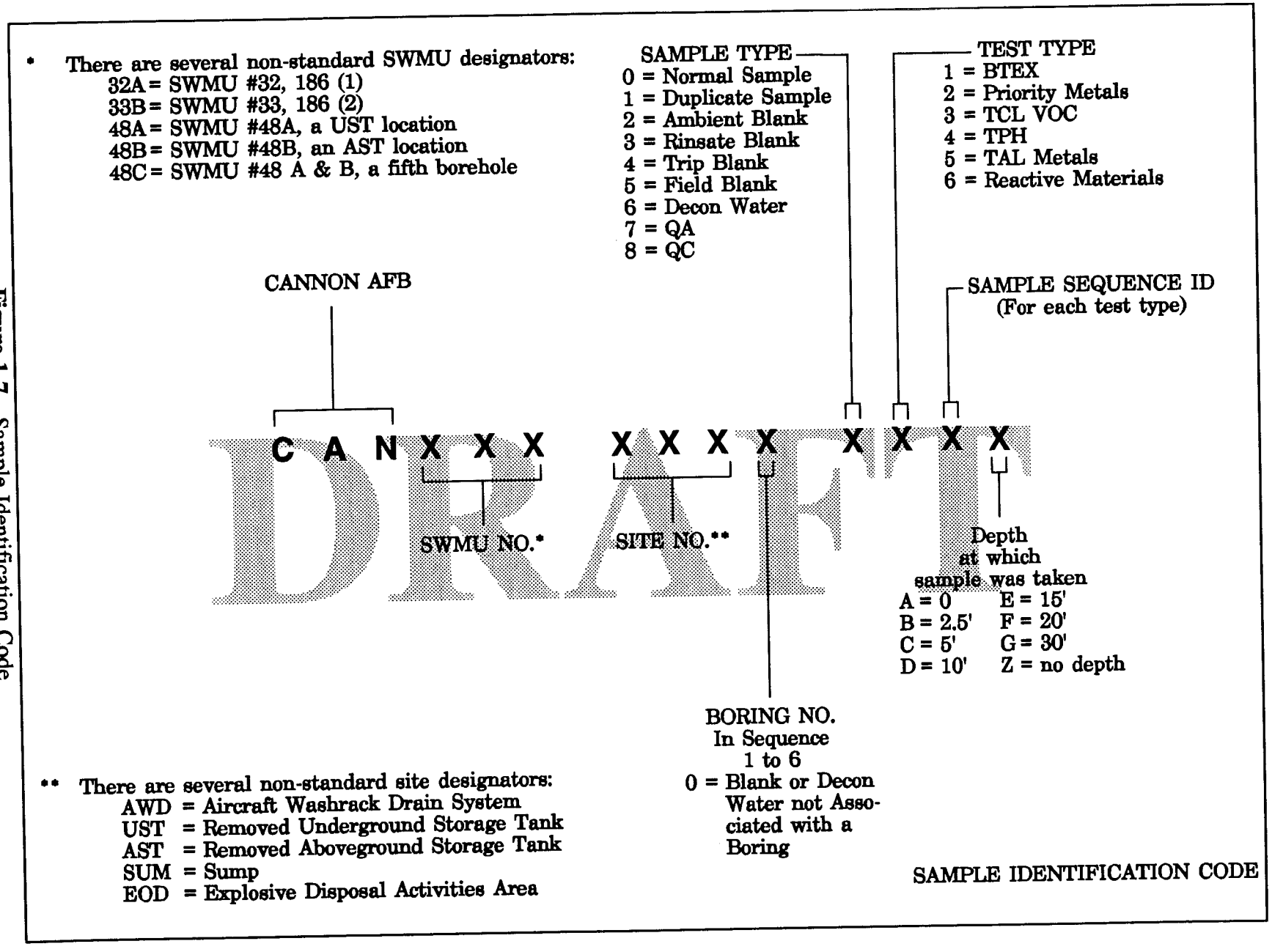

Figure 1-7. Sample Identification Code

Table 1-7. EPA Method Utilized for Evaluating Analytes

ANALYTE	METHOD
BTEX (Benzene, Toluene, Ethylbenzene, Xylene)	8020
Target Compound List Volatile Organic Compounds (TCL-VOC)	8240
Priority Metals (TCLP list metals plus nickel)	6010/7000S+
Target Analyte List Metals (TAL Metals)	6010/9012
Total Recoverable Petroleum Hydrocarbons (TRPH)	418.1
Cyanide	9010
Reactives	9010/9030++
Sulfides	9030

\+ Metals analyzed by the 7000 Series include: mercury, selenium, and arsenic.
++ Chapter 7 of SW-846.

1.7 Background Concentrations of Inorganic Compounds

To describe the different levels of chemical contamination, several definitions are necessary. For organics, it is assumed that any chemical found at measurable quanities will be considered to be above background levels. Metals are compared to the 95% upper confidence level of background concentrations (Table 1-8).

In 1993, Woodward-Clyde (WWC) published background data on levels of inorganic chemical constituents at Cannon AFB, based on a compilation of three investigations:

1. WWC(1992) - RI at Cannon AFB conducted by WCC in 1991 included three off-site background soil samples.

2. WWC(1993) - RFI at Cannon AFB included samples from borings located outside Landfill No. 2 area.

3. Walk, Haydel, and Associates(1990) conducted an IRP RI at Cannon AFB and analyzed four background soil samples.

USGS 1984 data for the Clovis region and other reports on regional soil data were used to further substantiate field sampling.

Table 1-8. Summary of Background Elemental Concentrations (1) in Soil Samples (2) Cannon AFB, New Mexico

ELEMENT	MEAN ($\bar{x}$)	STANDARD DEVIATION (SD)	($\bar{x}$)±2SD	TYPICAL LEVEL IN CLOVIS, NM REGION
Aluminum	5,700	2,420	860 - 10,540	50,000
Antimony	6.75	2.71	1.33 - 12.2	<1
Arsenic	3.5	6.0	0 - 15.5	6.5
Barium	166	238	0 - 642	500
Beryllium	0.41	0.16	0.09 - 0.73	1 - 2
Cadmium	1.1	0.90	0 - 2.9	---
Calcium	69,200	58,600	0 - 186,400	7,900 - 18,000
Chromium	6.98	2.78	1.42 - 12.5	30
Cobalt	2.5	1.0	0.5 - 4.5	3 - 7
Copper	5.40	3.79	0 - 13.0	20
Iron	4,780	1,970	840 - 8,720	100 - 15,000
Lead	7.12	9.35	0 - 25.8	15
Magnesium	4,650	3,570	0 - 11,790	2,000 - 5,000
Manganese	72.0	46.0	0 - 164	500
Mercury	0.11	0.01	0.09 - 0.13	0.032 - 0.082
Nickel	5.0	2.0	1.0 - 9.0	15
Potassium	1,360	606	148 - 2,572	16,000
Selenium	8.23	24.2	0 - 56.6	0.15 - 0.30
Silver	1.2	0.5	0.2 - 2.2	---
Sodium	514	264	0 - 1,042	7,000
Thallium	0.50	0.36	0 - 1.2	---
Vanadium	14.9	5.20	4.50 - 25.3	30 - 70
Zinc	11.3	5.29	0.72 - 21.9	45

1 All concentrations are in milligrams per kilogram (mg/kg).
2 Compiled from data collected by WCC for the RFI and RI (WCC 1992 and WCC 1993) and Walk, Haydel & Associates for the IRP (Walk, Haydel & Associates 1990).

SOURCE: WWC 1993

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2.0 OIL WATER SEPARATOR (SWMU NO. 1/SITE NO. 119)

2.1 SWMU Description

2.1.1 Setting

SWMU No. 1 is an oil/water separator with a skimmer located on the southeast corner of Building 119 next to the aircraft parking ramp. The separator is a 3-compartment underground unit, with a 700 gallon main compartment and a 280 gallon oil compartment. The unit is constructed of concrete. The opening to the separator is in a concrete pad, surrounded on all sides by asphalt. Drilling activities required penetration and restoration of the surface with a concrete plug. Borehole locations were chosen, in part, to avoid underground utilities and a light pole. Figure 2-1 shows the SWMU setting and borehole locations.

2.1.2 History of Use

The oil/water separator No. 119 has been active since 1963 and is still in use. The recovered oils are directed to the 280 gallon holding tank and the wastewater is discharged to the storm drainage system which flows to the Stormwater Collection Point (SWMU No. 85). Historically, the facility discharging to the separator was used for x-rays of aircraft and parts, and other operations which did not use chemicals. Aircraft fuels and fluids were disposed of through an established system which includes waste generation reporting procedures. The unit has received and now receives wash water generated from aircraft maintenance operations.

2.1.3 Past Investigations

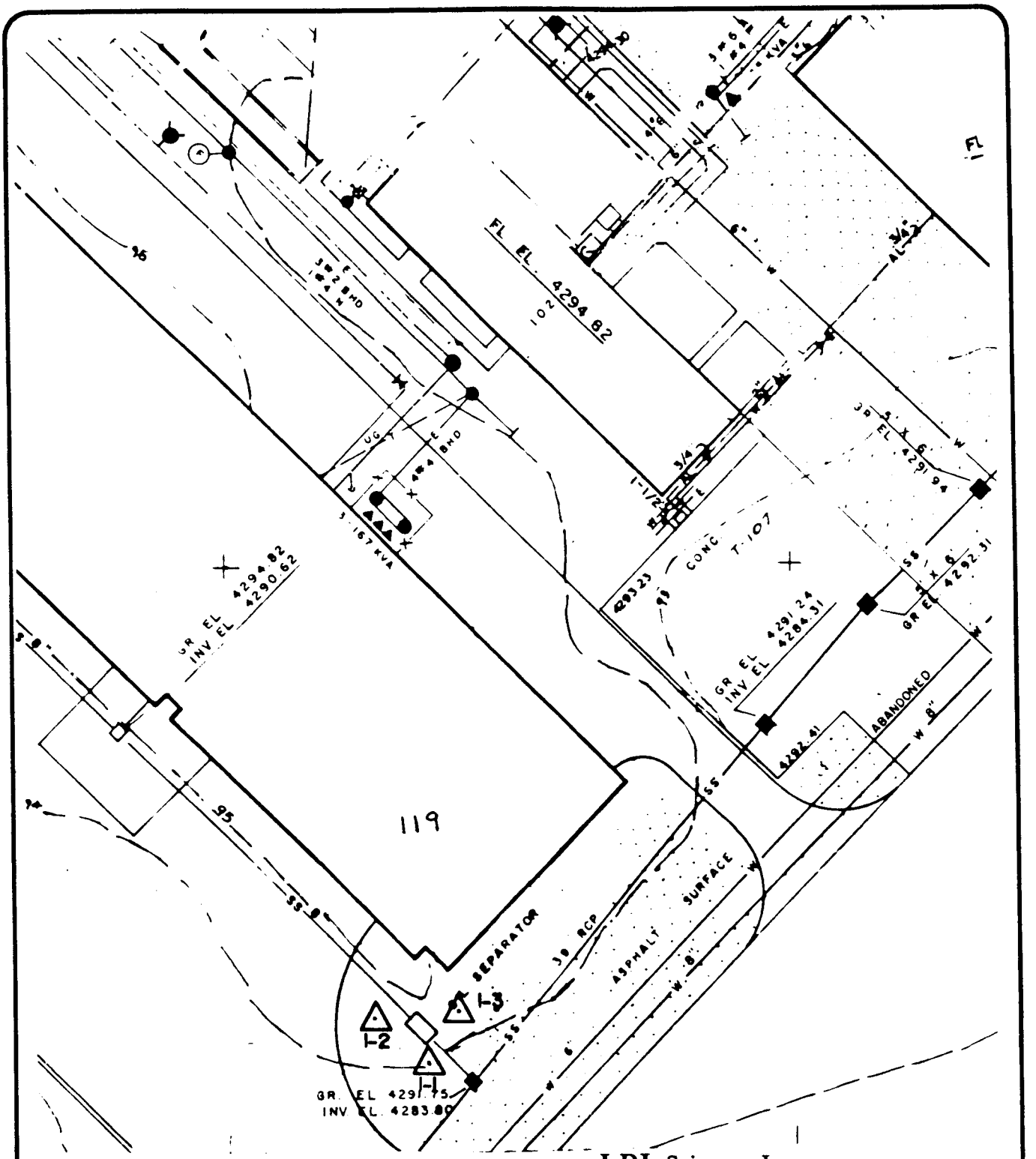
In 1987-1988 the Tulsa District Corps of Engineers sampled this and other oil/water separators at Cannon AFB. The results of this study were reported in Cannon Air Force Base Oil/Water Separators Sampling and Analytical Report, June, 1988. The results of this study indicated the presence of metals and organics in the liquid phase influent and/or effluent. The compounds found in either the influent, effluent or both include cadmium, chromium, nickel, lead, benzene, bromoform, bis(2-ethylhexyl)phthalate and di-n-butylphthalate.

2.1.4 Land Use and Demography

This SWMU is in an area of the base that is commonly frequented by flight line personnel. However, the separator is underground and the area is currently covered by asphalt.

2.2 Field Investigation

Drilling and sampling activities SWMU No. 1 occurred April 8, 1993 at 0805. The activities, as outlined in the FSP (LRL, 1993), consisted of drilling 3 boreholes, collecting 6 surface samples, 18 subsurface samples, 4 QA/QC duplicate samples, and 6 QA/QC water samples. Table 2-1 summarizes the field sampling program at SWMU 1. Table 2-2 summarizes the various samples collected and analyses performed.



▲ — Borehole

Boring No.	Elevation (ft.)
1	4292.50
2	4293.65
3	4293.07

N

LRL Sciences, Inc.

SWMU #1
OIL/WATER SEPARATOR - 119
CANNON AFB, NEW MEXICO

Project:	Cannon AFB RFI
Contract No:	DACA47-93-C-009
Prepared by: KLH	Date: 10-25-93

Fig. 2-1

Table 2-1.
Summary of Drilling and Sampling
SWMU No. 1 - Oil/Water Separator No. 119

Borehole Number	Sampling Depth (ft.-BGS)	Drilling/ Sampling Methods	Drillrig Used	Borehole Diameter (in.)	Ground Elevation (ft.-MSL)	Date Grouted
1	0	NA/SSS	NA	NA	4292.50	4/9/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
2	0	NA/SSS	NA	NA	4293.65	4/9/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
3	0	NA/SSS	NA	NA	4293.07	4/9/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		

HSA = Hollow Stem Auger
HA = Hand Auger
NA = Not Applicable
SBC = Split Barrel Continuous Sampler
SS = Split Spoon
SSS = Stainless Steel Spoon

Table 2-2.
Summary of Sampling and Analyses
SWMU No. 1 - Oil/Water Separator No. 119

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
1	0	CAN001-1191-021A	N	Soil	0910	PM	6010/7000S+
		CAN001-1191-031A	N	Soil	0910	TCL VOC	8240
	2.5	CAN001-1191-022B	N	Soil	0927	PM	6010/7000S
		CAN001-1191-032B	N	Soil	0925	TCL VOC	8240
	5.0	CAN001-1191-011C	N	Soil	0922	BTEX	8020
		CAN001-1191-023C	N	Soil	0930	PM	6010/7000S
	10.0	CAN001-1191-012D	N	Soil	0935	BTEX	8020
		CAN001-1191-024D	N	Soil	0935	PM	6010/7000S
2	0	CAN001-1192-021A	N	Soil	1005	PM	6010/7000S
		CAN001-1192-031A	N	Soil	1005	TCL VOC	8240
	2.5	CAN001-1192-022B	N	Soil	1025	PM	6010/7000S
		CAN001-1192-032B	N	Soil	1015	TCL VOC	8240
		CAN001-1192-821B	QCD	Soil	1025	PM	6010/7000S
		CAN001-1192-831B	QCD	Soil	1020	TCL VOC	8240
		CAN001-1192-721B	QAD	Soil	1025	PM	6010/7000S
		CAN001-1192-731B	QAD	Soil	1020	TCL VOC	8240
	5.0	CAN001-1192-011C	N	Soil	1027	BTEX	8020
		CAN001-1192-023C	N	Soil	1030	PM	6010/7000S
	10.0	CAN001-1192-012D	N	Soil	1027	BTEX	8020
		CAN001-1192-024D	N	Soil	1030	PM	6010/7000S

Table 2-2. (Concluded)
Summary of Sampling and Analyses
SWMU No. 1 - Oil/Water Separator No. 119

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
3	0	CAN001-1193-021A	N	Soil	1110	PM	6010/7000S
		CAN001-1193-031A	N	Soil	1110	TCL VOC	8240
		CAN001-1193-022B	N	Soil	1125	PM	6010/7000S
		CAN001-1193-032B	N	Soil	1125	TCL VOC	8240
		CAN001-1193-011C	N	Soil	1120	BTEX	8020
		CAN001-1193-023C	N	Soil	1127	PM	6010/7000S
		CAN001-1193-012D	N	Soil	1131	BTEX	8020
		CAN001-1193-024D	N	Soil	1133	PM	6010/7000S
		CAN001-1190-431Z	QC	Water	1140	TCL VOC	8240
		CAN001-1190-321Z	QC	Water	1225	PM	6010/7000S
		CAN001-1190-331Z	QC	Water	1140	TCL VOC	8240
		CAN001-1190-231Z	QC	Water	1140	TCL VOC	8240
		CAN001-1190-621Z	QC	Water	1225	PM	6010/7000S
		CAN001-1190-631Z	QC	Water	1140	TCL VOC	8240

BTEX = Benzene, Toluene, Ethyl Benzene, Xylene
ft-BGS = feet below ground surface
N = Normal soil sample
PM = Priority metals = 8 TCLP metals + Ni
TCL VOC = Target Compound List Volatile Organic Compounds
\+ = Metals analyzed using the 7000 Series include: mercury, selenium, and arsenic.

QAD = Duplicate soil sample (analyzed at different laboratory from normal samples).
QCD = Duplicate soil sample analyzed at same laboratory as normal samples.
QC = Quality control water sample (ambient blank, trip blank, etc.)
TAL Metals = Target analyte list metals

2.2.1 Sampling Objectives

Borehole locations, sampling depth, and parameters for analysis were selected, to the greatest extent possible, to determine if a release from the oil/water separator has occurred. Borehole 2 was moved from the original FSP location due to utility lines. Figure 2-2 shows the borehole locations.

2.2.2 Surface and Subsurface Soil Investigation

Three boreholes were drilled at this SWMU. Borehole 1 was drilled 5 feet south of the separator. Borehole 2 was drilled 12 feet west of the separator. Borehole 3 was drilled 10 feet northeast of the separator. Drilling was advanced to depth of 10 feet. Samples were collected at the surface, 2.5, 5, and 10 feet in depth. Surface samples were collected with a stainless steel trowel and subsurface samples were collected with a split barrel continuous sampler. Samples were collected at discrete depths and locations. No composite samples were taken. Samples were analyzed for BTEX, priority metals, and TCL VOL. Duplicates, rinsate blanks, ambient blanks, and decontamination water samples were also submitted to the laboratory for this SWMU. Trip Blanks and Ambient Blanks were inadvertently opened to the air at this site but were still included for analysis.

2.3 Physical Characteristics

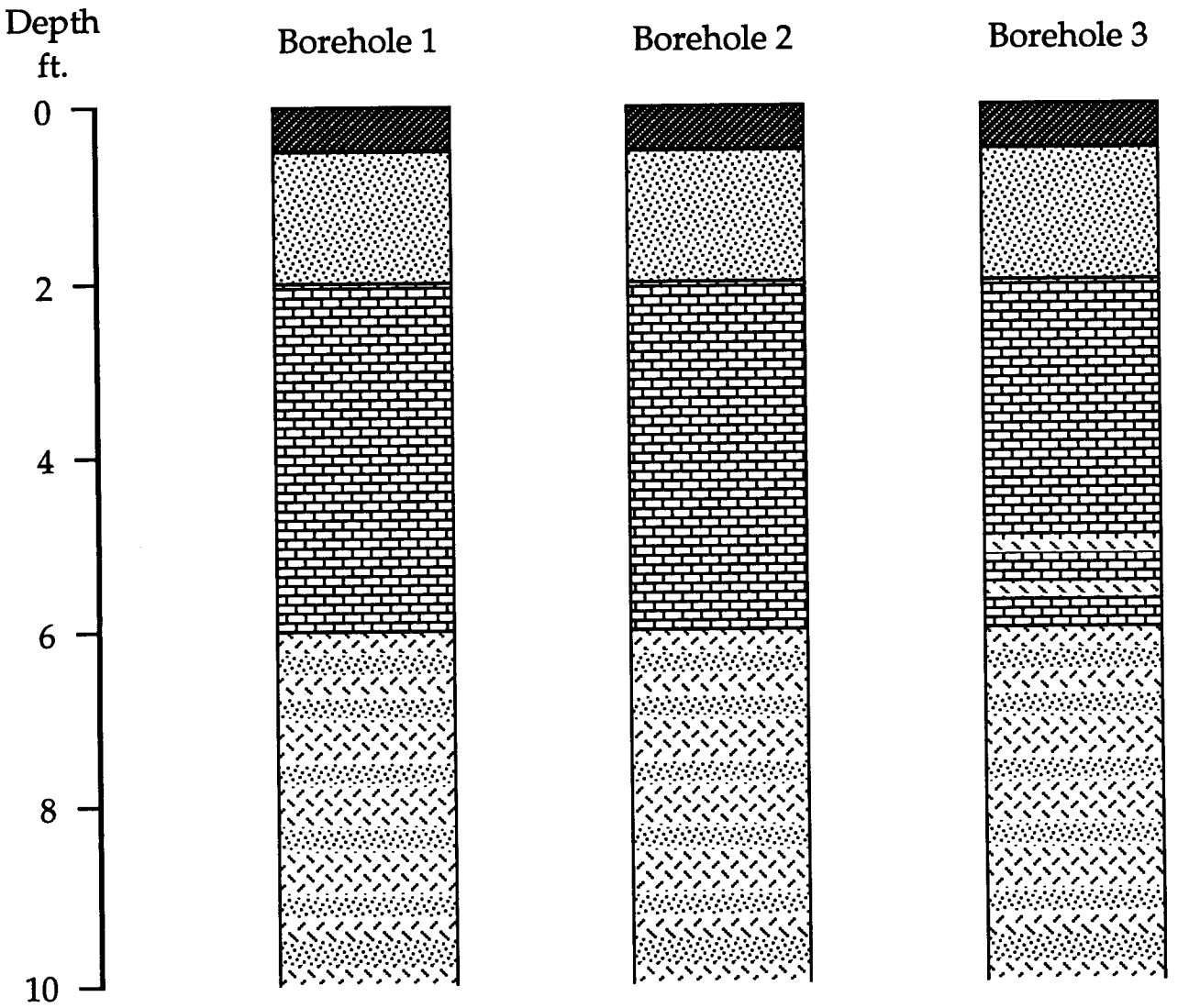
This section provides a discussion of the surface water drainage, groundwater, soils and geology at the No. 119 oil/water separator based on a review of information from previous investigations at Cannon AFB and from the lithologic descriptions from the split barrel continuous sampler.

2.3.1 Surface Water Drainage

A topographic/surface drainage map in addition to text found in Installation Restoration Program Records Search, August 1983 prepared by CH_2M Hill indicates that the surface water drainage in the vicinity of SWMU No. 1 enters the base storm water drainage system and flows to the Stormwater Collection Point (SWMU No. 85). SWMU No. 85 is an ephemeral lake basin (playa) located in the southwest corner of the base.

2.3.2 Groundwater

Depth to groundwater at Cannon AFB is approximately 250 feet or greater. Groundwater recharge rates for the High Plains Region are typically low. Localized recharge rates for Curry County range from 0.75 - 12.22 mm/yr (Stone, 1985). EPA, 1987 DRASTIC reports recharge rates of 1 in/yr. Section 1.4.3.5 of this report includes a discussion of groundwater hydrology for Cannon AFB.



LEGEND

- Asphalt
- Sand
- Clay
- Caliche

LRL Sciences, Inc.

SWMU #1
STRATIGRAPHIC COLUMN
CANNON AFB, NEW MEXICO

Project:	Cannon AFB RFI
Contract No:	DACA47-93-C-009
Prepared by: KLH	Date: 10-25-93

Fig. 2-2

2.3.3 Soils and Geology

The near surface (upper ten feet) stratigraphy in the area surrounding this SWMU consist of Tertiary Miocene to Pliocene fluvial deposits of the Ogallala Formation. The soils have been described as a fine sandy loam (Ab) of the Amarillo soil group (USDA, 1993). Interpretations and correlation on the fluvial deposits for this area are based on samples collected with a split barrel continuous sampler during the drilling process. The soils consist of very fine to fine-grained, moderate to well sorted, submature to mature (textural), unconsolidated, calcareous, brown to reddish brown, clays, silts and sands. Thin to moderately thin layers of caliche material were interbedded throughout much of the samples collected. The sands were comprised of angular to subangular grains with varying amounts of silts, clays, and calcium carbonate (caliche) material. This description of lithology (Figure 2-2) is similiar to the description of soils given by the USDA Draft Soil Survey, 1993. The thickness of this particular unit remains unknown, due to the fact that boring levels did not exceed ten feet. The total thickness of the Ogallala Formation beneath this SWMU is not presently known, but regional information based on Curry County reports have suggested thicknesses of approximately 320-400 feet. No groundwater was encountered while drilling at these three borehole locations. The minimum depth of the High Plains aquifer is reported to be greater than 250 feet below ground surface.

2.4 Nature and Extent of Contamination

2.4.1 Volatile Organic Compounds

A series of HNU meter readings were taken at the well head and in the breathing zone of each borehole for the purpose of worker safety. Boreholes 1 and 2 contained positive readings ranging from 0.0 to 4.0 ppm (Table 2-3) in the borehole headspace. No positive readings occurred in the breathing zone at any borehole.

Table 2-3.
HNU Meter* Readings (PPM) in Borehole Headspace
SWMU No. 1 - Oil/Water Separator No. 119

DATE: 4/8/93					
TIME	BH1	TIME	BH2	TIME	BH3
0922	0.0	1005	0.1	1110	0.0
0933	4.0	1010	0.0	1117	0.0
		1025	0.4	1135	0.0

* Model: 101, Type: OVA PID, Make: HNU

Samples were collected from all three boreholes, at the surface and at 2.5 feet, and analyzed for Target Compound List Volatile Organic Compounds (TCL VOC). Following are the results of these analysis:

Samples were collected from all three boreholes, at the surface and at 2.5 feet, and analyzed for Target Compound List Volatile Organic Compounds (TCL VOC). Following are the results of these analysis:

2.4.1.1 Borehole 1

Table 2-4 shows that in borehole 1 toluene was detected in the surface sample (CAN001-1191-031A) below the Contract Required Quantitation Limits (CRQL). TIC compounds were also detected. Acetone was detected in this sample but results were rejected during validation due to suspected co-elution with unknown contaminant(s).

Table 2-4.
Concentration (μg/kg) of Volatile Organic Compounds
SWMU No. 1 - Oil/Water Separator No. 119

Borehole Number	Cannon Number	Depth (ft.)	Chemical	
			Toluene	Acetone
1	CAN001-1191-031A	Surface	9J	R
	CAN001-1191-032B	2.5	11U	11UJ
2	CAN001-1192-031A	Surface	36J	10UJ
	CAN001-1192-032B	2.5	11U	24J
3	CAN001-1193-031A	Surface	4J	R
	CAN001-1193-032B	2.5	11U	11UJ

Duplicate samples or laboratory repeat samples are presented only if they are different from the original sample and not rejected.
J = estimate
R = rejected
U = not detected at CRQL
UJ = estimated as non-detect at CRQL

At 2.5 feet no target compounds or TIC compounds were detected.

2.4.1.2 Borehole 2

In borehole 2, toluene was detected again at the surface (CAN001-1192-031A) at 36 μg/kg. This value is an estimate due to low internal standard areas. TIC compounds were detected.

At 2.5 feet (CAN001-1192-032B), acetone was detected at 24 μg/kg. This value is estimated since continuing calibration %D exceeded QC limits. No TIC compounds were detected. Two duplicate samples were also collected at 2.5 feet. The QC duplicate was analyzed by the same laboratory and the QA duplicate was analyzed at a second laboratory. The QC duplicate (CAN001-1192-831B) also contained 24 μg/kg of acetone but was qualified as an estimate since continuing calibration %D exceeded QC limits. The QA duplicate contained acetone, methylene

chloride and 2-butanone. Nearly all of the samples analyzed at the QA lab contained acetone and methylene chloride. Approximately 25% of the samples contained 2-butanone. Methylene chloride and acetone due to their prevalence in all, or nearly all, the QA lab samples were rejected as laboratory contaminants. 2-butanone, which is a common laboratory contaminant, was never detected at the QC laboratory and was, therefore, also rejected. No other target analyte was detected in the QA duplicate sample.

2.4.1.3 Borehole 3

In borehole 3, toluene was detected below the CRQL in the surface sample (CAN001-1193-031A). Acetone was also detected but rejected due to contaminant coelution. TIC compounds were detected also.

At 2.5 feet, no target compounds or TIC compounds were detected.

2.4.2 BTEX

In each borehole two samples were collected for BTEX analysis. Samples were collected at 5 and 10 feet. No BTEX compounds were detected in any of the samples. QA/QC duplicates were not collected and therefore no analysis for BTEX was performed.

2.4.3 Priority Metals

Total metals concentrations, using the RCRA SW-846 test methods for the analysis of metals in soils, were determined for the eight TCLP metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver), plus nickel. These are the priority metals. Samples were collected for priority metals analysis at the surface, 2.5, 5 and 10 feet.

In the following presentation of metals results, only metals concentrations in excess of background concentrations are presented. No background data was collected for this investigation, therefore, background concentrations were taken from Concentrations of Selected Naturally Occurring Chemical Constituents in Soil and Groundwater at Cannon Air Force Base Clovis, New Mexico, March 1993 prepared by Woodward-Clyde. For a discussion of Woodward-Clyde's background data see Section 1.7.

2.4.3.1 Borehole 1

In the surface sample (CAN001-1191-021A), chromium was detected at 13.6 mg/kg (Table 2-5). This value is an estimate since the matrix spike recovery was not within control limits. Background for chromium is 12.5 mg/kg. Silver was also detected above background at 5.8 mg/kg. This value is estimated also since matrix spike recovery was not within control limits. Background for silver is 2.2 mg/kg.

At 2.5, 5 and 10 feet, no priority metals were detected above background.

Table 2-5
Concentration (mg/kg) of Priority Metals
SWMU No. 1 - Oil/Water Separator No. 119

Boring Number	Sample Number (CAN001-119)	Sample Depth (Feet)	Chromium		Mercury		Nickel		Silver	
1	1-021A	0	**13.6**	J	0.01	UJ	8	J	**5.8**	J
	1-022B	2.5	4.8	J	0.11	UJ	4.8	J	*	R
	1-023C	5	8.6	J	0.11	UJ	6.3	J	*	R
	1-024D	10	7.2	J	0.01	UJ	5.2	J	*	R
2	2-021A	0	**14.7**	J	0.01	UJ	5.8	J	*	R
	2-022B	2.5	8.5	J	0.11	UJ	6.5	J	*	R
(QAD)	2-721B	2.5	8.8		**0.15**		6.7		0.41	U
(QCD)	2-821B	2.5	4.5	J	0.02	UJ	5.2	J	*	R
	2-023C	5	10.2	J	0.11	UJ	**9.2**	J	*	R
	2-024D	10	4.1	J	0.11	UJ	5.1	UJ	*	R
3	3-021A	0	**34.6**	J	0.1	UJ	8	J	*	R
	3-022B	2.5	7.5	J	0.11	UJ	7	J	*	R
	3-023C	5	9.3	J	0.02	UJ	**9.6**	J	*	R
	3-024D	10	4.4		0.11	J	5.5	UJ	0.85	U
Background (95% UCL) (1)			12.50		0.13		9.00		2.20	

Notes:

Duplicate samples (QAD) or (QCD) samples are presented only if they are different from the original sample and not rejected.

U indicates that the compound was analyzed for, but not detected at or above the standard limit.
J indicates an estimated value.
UJ indicates the compound was analyzed for but not detected. The sample quantification limit or reported detection limit is an estimated quantity.
* R indicates that the data was rejected because of quality control measures

Boldface indicates a detection above the 95% UCL background level

Only data for metals detected above background is presented

(1) Background data is described in Section 17.0.

2.4.3.2 Borehole 2

In the surface sample (CAN001-1192-021A), chromium was detected at 14.7 mg/kg. This value is an estimate since the matrix spike recovery was not within control limits.

At 2.5 feet, no priority metals above background were detected. The QA/QC duplicates were collected at this depth. The QC duplicate, which was analyzed at the same lab as the normal sample, contained no priority metals above background. The QA duplicate, which was analyzed at a different lab than the normal sample, contained mercury at 0.15 mg/kg. Background for mercury is 0.13 mg/kg.

At 5 feet (CAN001-1192-023C), nickel was detected above background at 9.2 mg/kg. This value is an estimate since matrix spike recovery was not within control limits and contamination occurred in the method or calibration blank.

No priority metals were detected above background at 10 feet.

2.4.3.3 Borehole 3

In the surface sample (CAN001-1193-021A), chromium was detected at 34.6 mg/kg. This value is an estimate since matrix spike recovery was not within control limits.

At 2.5 feet, no priority metals above background were detected.

At 5 feet (CAN001-1193-023C), nickel was detected at 9.6 mg/kg. This value is an estimate since matrix spike recovery was not within control limits.

At 10 feet, no priority metals were detected above background concentration.

2.4.4 Summary

Toluene, chromium and TIC compounds were detected in the surface samples of all three boreholes. Borehole 2 contained the most subsurface analytes including acetone, mercury, and nickel. Borehole 3 contained only nickel in the subsurface.

Draft

3.0 OIL/WATER SEPARATOR (SWMU No. 3/SITE No. 108)

3.1 SWMU Description

3.1.1 Setting

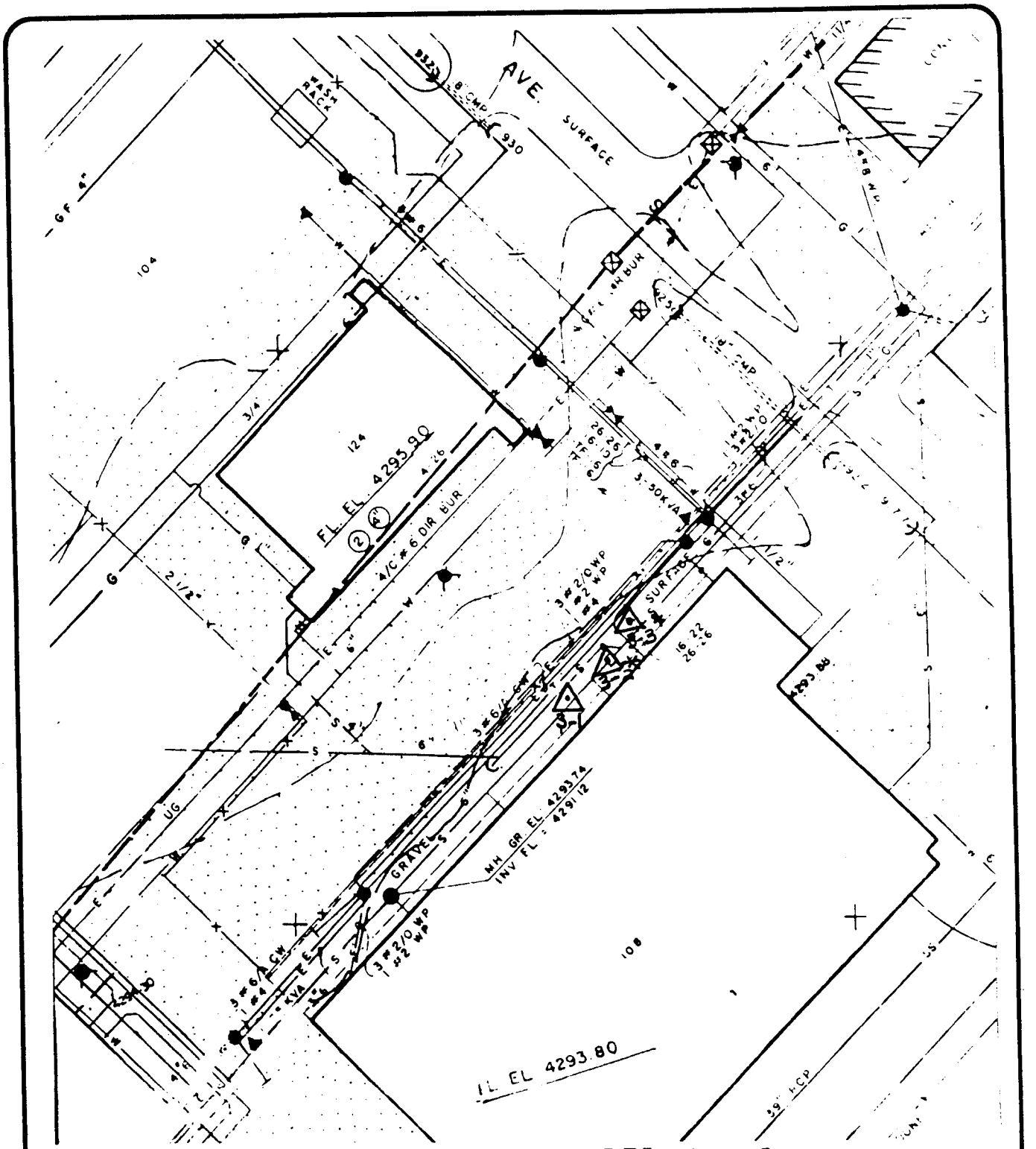
SWMU No. 3 is the location of a former oil/water separator with a skimmer and is found on the west side of Building 125. Building 125 replaced building 108 in 1990. The oil/water separator was removed during this construction. When in place, this unit was approximately 96 feet south of the NW corner of the building and 8 feet west of the building. The separator was a 3-compartment underground unit with a 700 gallon main compartment and a 280 gallon oil compartment. The construction materials are unknown. The former location of this unit is not visible as the area has been surfaced with asphalt. The driller was required to penetrate and restore the asphalt with a concrete plug. In the immediate vicinity (within approximately 30 feet) of this SWMU were eight 55-gallon drums labeled as waste coolant fluid, and five unlabeled 55-gallon drums, all stored on pallets. There were also several stacks of tires, and a hazardous spill response kit located nearby. Most of these pallets and drums were removed prior to drilling. Figure 3-1 shows the setting and borehole locations.

3.1.2 History of Use

This oil/water separator was active from 1943 until 1990 when it was removed during the construction of building 125. The remaining sewer line is active. This oil/water separator received discharge from building 102 and wash water generated from aircraft maintenance operations conducted in building 121. Wastewater discharged from this unit went to the Sanitary Sewer Line (SWMU No. 98) which ultimately discharged into one of two sewage lagoons (SWMU Nos. 101 and 102).

3.1.3 Past Investigations

In 1987-1988 the Tulsa District Corps of Engineers conducted a study of a number of oil/water separators on the base. The results of analyses performed on the influent and effluent from this separator are found in Cannon Air Force Base Oil/Water Separators Sampling and Analytical Report, June 1988. The following compounds were present in the influent and/or effluent of this oil/water separator: phenol, 4-methylphenol, benzoic acid, toluene, carbon disulfide, benzene, naphthalene, di-n-butylphthalate, bis(2-ehtylhexyl)phthalate, nickel, selenium and lead.



▲ — Borehole

Boring No.	Elevation (ft.)
1	4293.79
2	4294.00*
3	4294.00*

N

* Estimate

LRL Sciences, Inc.

SWMU #3
OIL/WATER SEPARATOR - 108
CANNON AFB, NEW MEXICO

Project:	Cannon AFB RFI
Contract No:	DACA47-93-C-009
Prepared by: KLH	Date: 10-25-93

Fig. 3-1

3.1.4 Land Use and Demography

This SWMU is located in an area of the base which is commonly used by base personnel. However, the separator has been removed and the area is currently covered by asphalt.

3.2 Field Investigation

This SWMU was sampled April 8, 1993 at 1400. The activities at SWMU No. 3 as outlined in the FSP (LRL, 1993) consisted of drilling 3 boreholes, and collecting 6 surface samples, 18 subsurface samples and 6 QA/QC samples. Table 3-1 summarizes the field sampling program at SWMU 3. Table 3-2 summarizes the various samples collected and analyses performed.

3.2.1 Sampling Objectives

Borehole locations, sampling depth, and parameters for analysis were selected, to the greatest extent possible, to determine if a release from the oil/water separator has occurred. All three borehole locations were changed from the FSP due to the presence of utility lines. However, a 6" sewer line which runs parallel to the hanger (Bldg. 125) and to the main line was hit during drilling. This feeder line feeds into the main line down stream from the former oil/water separator. Borehole locations are shown in Figure 3-1.

3.2.2 Surface and Subsurface Soil Investigation

Three boreholes were drilled at this SWMU. Borehole 1 was drilled to the southwest of the separator. Borehole 2 was drilled to the north of the separator. Borehole 3 was drilled to the northeast of the separator. Drilling was advanced to a depth of 10 feet. Samples were collected at the surface, 2.5, 5, and 10 feet in depth. Surface samples were collected with a stainless steel trowel. Subsurface samples were collected with a split barrel continuous sampler. Samples were collected at discrete depths and locations. No composite samples were taken. Samples were analyzed for BTEX, priority metals, and TCL VOC. Duplicates, rinsate blanks, ambient blanks and decontamination water samples were also submitted to the laboratory for this SWMU site. Trip Blanks and Ambient Blanks were inadvertently opened to the air at this site but were still included for analysis.

3.3 Physical Characteristics

This section provides a discussion of the surface water drainage, groundwater, soils, and geology at the No. 108 oil/water separator based on a review of information from previous investigations at Cannon AFB and from the lithologic descriptions from the split barrel continuous sample.

Table 3-1.
Summary of Drilling and Sampling
SWMU No. 3 - Oil/Water Separator No. 108

Borehole Number	Sampling Depth (ft.-BGS)	Drilling/ Sampling Methods	Drillrig Used	Borehole Diameter (in.)	Ground Elevation (ft.-MSL)	Date Grouted
1	0	NA/SSS	NA	NA	429.79	4/9/93
	2.5	HSA/SBC	CM3-75	8.0		
	5.0	HSA/SBC	CM3-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
2	0	NA/SSS	NA	NA	Not Available	4/9/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
3	0	NA/SSS	NA	NA	Not Available	4/9/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		

HSA = Hollow Stem Auger
HA = Hand Auger
NA = Not Applicable
SBC = Split Barrel Continuous Sampler
SS = Split Spoon
SSS = Stainless Steel Spoon

Table 3-2.
Summary of Sampling and Analyses
SWMU No. 3 - Oil/Water Separator No. 108

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
1	0	CAN003-1081-021A	N	Soil	1345	PM	6010/7000S
		CAN003-1081-031A	N	Soil	NA	TCL VOC	8240
	2.5	CAN003-1081-011B	N	Soil	1400	BTEX	8020
		CAN003-1081-022B	N	Soil	1405	PM	6010/7000S
	5.0	CAN003-1081-023C	N	Soil	1405	PM	6010/7000S
		CAN003-1081-032C	N	Soil	1450	TCL VOC	8240
		CAN003-1081-821C	QCD	Soil	1410	PM	6010/7000S
		CAN003-1081-831C	QCD	Soil	1420	TCL VOC	8240
		CAN003-1081-721C	QCD	Soil	1411	PM	6010/7000S
		CAN003-1081-731C	QCD	Soil	1420	TCL VOC	8240
	10.0	CAN003-1081-012D	N	Soil	1425	BTEX	8020
		CAN003-1081-024D	N	Soil	1430	PM	6010/7000S
2	0	CAN003-1082-021A	N	Soil	1433	PM	6010/7000S
		CAN003-1082-031A	N	Soil	1435	TCL VOC	8240
	2.5	CAN003-1082-011B	N	Soil	1445	BTEX	8020
		CAN003-1082-022B	N	Soil	1445	PM	6010/7000S
	5.0	CAN003-1082-023C	N	Soil	1455	PM	6010/7000S
		CAN003-1082-032C	N	Soil	1450	TCL VOC	8240
	10.0	CAN003-1082-012D	N	Soil	1451	BTEX	8020
		CAN003-1082-024D	N	Soil	1455	PM	6010/7000S

Table 3-2. (Concluded)
Summary of Sampling and Analyses
SWMU No. 3 - Oil/Water Separator No. 108

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
3	0	CAN003-1083-021A	N	Soil	1540	PM	6010/7470
		CAN003-1083-031A	N	Soil	1540	TCL VOC	8240
	2.5	CAN003-1083-011B	N	Soil	1600	BTEX	8020
		CAN003-1083-022B	N	Soil	1600	PM	6010/7470
	5.0	CAN003-1083-023C	N	Soil	1605	PM	6010/7470
		CAN003-1083-032C	N	Soil	1605	TCL VOC	8240
	10.0	CAN003-1083-012D	N	Soil	1715	BTEX	8020
		CAN003-1083-024D	N	Soil	1715	PM	6010/7470
		CAN003-1080-431Z	QC	Water	1540	TCL VOC	8240
		CAN003-1080-321Z	QC	Water	1620	PM	6010/7470
		CAN003-1080-331Z	QC	Water	1430	TCL VOC	8240
		CAN003-1080-231Z	QC	Water	1725	TCL VOC	8240
		CAN003-1080-621Z	QC	Water	1520	PM	6010/7470
		CAN003-1080-631Z	QC	Water	1515	TCL VOC	8240

BTEX = Benzene, Toluene, Ethyl Benzene, Xylene
ft-BGS = feet below ground surface
N = Normal soil sample
PM = Priority metals = 8 TCLP metals + Ni
TCL-VOC = Target Compound List Volatile Organic Compound
\+ = Metals analyzed using the 7000 Series include: mercury, selenium, and arsenic.

QAD = Duplicate soil sample (analyzed at different laboratory from normal samples).
QCD = Duplicate soil sample analyzed at same laboratory as normal samples.
QC = Quality control water sample (ambient blank, trip blank, etc.)
TAL Metals = Target analyte list metals

3.3.1 Surface Water Drainage

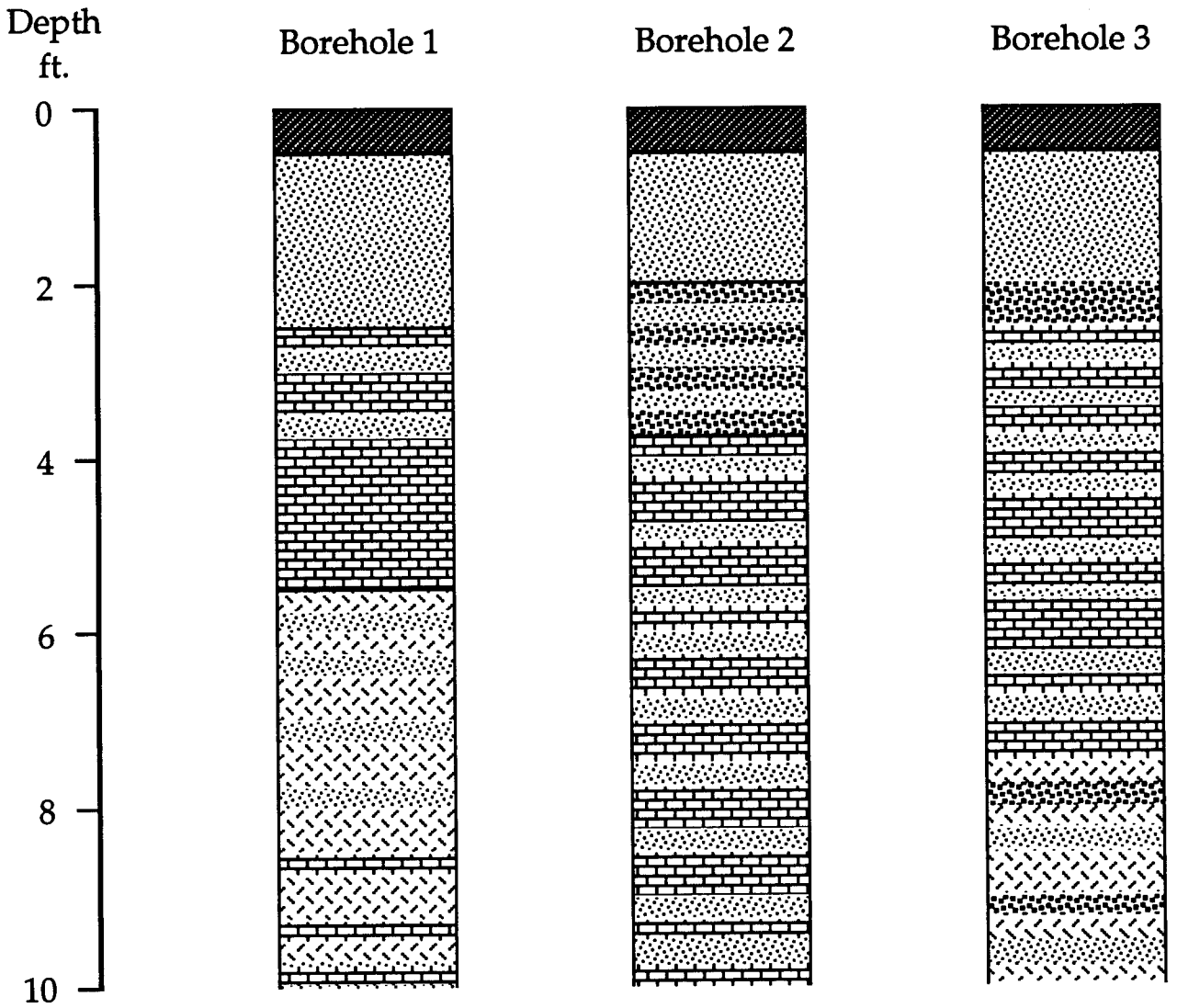
A topographic/surface drainage map in addition to text found in Installation Restoration Program Records Search, August 1993, prepared by CH_2M Hill indicates that the surface water drainage in the vicinity of SWMU No. 3 enters the Base storm water drainage system and flows to the Stormwater Collection Point (SWMU No. 85). SWMU No. 85 is an ephemeral lake basin (playa) located in the southwest corner of the base.

3.3.2 Groundwater

Depth to groundwater at Cannon AFB is approximately 250 feet or greater. Groundwater recharge rates for the High Plains Region are typically low. Localized recharge rates for Curry County range from 0.75 - 12.22 mm/yr (Stone, 1985). EPA, 1987 DRASTIC reports recharge rates of 1 in/yr. Section 1.4.3.5 of this report includes a discussion of groundwater hydrology for Cannon AFB.

3.3.3 Soils and Geology

The near surface (upper ten feet) stratigraphy in the area surrounding this SWMU consist of Tertiary Miocene to Pliocene fluvial deposits of the Ogallala Formation. The soils have been described as a fine sandy loam (Ab) of the Amarillo soil group (USDA, 1993). Interpretations and correlation on the fluvial deposits for this area are based on samples collected with a split barrel continuous sampler during the drilling process. The soils consist of very fine to coarse-grained, poor to moderately sorted, submature to mature (textural), unconsolidated, calcareous, clays, silts, sands, and gravel. Thin to moderately thin layers of caliche material were interbedded throughout much of the samples collected. The sands were comprised of angular to subangular grains with varying amounts of silts, clays, and calcium carbonate (caliche) material. This description of lithology (Figure 3-2) is similiar to the description of soils given by the USDA Draft Soil Survey, 1993. The thickness of this particular unit remains unknown, due to the fact that boring levels did not exceed ten feet. The total thickness of the Ogallala Formation beneath this SWMU is not presently known, but regional information based on Curry County reports have suggested thicknesses of approximately 320-400 feet. No groundwater was encountered while drilling at these three borehole locations. The minimum depth of the High Plains aquifer is approximately 250 feet below ground surface.



LEGEND

- Asphalt
- Gravel
- Sand
- Clay
- Caliche

LRL Sciences, Inc.

SWMU #3
STRATIGRAPHIC COLUMN
CANNON AFB, NEW MEXICO

Project: Cannon AFB RFI	
Contract No: DACA47-93-C-009	
Prepared by: KLH	Date: 10-25-93

Fig. 3-2

3.4 Nature and Extent of Contamination

3.4.1 Volatile Organic Compounds

A series of HNU meter readings were taken over time at the well head and in the breathing zone of each borehole for the purpose of worker safety. A single positive reading occurred at the well head of borehole 3 in the amount of 3.6 ppm (Table 3-3).

Table 3-3.
HNU Meter* Readings (PPM) in Borehole Headspace
SWMU No. 3 - Oil/Water Separator No. 108

DATE: 4/8/93					
TIME	BH1	TIME	BH2	TIME	BH3
1350	0.0	1436	0.0	1540	0.0
1355	0.0	1440	0.0	1545	0.0
1405	0.0	1455	0.0	1550	3.6
				1706	0.0

* Model: 101, Type: OVA PID, Make: HNU

Samples were collected from three boreholes, at the surface and at 5 feet and analyzed for Target List Compound Volatile Organic Compounds (TCL VOC). Following are the results of these analyses:

3.4.1.1 Borehole 1

In surface sample (CAN003-1081-031A) toluene was detected below the CRQL (Table 3-4). No other target analyte or TIC compound was detected.

At 5 feet, no target analytes or TIC compounds were detected. The QA and QC duplicate samples were taken in association with this sample. The QC duplicate (CAN003-1081-831C), which was analyzed at the same lab, contained acetone, the concentration of which is an estimate since continuing calibration %D was above QC limits and because it is below the CRQL. The QA sample contained acetone, methylene chloride and 2-butanone. The prevalence of methylene chloride and acetone in all, or nearly all, of the QA lab samples suggests that they may be laboratory contaminants and they were therefore rejected. Since 2-butanone is a common laboratory contaminant and did not occur at the QC laboratory, it was also rejected.

3.4.1.2 Borehole 2

In borehole 2, no target compounds or TIC compounds were detected at the surface or at 5 feet.

Table 3-4.
Concentration (μg/kg) of Volatile Organic Compounds
SWMU No. 3 - Oil/Water Separator No. 108

Borehole Number	Cannon Number	Depth (ft.)	Chemical	
			Toluene	Acetone
1	CAN003-1081-031A	Surface	8J	11UJ
	CAN003-1081-032C	5.0	11U	11UJ
	CAN003-1081-831C	5.0		8J (QCD)
2	CAN003-1082-031A	Surface	11U	11UJ
	CAN003-1082-032C	5.0	11U	11UJ
3	CAN003-1083-031A	Surface	11UJ	11UJ
	CAN003-1083-032C	5.0	11U	11UJ

Duplicate samples or laboratory repeat samples are presented only if they are different from the original sample and not rejected.

J = estimate
R = rejected
U = not detected at CRQL
UJ = estimated as non-detect at CRQL
QCD = duplicate analyzed at the same lab as normal sample.

3.4.1.3 Borehole 3

In borehole 3, the surface sample and a laboratory repeat analysis of this sample contained no target compounds or TIC compounds. The laboratory repeated the analysis due to low internal standard recoveries.

At 5 feet, no target analytes or TIC compounds were detected.

3.4.2 BTEX

In each borehole, 2 samples were collected for BTEX analysis at 2.5 and 10 feet of depth. Following are the results of these analyses:

No BTEX compounds were detected in any of the samples. QA/QC duplicate samples were not collected and therefore analyses for BTEX was not performed.

3.4.3 Priority Metals

Total metals concentrations, using the RCRA SW-846 test methods for the analysis of metals in soils, were determined for the eight TCLP metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) plus nickel. These are the priority metals. Samples were collected for priority metals analyses at the surface, 2.5, 5 and 10 feet.

DRAFT

In the following presentation of metals results, only metals concentrations in excess of background concentrations are presented. No background data was collected for this investigation, therefore, background concentrations were taken from Concentrations of Selected Naturally Occurring Chemical Constituents in Soil and Groundwater at Cannon Air Force Base Clovis, New Mexico, March 1993 prepared by Woodward-Clyde. For a discussion of Woodward-Clydes background data see Section 1.7.

3.4.3.1 Borehole 1

In the surface sample (CAN003-1081-021A), chromium was detected at 17.8 mg/kg (Table 3-5). This value is an estimate since matrix spike recovery was not within control limits.

At 2.5, 5 and 10 feet no priority metals were detected above background. The QC duplicate, collected at 5 feet and analyzed at the same lab as the normal sample contained no priority metals above background. The QA duplicate (CAN003-1081-721C), which was analyzed at a different lab, contained nickel at 10.3 mg/kg and mercury at 0.15 mg/kg. Background values for these two metals are 9.0 and 0.13 mg/kg, respectively.

3.4.3.2 Borehole 2

In the surface sample (CAN003-1082-021A), nickel was detected at 9.2 mg/kg. This value is an estimate since the Laboratory Control Sample %R were not within control limits.

At 2.5 feet (CAN003-1082-022B), nickel was detected at 9.6 mg/kg. This value is an estimate since the Laboratory Control Sample %R were not within control limits.

No priority metals, above background, were detected in the 5 feet samples.

At 10 feet (CAN003-1082-024D), barium was detected at 816 mg/kg.

3.4.3.3 Borehole 3

In the surface sample (CAN003-1083-021A), chromium was detected at 16.4 mg/kg. This value is an estimate since matrix spike recovery was not within control limits.

No priority metals were detected above background at 2.5 or 5 feet.

At 10 feet (CAN003-1083-024D), barium was detected at 753 mg/kg.

3.4.4 Summary

In borehole 1 both organics and metals were detected at the surface and at depth (toluene, acetone, chromium, nickel and mercury). In boreholes 2 and 3 no organics were detected. However, metals were detected at the surface and at depth.

Table 3-5
Concentration (mg/kg) of Priority Metals
SWMU No. 3 - Oil/Water Separator No. 108

Boring Number	Sample Number (CAN003-108)	Sample Depth (Feet)	Barium	Chromium		Mercury		Nickel		Silver	
1	1-021A	0	614	**17.8**	J	0.01	U	8.1		1.6	
	1-022B	2.5	70.4	10.7	J	0.02	U	7.3	J	0.85	U
	1-023C	5	63.6	6.2	J	0.02	U	7.5	J	0.93	U
(QAD)	1-721C	5	112	**10.2**		**0.15**		**10.3**		0.41	U
(QCD)	1-821C	5	80.9	8.5	J	0.02	U	8.3	J	0.93	U
	1-024D	10	54.3	4.8	J	0.1	U	4.8	J	0.92	U
2	2-021A	0	483	6.1	J	0.01	U	**9.2**	J	21.1	U
	2-022B	2.5	101	7.2	J	0.02	U	**9.6**	J	0.93	U
	2-023C	5	91.8	6.5	J	0.01	U	6.9	J	0.89	U
	2-024D	10	**816**	3	J	0.01	U	4.4	J	0.88	U
3	3-021A	0	632	**16.4**	J	0.01	U	7.5		1	
	3-022B	2.5	196	7.7	J	0.02	U	6.8		0.92	U
	3-023C	5	66.5	5.9	J	0.03	U	8.5		0.95	U
	3-024D	10	**753**	2.7	J	0.02	U	4.4		0.98	
Background (95% UCL) (1)			642.00	12.50		0.13		9.00		2.20	

Notes:

Duplicate samples (QAD) or (QCD) samples are presented only if they are different from the original sample and not rejected.

U indicates that the compound was analyzed for, but not detected at or above the standard limit.
J indicates an estimated value.
UJ indicates the compound was analyzed for but not detected. The sample quantification limit or reported detection limit is an estimated quanti
* R indicates that the data was rejected because of quality control measures

Boldface indicates a detection above the 95% UCL background level

Only data for metals detected above background is presented

(1) Background data is described in Section 17.0.

4.0 OIL/WATER SEPARATOR (SWMU NO. 5/SITE NO. 121)

4.1 SWMU Description

4.1.1 Setting

Oil/water separator No. 121 is located on the west side of building 126, formerly Building 121. This unit lies approximately 80 feet south of the NW corner of the building and 8 feet west of building 126. This is a three compartment underground unit with a 700 gallon main compartment and a 280 gallon oil compartment. The unit is equipped with a skimmer. The construction materials are unknown. The unit is not visible from the surface as the area has been covered by asphalt. The unit is connected to a 6" sewer main which angles north to a manhole. The exact position of the separator is unknown. Boreholes were aligned exterior to the sewer line. The driller was required to penetrate and restore the surface with a concrete plug. Figure 4-1 shows the SWMU setting and borehole locations.

4.1.2 History of Use

This unit has been active since 1943. It receives waste water from building 102 and 125. The unit also receives wash water generated from aircraft maintenance operations conducted in building 121. The recovered oils are directed to the 280 gallon holding tank and the waste water is discharged to the Sanitary Sewer Line (SWMU No. 98).

4.1.3 Past Investigations

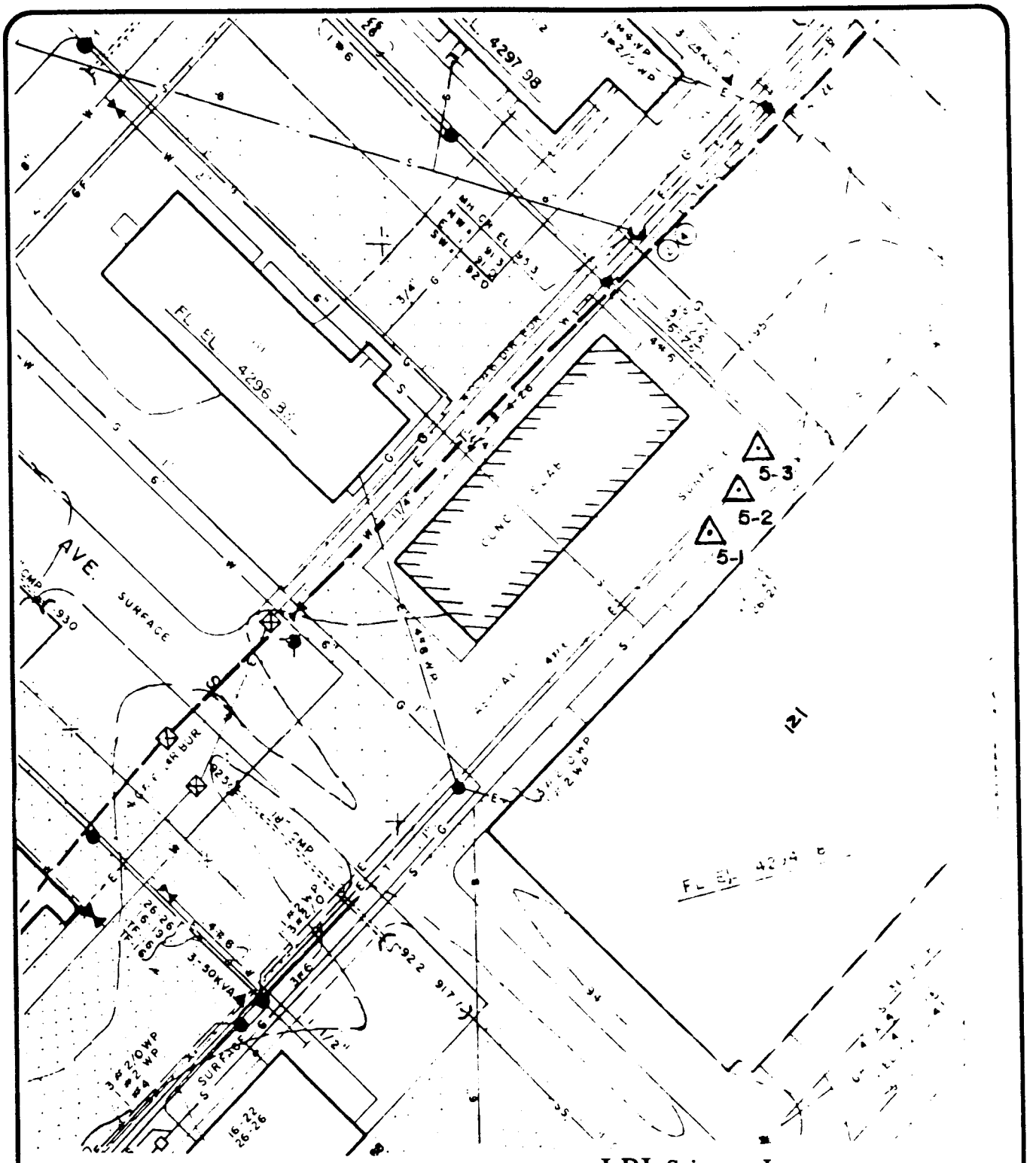
In 1987-1988 the Tulsa District Corps of Engineers sampled this and other oil/water separators at Cannon AFB. The results of this study were reported in Cannon Air Force Base Oil/Water Separators Sampling and Analytical Report, June, 1988. The results of this study indicated the presence of metals and organics in the liquid phase influent and/or effluent. The compounds found in either the influent, effluent or both include: lead, nickel and bis(2-ethylhexyl)phthalate.

4.1.4 Land Use and Demography

This SWMU is in an area of the base commonly used by base personnel. However, the separator is underground and the area is currently covered by asphalt.

4.2 Field Investigation

This SWMU was sampled April 9, 1993 at 1300. The activities at SWMU No. 5 as outlined in the FSP (LRL, 1993) consisted of drilling 3 boreholes, collecting 6 surface samples, 18 subsurface samples, 4 QA/QC duplicate samples and 6 QA/QC water samples. Table 4-1 summarizes the field sampling program at SWMU 5. Table 4-2 summarizes the various samples collected and analyses performed.



▲ — Borehole

Boring No.	Elevation (ft.)
1	4294.49
2	4294.55
3	4294.68

N

LRL Sciences, Inc.

SWMU #5
OIL/WATER SEPARATOR - 121
CANNON AFB, NEW MEXICO

Project:	Cannon AFB RFI
Contract No:	DACA47-93-C-009
Prepared by: KLH	Date: 10-28-93

Fig. 4-1

Table 4-1.
Summary of Drilling and Sampling
SWMU No. 5 - Oil/Water Separator No. 121

Borehole Number	Sampling Depth (ft.-BGS)	Drilling/ Sampling Methods	Drillrig Used	Borehole Diameter (in.)	Ground Elevation	Date Grouted
1	0	NA/SSS	NA	NA	4294.49	4/09/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
2	0	NA/SSS	NA	NA	4294.55	4/09/93
	2.5	HSA/SSS	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
3	0	NA/SSS	NA	NA	42.9468	4/09/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		

HSA = Hollow Stem Auger
HA = Hand Auger
SBC = Split Barrel Continuous Sampler
SS = Split Spoon
SSS = Stainless Steel Spoon

Table 4-2.
Summary of Sampling and Analyses
SWMU No. 5 - Oil/Water Separator No. 121

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
1	0	CAN005-1211-021A	N	SOIL	1310	PM	6010\7000S+
		CAN005-1211-031A	N	SOIL	1310	TCL VOC	8240
	2.5	CAN005-1211-011B	N	SOIL	1320	BTEX	8020
		CAN005-1211-022B	N	SOIL	1320	PM	6010\7000S
	5.0	CAN005-1211-012C	N	SOIL	1325	BTEX	8020
		CAN005-1211-023C	N	SOIL	1325	PM	6010\7000S
	10.0	CAN005-1211-024D	N	SOIL	1330	PM	6010\7000S
		CAN005-1211-032D	N	SOIL	1330	TCL VOC	8240
2	0	CAN005-1212-021A	N	SOIL	1345	PM	6010\7000S
		CAN005-1212-031A	N	SOIL	1345	TCL VOC	8240
	2.5	CAN005-1212-011B	N	SOIL	1355	BTEX	8020
		CAN005-1212-022B	N	SOIL	1355	PM	6010\7000S
	5.0	CAN005-1212-012C	N	SOIL	1400	BTEX	8020
		CAN005-1212-023C	N	SOIL	1400	PM	6010\7000S
	10.0	CAN005-1212-024D	N	SOIL	1405	PM	6010\7000S
		CAN005-1212-032D	N	SOIL	1405	TCL VOC	8240
3	0	CAN005-1213-021A	N	SOIL	1440	PM	6010\7000S
		CAN005-1213-031A	N	SOIL	1440	TCL VOC	8240
	2.5	CAN005-1213-011B	N	SOIL	1445	BTEX	8020
		CAN005-1213-022B	N	SOIL	1445	PM	6010\7000S

Table 4-2. (Concluded)
Summary of Sampling Analyses
SWMU No. 5 - Oil/Water Separator No. 121

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
		CAN005-1210-431Z	QC	WATER	1530	TCL VOC	8240
		CAN005-1210-321Z	QC	WATER	1545	PM	6010\7000S
		CAN005-1210-331Z	QC	WATER	1550	TCL VOC	8240
		CAN005-1210-231Z	QC	WATER	1540	TCL VOC	8240
		CAN005-1210-621Z	QC	WATER	1545	PM	6010\7000S
		CAN005-1210-631Z	QC	WATER	1550	TCL VOC	8240

BTEX = Benzene, Toluene, Ethyl Benzene, Xylene
ft-BGS = feet below ground surface
N = Normal soil sample
PM = Priority metals = 8 TCLP metals + Ni
TCL VOC = Target Compound List Volatile Organic Compound
+ = Metals analyzed using the 7000 Series include: mercury, selenium, and arsenic.

QAD = Duplicate soil sample (analyzed at different laboratory from normal samples).
QCD = Duplicate soil sample analyzed at same laboratory as normal samples.
QC = Quality control water sample (ambient blank, trip blank, etc.)
TAL Metals = Target analyte list metals

4.2.1 Sampling Objectives

Borehole locations, sampling depth, and parameters for analysis were selected, to the greatest extent possible, to determine if a release from the oil/water separator has occurred. Boreholes 1 and 3 were moved from the original FSP locations in order to place them exterior to the sewer line. Borehole locations are shown in 54.

4.2.2 Surface and Subsurface Soil Investigation

Three boreholes were drilled at this SWMU. Borehole 1 was drilled southwest of the separator, borehole 2 was drilled west of the separator and borehole 3 was placed north of the separator. Drilling was advanced to a depth of 10 feet. Samples were collected at the surface, 2.5, 5 and 10 feet in depth. Surface samples were collected using a stainless steel trowel and subsurface samples were collected with a split barrel continuous sampler. Samples were collected at discrete depths and locations. No composite samples were taken. Samples were analyzed for BTEX, priority metals and TCL VOCs. Duplicates, rinsate blanks, ambient blanks, decontamination water, and trip blanks were also submitted to the laboratory for this SWMU.

4.3 Physical Characteristics

This section provides a discussion of the surface water drainage, groundwater, and soils and geology at the No. 121 oil/water separator based on a review of information from previous investigations at Cannon AFB and from the lithologic descriptions from a split barrel continuous sampler.

4.3.1 Surface Water Drainage

A topographic/surface drainage map in addition to text found in Installation Restoration Program Records Search, August 1983 prepared by CH_2M Hill indicates that the surface water drainage in the vicinity of SWMU No. 5 enters the base storm water drainage system and flows to the Stormwater Collection Point (SWMU No. 85). SWMU No. 85 is an ephemeral lake basin (playa) located in the southwest corner of the base.

4.3.2 Groundwater

Depth to groundwater at Cannon AFB is approximately 250 feet or greater. Groundwater recharge rates for the High Plains Region are typically low. Localized recharge rates for Curry County range from 0.75 - 12.22 mm/yr (Stone, 1985). EPA, 1987 DRASTIC reports recharge rates of 1 in/yr. Section 1.4.3.5 of this report includes a discussion of groundwater hydrology for Cannon AFB.

4.3.3 Soils and Geology

The near surface (upper ten feet) stratigraphy in the area surrounding this SWMU consist of Tertiary Miocene to Pliocene fluvial deposits of the Ogallala Formation. The soils have been described as a fine sandy loam (Ab) of the Amarillo soil group (USDA, 1993). Interpretations

and correlation on the fluvial deposits for this area are based on samples collected with a split barrel continuous sampler during the drilling process. The soils consist of very fine to fine-grained, moderately sorted, submature to mature (textural), unconsolidated, calcareous, dark red, clays, silts, and sands. Thin to moderately thin layers of caliche material were interbedded throughout much of the samples collected. The sands were comprised of angular to subangular grains with varying amounts of silts, clays, and calcium carbonate (caliche) material. This description of lithology (Figure 4-2) is similiar to the description of soils given by the USDA Draft Soil Survey, 1993. The thickness of this particular unit remains unknown, due to the fact that boring levels did not exceed ten feet. The total thickness of the Ogallala Formation beneath this SWMU is not presently known, but regional information based on Curry County reports have suggested thicknesses of approximately 320-400 feet. No groundwater was encountered while drilling at these three borehole locations. The minimum depth of the High Plains aquifer is reported to be greater than 250 feet below ground surface.

4.4 Nature and Extent of Contamination

4.4.1 Volatile Organic Compounds

A series of HNU meter readings were taken at each of the boreholes in the well head and in the breathing zone for the purpose of worker safety. Borehole 1 contained a single reading of 0.6 ppm (Table 4-3) at the wellhead.

Table 4-3.
HNU Meter* Readings (PPM) in Borehole Headspace
SWMU No. 5 - Oil/Water Separator No. 121

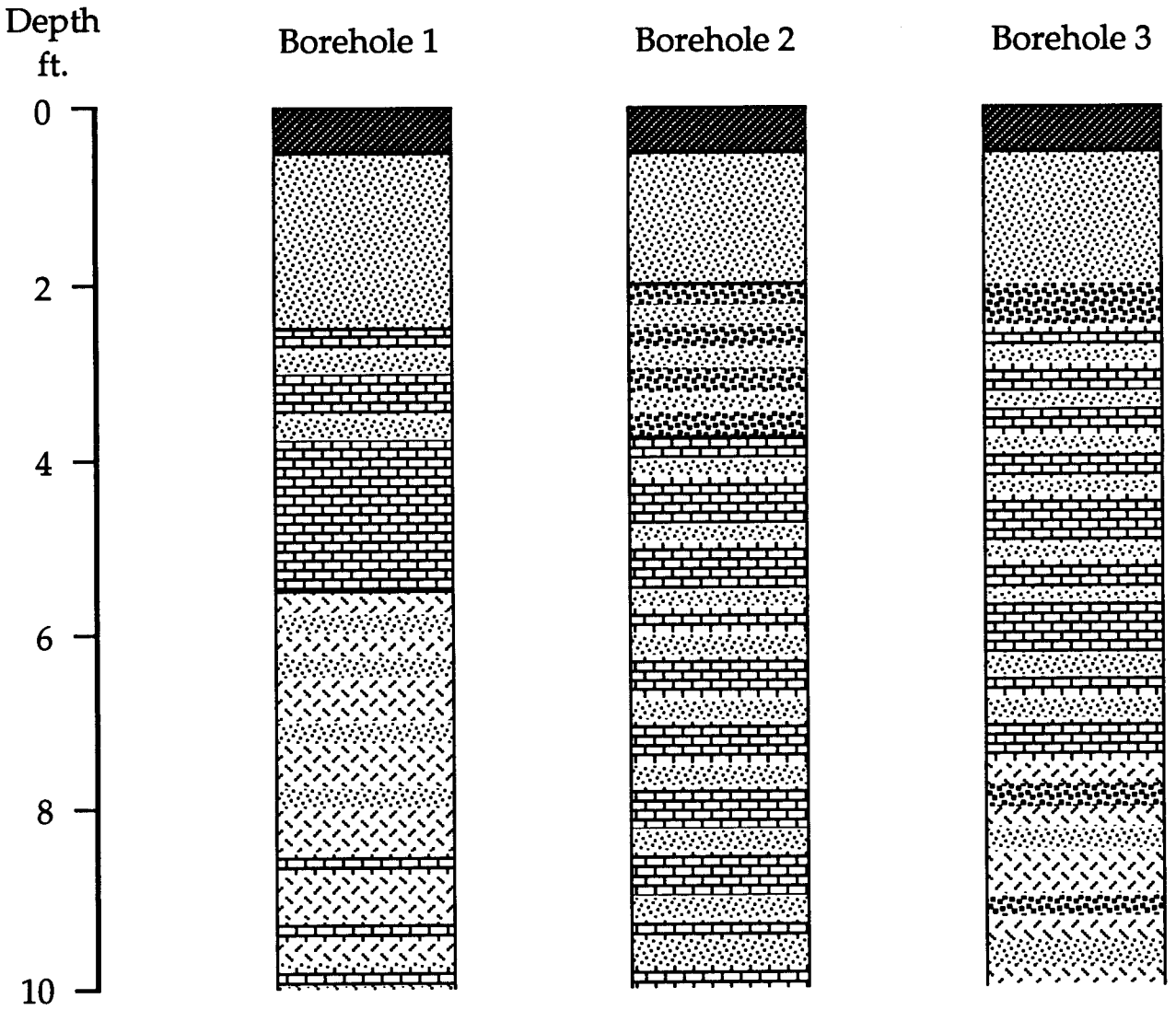
DATE: 4/ /93					
TIME	BH1	TIME	BH2	TIME	BH3
1317	0.0	1340	0.0	1439	0.0
1324	0.0	1344	0.0	1444	0.0
1330	0.6	1350	0.0	1447	0.0

* Model: 101, Type: OVA PID, Make: HNU

Samples were collected from three boreholes at the surface and at 10 feet and analyzed for Target List Compound Volatile Organic Compounds (TLC VOC). Following are the results of these analyses.

4.4.1.1 Borehole 1

In borehole 1, no target compounds or TIC compounds were detected in the surface sample or at 10 feet.



LEGEND

- Asphalt
- Gravel
- Sand
- Clay
- Caliche

LRL Sciences, Inc.

SWMU #5
STRATIGRAPHIC COLUMN
CANNON AFB, NEW MEXICO

Project: Cannon AFB RFI	
Contract No: DACA47-93-C-009	
Prepared by: KLH	Date: 10-25-93

Fig. 4-2

4.4.1.2 Borehole 2

In borehole 2, the surface sample contained no target compounds or TIC compounds.

The sample at 10 feet (CAN005-1212-032D) contained acetone at 14 μg/kg (Table 4-4). The acetone concentration is considered an estimate since continuing calibration %D exceeded QC limits. One TIC compound was detected with the 10 foot sample.

Table 4-4.
Concentration (μg/kg) of Volatile Organic Compounds
SWMU No. 5 - Oil/Water Separator No. 121

Borehole Number	Cannon Number	Depth (ft.)	Chemical: Acetone
1	CAN005-1211-031A	Surface	11UJ
	CAN005-1211-032D	10.0	12UJ
2	CAN005-1212-031A	Surface	11UJ
	CAN005-1212-032D	10.0	14J
3	CAN005-1213-031A	Surface	11UJ
	CAN005-1213-032D	10.0	11UJ
	CAN005-1213-831D	10.0	16J (QCD)

Duplicate samples or laboratory repeat samples are presented only if they are different from the original sample and not rejected.

J = estimate
R = rejected
U = not detected at CRQL
UJ = estimated as non-detect at CRQL
QCD = duplicate analyzed at same lab as normal sample.

4.4.1.3 Borehole 3

In borehole 3, the surface sample contained no target compounds or TIC compounds.

The sample at 10 feet contained no target compounds or TIC compounds. One duplicate pair was collected in association with this sample. The QC duplicate (CAN005-1213-831D), analyzed at the same lab as the original sample, contained acetone at 16 μg/kg. This value is an estimate since continuing calibration %D exceeded QC limits. The QA duplicate, analyzed at a different lab from the original sample, contained acetone and methylene chloride. However, in nearly all the samples analyzed at the QA laboratory contained these compounds, they were rejected as laboratory contaminants. No other target analytes or TIC compounds were detected.

4.4.2 BTEX

In each borehole, 2 samples were collected for BTEX analysis at 2.5 and 5 feet of depth. No BTEX compounds were detected in any of the samples. QA/QC duplicate samples were not collected for BTEX and therefore no analyses were performed.

4.4.3 Priority Metals

Total metals concentrations, using the RCRA SW-846 test methods for the analysis of metals in soils, were determined for the eight TCLP metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) plus nickel. These are the priority metals. Samples were collected for priority metals analysis at the surface, 2.5, 5, and 10 feet.

In the following presentation of metals results, only metals concentrations in excess of background concentrations are presented. No background data was collected for this investigation, therefore, background concentrations were taken from Concentrations of Selected Naturally Occurring Chemical Constituents in Soil and Groundwater at Cannon Air Force Base Clovis, New Mexico, March 1993 prepared by Woodward-Clyde. For a discussion of Woodward-Clydes background data see Section 1.7.

4.4.3.1 Borehole 1

No priority metals were detected above background in the surface sample of borehole 1.

At 2.5 feet (CAN005-1211-022B), nickel was detected at 10.10 mg/kg (Table 4-5). Background for nickel is 9.0 mg/kg.

No priority metals were detected above background at 5 and 10 feet.

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Table 4-5
Concentration (mg/kg) of Priority Metals
SWMU No. 5 - Oil/Water Separator No. 121

Boring Number	Sample Number (CAN005-121)	Sample Depth (Feet)	Barium	Mercury		Nickel	
1	1-021A	0	341	0.1	U	7.3	
	1-022B	2.5	68.5	0.1	U	10.1	
	1-023C	5	90.3	0.1	U	6.5	
	1-024D	10	37.9	0.1	U	7.6	
2	2-021A	0	357	0.1	U	6	UJ
	2-022B	2.5	60.9	0.1	U	12.7	
	2-023C	5	118	0.1	U	7.4	
	2-024D	10	344	0.1	U	10.1	
3	3-021A	0	337	0.1	U	6.6	
	3-022B	2.5	65.4	0.1	U	9.9	
	3-023C	5	73.1	0.1	U	7.7	
	3-024D	10	597	0.1	U	5.9	
(QAD)	3-721D	10	**749**	**0.2**		8.1	
(QCD)	3-821D	10	**714**	0.1	U	5.2	
Background (95% UCL) (1)			642.00	0.13		9.00	

Notes:

Duplicate samples (QAD) or (QCD) samples are presented only if they are different from the original sample and not rejected.

U indicates that the compound was analyzed for, but not detected at or above the standard limit.
J indicates an estimated value.
UJ indicates the compound was analyzed for but not detected. The sample quantification limit or reported detection limit is an estimated quantity.
* R indicates that the data was rejected because of quality control measures

Boldface indicates a detection above the 95% UCL background level

Only data for metals detected above background is presented

(1) Background data is described in Section 17.0.

4.4.3.2 Borehole 2

No priority metals were detected above background in the surface sample of borehole 2.

At 2.5 feet (CAN005-1212-022B), nickel was detected at 12.7 mg/kg.

No priority metals were detected above background in the sample collected at 5 feet.

At 10 feet (CAN005-1212-024D), nickel was detected at 10.1 mg/kg.

4.4.3.3 Borehole 3

No priority metals were detected above background in the surface sample.

At 2.5 feet (CAN005-1213-022B), nickel was detected at 9.9 mg/kg.

At 10 feet no priority metals were detected above background. The QA/QC duplicates were collected at this depth. The QC duplicate (CAN005-1213-821D), analyzed at the same lab as the normal sample, contained barium at 714 mg/kg. The QA duplicate (CAN005-1213-721D), analyzed at a different lab than the normal sample, also contained barium at 749 mg/kg and mercury at 0.2 mg/kg. Background for these metals is 642 and 0.13 mg/kg respectively.

4.4.4 Summary

No VOCs were detected or metal detected above background in any of the surface samples for the three boreholes. Nickel was detected above background in all the boreholes at 2.5 feet. Boreholes 2 and 3 contained acetone and nickel or barium at 10 feet.

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5.0 OIL WATER SEPARATOR (SWMU NO. 7/SITE NO. 129)

5.1 SWMU Description

5.1.1 Setting

SWMU No.7 is an oil/water separator located on the northwest side of Building 129, approximately 33 feet east of the NW corner. The separator is a 3 compartment underground unit, with a 700 gallon main compartment, a 280 gallon oil compartment, and a skimmer. The unit is constructed of concrete. The opening to the separator is covered on all sides by asphalt. Borehole locations were selected, in part, to avoid underground sewer, TV cable and electrical lines. The driller was required to penetrate the asphalt and restore the surface with a concrete plug. Setting and borehole locations are provided in Figure 5-1.

5.1.2 History of Use

The oil/water separator No. 129 has been active since 1943 and is still in use. The unit receives wastewater from building 129. The recovered oils are directed to the 280 gallon holding tank and the wastewater is discharged to the Sanitary Sewage Line (SWMU No. 98). Historically, the unit has received washwater generated from aircraft washing and aircraft maintenance operations. Aircraft fuels and fluids were disposed of through the waste generation reporting procedures.

5.1.3 Past Investigations

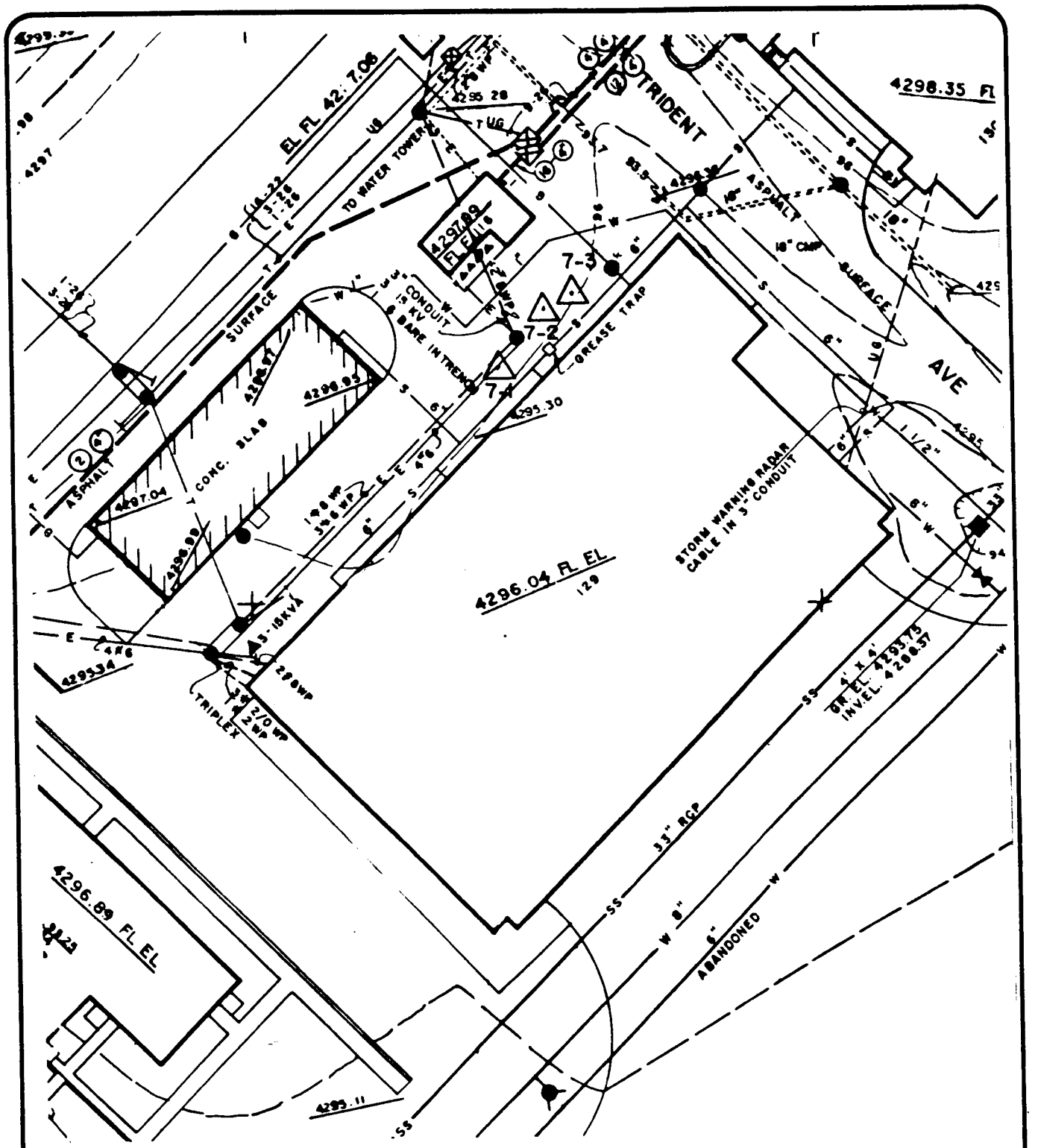
In 1987-1988 the Tulsa District Corps of Engineers sampled this and other oil/water separators at Cannon AFB. The results of this study were reported in Cannon Air Force Base Oil/Water Separators Sampling and Analytical Report, June, 1988. The results of this study indicated the presence of metals and organics in the liquid phase influent and/or effluent. The compounds found include: benzene, toluene, ethylbenzene, xylene, 2-hexanone, lead, cadmium, 2-methylnaphthalene, and several phthalates in the influent/effluent of this separator.

5.1.4 Land Use and Demography

This SWMU is located in an area of the base which is commonly used by base personnel. However, this SWMU is underground and presently covered by asphalt.

5.2 Field Investigation

SWMU 7 was sampled April 9, 1993 at 0830. The activities at oil/water separator No. 129, as outlined in the FSP (LRL, 1993), consisted of drilling 3 boreholes, collecting 6 surface samples, 18 subsurface samples, 4 QA/QC duplicate samples and 6 QA/QC water samples. Table 5-1 summarizes the field sampling program at SWMU 7. Table 5-2 summarizes the various samples collected and analyses performed.



▲ — Borehole

Boring No.	Elevation (ft.)
1	4296.03
2	4295.08
3	4296.10

N

LRL Sciences, Inc.

SWMU #7
OIL/WATER SEPARATOR - 129
CANNON AFB, NEW MEXICO

Project: Cannon AFB RFI	
Contract No: DACA47-93-C-009	
Prepared by: KLH	Date: 10-25-93

Fig. 5-1

Table 5-1.
Summary of Drilling and Sampling
SWMU No.7 - Oil/Water Separator No. 129

Borehole Number	Sampling Depth (ft.-BGS)	Drilling/ Sampling Methods	Drillrig Used	Borehole Diameter (in.)	Ground Elevation	Date Grouted
1	0	NA/SSS	NA	NA	4296.03	4\09\93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
2	0	NA\SSS	NA	NA	4295.08	4/09/93
	2.5	HSA\SBC	CME-75	8.0		
	5.0	HSA\SBC	CME-75	8.0		
	10.0	HSA\SBC	CME-75	8.0		
3	0	NA\SSS	NA	NA	4296.10	4/09/93
	2.5	HSA\SBC	CME-75	8.0		
	5.0	HSA\SBC	CME-75	8.0		
	10.0	HSA\SBC	CME-75	8.0		

HSA = Hollow Stem Auger
HA = Hand Auger
SBC = Split Barrel Continuous Sampler
SS = Split Spoon
SSS = Stainless Steel Spoon

Table 5-2.
Summary of Sampling and Analyses
SWMU No. 7 - Oil/Water Separator No. 129

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
1	0	CAN007-1291-021A	N	SOIL	0850	PM	6010\7000S+
		CAN007-1291-031A	N	SOIL	0850	TCL VOC	8240
	2.5	CAN007-1291-011B	N	SOIL	0910	BTEX	8020
		CAN007-1291-022B	N	SOIL	0910	PM	6010\7000S
	5.0	CAN007-1291-023C	N	SOIL	0915	PM	6010\7000S
		CAN007-1291-032C	N	SOIL	0915	TCL VOC	8240
		CAN007-1291-821C	QCD	SOIL	0915	PM	6010\7000S
		CAN007-1291-831C	QCD	SOIL	0915	TCL VOC	8240
		CAN007-1291-721C	QAD	SOIL	0915	PM	6010\7000S
		CAN007-1291-731C	QAD	SOIL	0915	TCL VOC	8240
	10.0	CAN007-1291-012D	N	SOIL	0920	BTEX	8020
		CAN007-1291-024D	N	SOIL	0920	PM	6010\7000S
2	0	CAN007-1292-021A	N	SOIL	0950	PM	6010\7000S
		CAN007-1292-031A	N	SOIL	0950	TCL VOC	8240
	2.5	CAN007-1292-011B	N	SOIL	1005	BTEX	8020
		CAN007-1292-022B	N	SOIL	1007	PM	6010\7000S
	5.0	CAN007-1292-023C	N	SOIL	1015	PM	6010\7000S
		CAN007-1292-032C	N	SOIL	1015	TCL VOC	8240
	10.0	CAN007-1292-012D	N	SOIL	1017	BTEX	8020
		CAN007-1292-024D	N	SOIL	1017	PM	6010\7000S

Table 5-2. (Concluded)
Summary of Sampling and analyses
SWMU No. 7 - Oil/Water Separator No. 129

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
3	0	CAN007-1293-021A	N	SOIL	1035	PM	6010/7000S
		CAN007-1293-031A	N	SOIL	1035	TCL VOC	8240
	2.5	CAN007-1293-011B	N	SOIL	1100	BTEX	8020
		CAN007-1293-022B	N	SOIL	1100	PM	6010/7000S
	5.0	CAN007-1293-023C	N	SOIL	1107	PM	6010/7000S
		CAN007-1293-032C	N	SOIL	1105	TCL VOC	8240
	10.0	CAN007-1293-012D	N	SOIL	1107	BTEX	8020
		CAN007-1293-024D	N	SOIL	1110	PM	6010/7000S
		CAN007-1290-431Z	QC	WATER	1125	TCL VOC	8240
		CAN007-1290-321Z	QC	WATER	1130	PM	6010/7000S
		CAN007-1290-331Z	QC	WATER	1123	TCL VOC	8240
		CAN007-1290-231Z	QC	WATER	1120	TCL VOC	8240
		CAN007-1290-621Z	QC	WATER	1130	PM	6010/7000S
		CAN007-1290-631Z	QC	WATER	1123	TCL VOC	8240-

BTEX = Benzene, Toluene, Ethyl Benzene, Xylene
ft-BGS = feet below ground surface
N = normal soil sample
PM = Priority metals = 8 TCLP metals + Ni
TCL VOC = Target Compound List Volatile Organic Compounds
\+ = Metals analyzed using the 7000 Series include: mercury, selenium, and arsenic.

QAD = Duplicate soil sample (analyzed at different laboratory from normal samples).
QCD = Duplicate soil sample analyzed at same laboratory as normal samples.
QC = Quality control water sample (ambient blank, trip blank, etc.)
TAL Metals = Target analyte list metals

5.2.1 Sampling Objectives

Borehole locations, sampling depth, and parameters for analysis were selected, to the greatest extent possible, to determine if a release from the oil/water separator has occurred. Borehole 1 was moved from its original FSP location due to utility lines and restricted space considerations. Borehole locations are shown in Figure 5-1.

5.2.2 Surface and Subsurface Soil Investigation

Three boreholes were drilled at SWMU No.7. Borehole 1 was drilled southwest of the separator. Borehole 2 was drilled north of the separator and borehole 3 was drilled to the northeast of the separator. Drilling was advanced to a depth of 10 feet. Samples were collected at the surface, 2.5, 5 and 10 feet in depth. Surface samples were collected with a stainless steel trowel and subsurface samples were collected with a split barrel continuous sampler. Samples were collected at discrete depths and locations. No composite samples were taken. Samples were analyzed for BTEX, priority metals and TCL VOCs. Duplicates, rinsate blanks, ambient blanks and decontamination water samples were also submitted to the laboratory for this SWMU. Trip Blanks and Ambient Blanks were inadvertently opened to the air at SWMU #1; however, these blanks were used for analysis at SWMU #7.

5.3 Physical Characteristics

Following is a discussion of the surface water drainage, groundwater, and soils and geology at the No. 121 oil/water separator based on a review of information from previous investigations at Cannon AFB and from the lithologic descriptions from the split barrel continuous sampler.

5.3.1 Surface Water Drainage

A topographic/surface drainage map in addition to text found in Installation Restoration Program Records Search, August 1983 prepared by CH_2M Hill indicates that the surface water drainage in the vicinity of SWMU No.7 enters the base storm water drainage system and flows to the Stormwater Collection Point (SWMU No. 85). SWMU No. 85 is an ephemeral lake basin (playa) located in the southwest corner of the base.

5.3.2 Groundwater

Depth to groundwater at Cannon AFB is approximately 250 feet or greater. Groundwater recharge rates for the High Plains Region are typically low. Localized recharge rates for Curry County range from 0.75 - 12.22 mm/yr (Stone, 1985). EPA, 1987 DRASTIC reports recharge rates of 1 in/yr. Section 1.4.3.5 of this report includes a discussion of groundwater hydrology for Cannon AFB.

5.3.3 Soils and Geology

The near surface (upper ten feet) stratigraphy in the area surrounding this SWMU consist of Tertiary Miocene to Pliocene fluvial deposits of the Ogallala Formation. The soils have been

described as a fine sandy loam (Ab) of the Amarillo soil group (USDA, 1993). Interpretations and correlation on the fluvial deposits for this area are based on samples collected with a split barrel continuous sampler during the drilling process. The soils consist of very fine to fine-grained, moderately sorted, immature (textural), unconsolidated, calcareous, dark red, clays, silts, and sands. Thin to moderately thin layers and nodules of caliche material were interbedded throughout much of the samples collected. The sands were comprised of angular to subangular grains with varying amounts of silts, clays, and calcium carbonate (caliche) material. This description of lithology (Figure 5-2) is simuliar to the description of soils given by the USDA Draft Soil Survey, 1993. The thickness of this particular unit remains unknown, due to the fact that boring levels did not exceed ten feet. The total thickness of the Ogallala Formation beneath this SWMU is not presently known, but regional information based on Curry County reports have suggested thicknesses of approximately 320-400 feet. No groundwater was encountered while drilling at these three borehole locations. The minimum depth of the High Plains aquifer is reported to be greater than 250 feet below ground surface.

5.4 Nature and Extent of Contamination

5.4.1 Volatile Organic Compounds

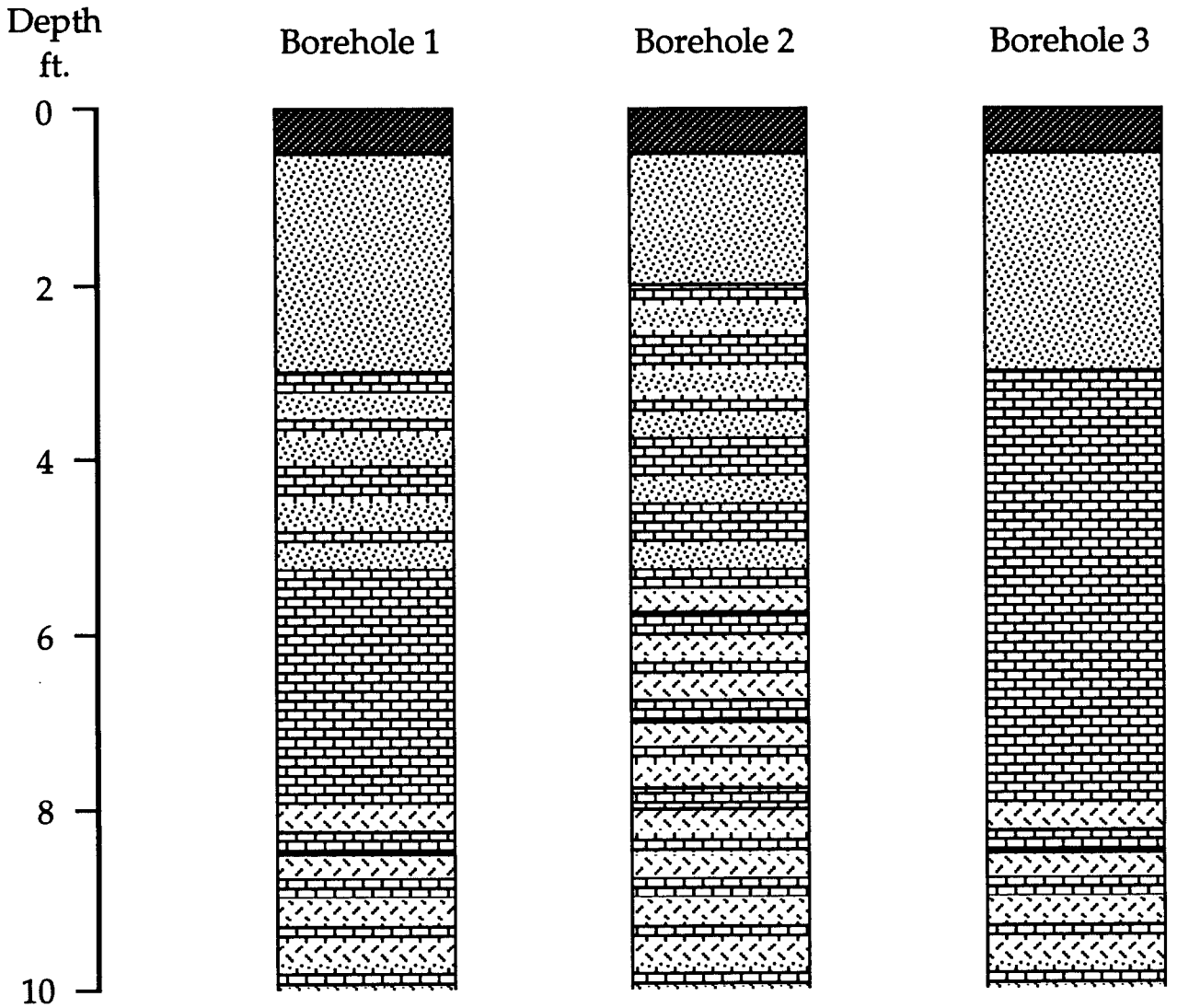
A series of HNU meter readings were taken in the well head and in the breathing zone at each borehole for the purpose of worker safety. No positive readings occurred.

Samples were collected from the three boreholes at the surface and at 5 feet and analyzed for Target List Compound Volatile Organic Compounds (TCL VOC). Following are the results of these analyses:

5.4.1.1 Borehole 1

In borehole 1, the surface sample (CAN007-1291-031A) contained 1,1,1-trichlorethane below the CRQL, toluene at 15 μg/kg and xylene below the CRQL (Table 5-3). This sample also contained TIC compounds. The laboratory conducted a repeat of this sample due to one of the internal standard areas being outside the QC limits. The repeat sample contained 1,1,1-trichlorethane below the CRQL, toluene at 20 μg/kg and xylene at 11 μg/kg. The repeat sample also contained acetone at 40 mg/kg. The repeat sample had the same internal standard problem that original analysis had. All results, except for acetone in the repeat sample, are therefore estimates either because they are below the CRQL or because of the internal standard problems.

The sample collected at 5 feet (CAN007-1291-032C) contained no target analytes or TIC compounds. Two duplicate samples were collected in association with the 5 foot sample. The QC sample, analyzed at the same lab, contained no target compounds or TIC compounds. The QA duplicate, analyzed at a different lab, contained methylene chloride and acetone. Due to the prevalence of these two compounds in nearly all of the samples run at the QA lab, these compounds were considered contaminants and rejected.



LEGEND

- Asphalt
- Sand
- Clay
- Caliche

LRL Sciences, Inc.

SWMU #7
STRATIGRAPHIC COLUMN
CANNON AFB, NEW MEXICO

Project: Cannon AFB RFI	
Contract No: DACA47-93-C-009	
Prepared by: KLH	Date: 10-25-93

Fig. 5-2

Table 5-3.
Concentration (μg/kg) of Volatile Organic Compounds
SWMU No.7 - Oil/Water Separator No. 129

Borehole Number	Cannon Number	Depth (ft.)	Chemical			
			Toluene	Acetone	1,1,1-Trichloroethane	Xylene
1	CAN007-1291-031A	Surface	15J	10UJ	5J	7J
	CAN007-1291-032C	5.0	20J (RE)	40 (RE)	11U	11J (RE)
	CAN007-1291-032C	5.0	11J	11U		11U
2	CAN007-1292-031A	Surface	11U	11U	11U	11U
	CAN007-1292-032C	5.0	11U	11U	11U	11U
3	CAN007-1293-031A	Surface	6J	10UJ	10U	10U
	CAN007-1293-032C	5.0	11U	24J	11U	11U

Duplicate samples or laboratory repeat samples are presented only if they are different from the original sample and not rejected.

J = estimate
R = rejected
RE = laboratory repeat
U = not detected at CRQL
UJ = estimated as non-detect at CRQL

5.4.1.2 Borehole 2

In borehole 2, the surface sample contained no target compounds. Although acetone was detected, validation revealed acetone contamination in the method blank associated with this sample. No TIC compounds were detected in this sample.

The sample collected at 5 feet contained no target compounds. Again, an acetone detection was eliminated during validation due to contamination of the associated method blank. No TIC compounds were detected.

5.4.1.3 Borehole 3

In borehole 3, the surface sample (CAN007-1293-031A) contained toluene below the CRQL. No other target compounds were detected. No TIC compounds were detected.

The sample collected at 5 feet (CAN007-1293-032C) contained 24 μg/kg acetone. This value is an estimate since continuing calibration %D exceeded QC limits. No other target compounds were detected. No TIC compounds were detected.

5.4.2 BTEX

In each borehole, 2 samples were collected for BTEX analysis at 2.5 and 10 feet of depth. No BTEX compounds were detected in any of the samples. QA/QC duplicate samples were not collected for BTEX, therefore no analyses were performed.

5.4.3 Priority Metals

Total metals concentrations, using the RCRA SW-846 test methods for the analysis of metals in soils, were determined for the eight TCLP metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) plus nickel. These are the priority metals. Samples were collected for priority metals analysis at the surface, 2.5, 5 and 10 feet.

In the following presentation of metals results, only metals concentrations in excess of background concentrations are presented. No background data was collected for this investigation, therefore, background concentrations were taken from Concentrations of Selected Naturally Occurring Chemical Constituents in Soil and Groundwater at Cannon Air Force Base Clovis, New Mexico, March 1993 prepared by Woodward-Clyde. For a discussion of Woodward-Clydes background data see Section 1.7.

5.4.3.1 Borehole 1

In the surface sample (CAN007-1291-021A), chromium was detected at 38.7 mg/kg (Table 5-4). This value is an estimate since the matrix spike recovery was not within control limits.

No priority metals were detected above background at 2.5, 5 or 10 feet. The QA/QC samples were collected at 5 feet. The QC duplicate, analyzed at the same lab as the normal sample and collected at 5 feet, contained no priority metals above background. The QA duplicate (CAN007-1291-721C), analyzed at a different laboratory, contained mercury at 0.20 mg/kg.

5.4.3.2 Borehole 2

In the surface sample (CAN007-1292-021A), arsenic was detected at 31.8 mg/kg and chromium was detected at 20.6 mg/kg. Both values are estimates since matrix spike recovery was not within control limits. The background value for arsenic is 15.5 mg/kg and for chromium 12.5 mg/kg.

No priority metals were detected above background at 2.5 feet.

Nickel was detected at 5 feet (CAN007-1292-023C) at 9.8 mg/kg.

Table 5-4

Concentration (mg/kg) of Priority Metals

SWMU No. 7 - Oil/Water Separator No. 129

Boring Number	Sample Number (CAND07-129)	Sample Depth (Feet)	Arsenic		Chromium		Mercury		Nickel
1	1-021A	0	5.2	J	**38.7**	J	0.01	U	8.1
	1-022B	2.5	2.7	J	8.1	J	0.02	U	8.2
	1-023C	5	2.1	J	5.5	J	0.01	U	7.3
(QAD)	1-721C	5	3.1	UJ	8		**0.2**		
(QCD)	1-821C	5	2.2	J	5.5	J	0.01	U	7.1
	1-024D	10	0.98	J	6.5	J	0.01	U	7.5
2	2-021A	0	**31.8**	J	**20.6**	J	0.01	U	7.5
	2-022B	2.5	13.6	J	7.6	J	0.02	U	8.2
	2-023C	5	3.1	J	8		0.02	U	**9.8**
	2-024D	10	4.3	J	5.2	J	0.02	U	7.8
3	3-021A	0	4.8	J	**15.6**	J	0.01	U	7.5
	3-022B	2.5	2.8	J	6.3	J	0.07	U	6.3
	3-023C	5	3.3	J	3.6	J	0.02	U	6.4
	3-024D	10	4.4	J	5.3	J	0.01	U	7
Background (95% UCL) (1)			15.50		12.50		0.13		9.00

Notes:

Duplicate samples (QAD) or (QCD) samples are presented only if they are different from the original sample and not rejected.

U indicates that the compound was analyzed for, but not detected at or above the standard limit.
J indicates an estimated value.
UJ indicates the compound was analyzed for but not detected. The sample quantification limit or reported detection limit is an estimated quantity.
* R indicates that the data was rejected because of quality control measures

Boldface indicates a detection above the 95% UCL background level

Only data for metals detected above background is presented

(1) Background data is described in Section 17.0.

5.4.3.3 Borehole 3

In the surface sample (CAN007-1293-021A), chromium was detected at 15.6 mg/kg. This value is an estimate since matrix spike recovery was not within control limits.

No priority metals were detected at 2.5, 5 or 10 feet in depth.

5.4.4 Summary

Chromium was detected on the surface of all three boreholes. Arsenic and several organics were also detected in the surface sample of some boreholes. At 5 feet, borehole 1 contained mercury, borehole 2 contained nickel and borehole 3 contained acetone.

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6.0 OIL WATER SEPARATOR (SWMU NO. 8/SITE NO. 165)

6.1 SWMU Description

6.1.1 Setting

The oil/water separator No. 165 is located on the south end of the aircraft washrack at Facility 165. The separator is a 3-compartment underground unit with a 4,500 gallon main compartment and a 710 gallon oil compartment. The unit is constructed of concrete. The separator is surrounded on all sides by soil, and is adjacent to a concrete-covered washing area (SWMU No. 9). Boreholes were hand augered at this site and not drilled using the CME 75 drill rig in order to avoid crushing shallow sprinklers and water lines. Due to the thickness of the concrete of this SWMU, any leakage that may have occurred is suspected to be associated with the joints between the sewer drains and the SWMU unit and not from the SWMU unit itself. Borehole locations were selected to test areas where leaky joints may have affected the surrounding soil. The SWMU setting and borehole locations are presented in Figure 6-1.

6.1.2 History of Use

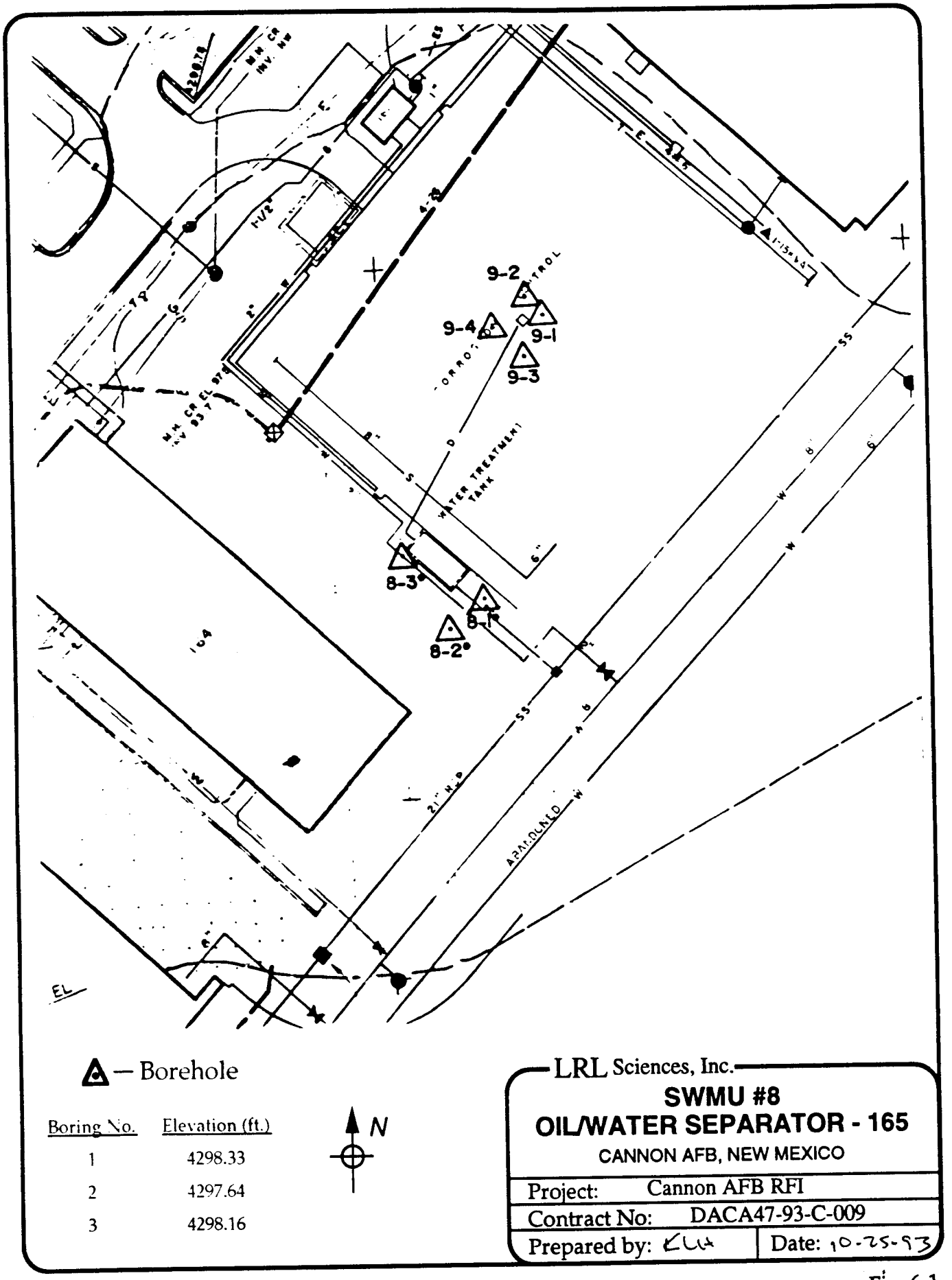
The oil/water separator No. 165 has been active since 1963 and is still in use. This SWMU receives wastewater from the washing of aircraft. The recovered oils are directed to the 710 gallon holding tank and the wastewater is discharged to the Storm Drainage System which flows to the Stormwater Collection Point (SWMU No. 85). During field reconnaissance, this tank contained material with a strong sewage odor. Currently, in the immediate area of the SWMU, aircraft washing is infrequent. The area is used instead for logistics where materials, supplies and goods are temporarily staged for air shipment. Rain water collection through a grill, in the middle of the washrack, comes to SWMU 8.

6.1.3 Past Investigations

No previous investigations are availble for this SWMU; however, chemical components which might appear in the influent and effluent would be similar to compounds associated with SWMU No. 9 which is served by this separator. Compounds include ethylene glycol n-mono butyl ether and PD-680 constituents. Washrack components would include fuels, solvents and lubricating oils.

6.1.4 Land Use and Demography

This SWMU is located in an area of the base which is commonly used by base personnel. This SWMU is underground but not covered by asphalt.



▲ — Borehole

Boring No.	Elevation (ft.)
1	4298.33
2	4297.64
3	4298.16

N

LRL Sciences, Inc.

SWMU #8
OIL/WATER SEPARATOR - 165
CANNON AFB, NEW MEXICO

Project:	Cannon AFB RFI
Contract No:	DACA47-93-C-009
Prepared by: KLH	Date: 10-25-93

Fig. 6-1

6.2 Field Investigation

SWMU 8 was sampled April 15, 1993 at 1600. The activities at oil/water separator No. 165, as outlined in the FSP (LRL, 1993), consisted of hand augering 3 boreholes, 6 surface samples, 18 subsurface samples, 4 QA/QC duplicate samples, and 6 QA/QC water samples. Table 6-1 summarizes the field sampling program at SWMU 8. Table 6-2 summarizes the various samples collected and analyses performed.

6.2.1 Sampling Objectives

Borehole locations, sampling depth, and parameters for analysis were selected, to the greatest extent possible, to determine if a release from the oil/water separator has occurred. All three boreholes were moved form the original FSP locations in order to test soils near the joints between the sewer drains and the separator. It was assumed for this site that any leaks would have occurred from these joints rather than the unit itself, as it was made of very thick concrete. Borehole locations are shown in 78.

6.2.2 Surface and Subsurface Soil Investigation

Three boreholes were hand augered at this SWMU. Borehole 1 was located 8 feet 6 inches to the southeast of the unit. Borehole 2 was placed 12 feet 6" inches to the south of the unit and borehole 3 was placed 3 feet to the west of the unit. Augering was advanced to a depth of 10 feet. Samples were collected at the surface, 2.5, 5 and 10 feet in depth. Surface samples were collected using a stainless steel trowel and subsurface samples were collected by hand auger. Samples were collected at discrete depths and locations. No composite samples were taken. Samples were analyzed for BTEX, priority metals and TCL VOCs. Duplicates, rinsate blanks, ambient blanks and decontamination water samples were also submitted to the laboratory for this SWMU site.

6.3 Physical Characteristics

This section provides a discussion of the surface water drainage, groundwater, soils, and geology at the No. 165 oil/water separator based on a review of information from previous investigations at Cannon AFB and from the lithologic descriptions from the soils removed with a hand auger.

6.3.1 Surface Water Drainage

A topographic/surface drainage map in addition to text found in Installation Restoration Program Records Search, August 1983 prepared by CH_2M Hill indicates that the surface water drainage in the vicinity of SWMU No. 8 enters the base storm water drainage system and flows to the Stormwater Collection Point (SWMU No. 85). SWMU No. 85 is an ephemeral lake basin (playa) located in the southwest corner of the base.

Table 6-1.
Summary of Drilling and Sampling
SWMU No.8 - Oil/Water Separator No. 165

Borehole Number	Sampling Depth (ft.-BGS)	Drilling/ Sampling Methods	Drillrig Used	Borehole Diameter (in.)	Ground Elevation	Date Grouted
1	0	HA	NA	NA	4298.33	4/15/93
	2.5	HSA/SBC	CME-75	3.0		
	5.0	HSA/SBC	CME-75	3.0		
	10.0	HSA/SBC	CME-75	3.0		
2	0	NA/SSS	NA	NA	4297.64	4/15/93
	2.5	HSA/SBC	CME-75	3.0		
	5.0	HSA/SBC	CME-75	3.0		
	10.0	HSA/SBC	CME-75	3.0		
3	0	NA/SSS	NA	NA	4298.16	4/15/93
	2.5	HSA/SBC	CME-75	3.0		
	5.0	HSA/SBC	CME-75	3.0		
	10.0	HSA/SBC	CME-75	3.0		

HSA = Hollow Stem Auger
HA = Hand Auger
SBC = Split Barrel Continuous Sampler
SS = Split Spoon
SSS = Stainless Steel Spoon

Table 6-2.
Summary of Sampling and Analyses
SWMU No. 8 - Oil/Water Separator No. 165

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
1	0	CAN008-1651-021A	N	SOIL	1605	PM	6010\7000S+
		CAN008-1651-031A	N	SOIL	1605	TCL VOC	8240
	2.5	CAN008-1651-022B	N	SOIL	1630	PM	6010\7000S
		CAN008-1651-032B	N	SOIL	1625	TCL VOC	8240
		CAN008-1651-821B	QCD	SOIL	1650	PM	6010\7000S
		CAN008-1651-831B	QCD	SOIL	1625	TCL VOC	8240
		CAN008-1651-721B	QAD	SOIL	1630	PM	6010/7000S
		CAN008-1651-731B	QAD	SOIL	1625	TCL VOC	8240
	5.0	CAN008-1651-011C	N	SOIL	1640	BTEX	8020
		CAN008-1651-023C	N	SOIL	1640	PM	6010\7000S
	10.0	CAN008-1651-024D	N	SOIL	1655	PM	6010\7000S
		CAN008-1651-012D	N	SOIL	1655	BTEX	8020
2	0	CAN008-1652-021A	N	SOIL	1645	PM	6010\7000S
		CAN008-1652-031A	N	SOIL	1645	TCL VOC	8240
	2.5	CAN008-1652-022B	N	SOIL	1710	PM	6010\7000S
		CAN008-1652-032B	N	SOIL	1710	TCL VOC	8240
	5.0	CAN008-1652-011C	N	SOIL	1720	BTEX	8020
		CAN008-1652-023C	N	SOIL	1720	PM	6010\7000S
	10.0	CAN008-1652-022D	N	SOIL	1740	PM	6010\7000S
		CAN008-1652-014D	N	SOIL	1740	BTEX	8020

Table 6-2. (Concluded)
Summary of Sampling and Analyses
SWMU No. 8 - Oil/Water Separator No. 165

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
3	0	CAN008-1653-021A	N	SOIL	1750	PM	6010\7000S
		CAN008-1653-031A	N	SOIL	1750	TCL VOC	8240
	2.5	CAN008-1653-022B	N	SOIL	1805	PM	6010\7000S
		CAN008-1653-032B	N	SOIL	1800	TCL VOC	8240
		CAN008-1653-821B	QCD	SOIL	1805	PM	6010\7000S
		CAN008-1653-831B	QCD	SOIL	1800	TCL VOC	8240
		CAN008-1653-721B	QAD	SOIL	1805	PM	6010\7000S
		CAN008-1653-731B	QAD	SOIL	1800	TCL VOC	8240
	5.0	CAN008-1653-011C	N	SOIL	1810	BTEX	8020
		CAN008-1653-023C	N	SOIL	1815	PM	6010\7000S
	10.0	CAN008-1653-022D	N	SOIL	1805	PM	6010\7000S
		CAN008-1653-014D	N	SOIL	1825	BTEX	8020
		CAN008-1650-431Z	QC	WATER	1830	TCL VOC	8240
		CAN008-1650-321Z	QC	WATER	1835	PM	6010\7000S
		CAN008-1650-331Z	QC	WATER	1840	TCL VOC	8240
		CAN008-1650-231Z	QC	WATER	1840	TCL VOC	8240
		CAN008-1650-621Z	QC	WATER	1835	PM	6010\7000S
		CAN008-1650-631Z	QC	WATER	1840	TCL VOC	8240

BTEX = Benzene, Toluene, Ethyl Benzene, Xylene
ft-BGS = feet below ground surface
N = Normal soil sample
PM = Priority metals = 8 TCLP metals + Ni
TCL VOC = Target Compound List Volatile Organic Compounds
\+ = Metals analyzed using the 7000 Series include: mercury, selenium, and arsenic.

QAD = Duplicate soil sample (analyzed at different laboratory from normal samples).
QCD = Duplicate soil sample analyzed at same laboratory as normal samples.
QC = Quality control water sample (ambient blank, trip blank, etc.)
TAL Metals = Target analyte list metals

6.3.2 Groundwater

Depth to groundwater at Cannon AFB is approximately 250 feet or greater. Groundwater recharge rates for the High Plains Region are typically low. Localized recharge rates for Curry County range from 0.75 - 12.22 mm/yr (Stone, 1985). EPA, 1987 DRASTIC reports recharge rates of 1 in/yr. Section 1.4.3.5 of this report includes a discussion of groundwater hydrology for Cannon AFB.

6.3.3 Soils and Geology

The near surface (upper ten feet) stratigraphy in the area surrounding this SWMU consist of Tertiary Miocene to Pliocene fluvial deposits of the Ogallala Formation. The soils have been described as a fine sandy loam (Ab) of the Amarillo soil group (USDA, 1993). Interpretations and correlation on the fluvial deposits for this area are based on hand augered samples collected during the drilling process. The soils consist of very fine to coarse-grained, poorly to moderately sorted, submature to mature (textural), unconsolidated, calcareous, dark reddish brown, clays, silts, sands, and gravel. Thin to moderately thin layers of caliche material were interbedded throughout much of the samples collected. The sands were comprised of angular to subangular grains with varying amounts of silts, clays, and calcium carbonate (caliche) material. This description of lithology (Figure 6-2) is similiar to the description of soils given by the USDA Draft Soil Survey, 1993. The thickness of this particular unit remains unknown, due to the fact that boring levels did not exceed ten feet. The total thickness of the Ogallala Formation beneath this SWMU is not presently known, but regional information based on Curry County reports have suggested thicknesses of approximately 320-400 feet. No groundwater was encountered while drilling at these three borehole locations. The minimum depth of the High Plains aquifer is reported to be greater than 250 feet below ground surface.

6.4 Nature and Extent of Contamination

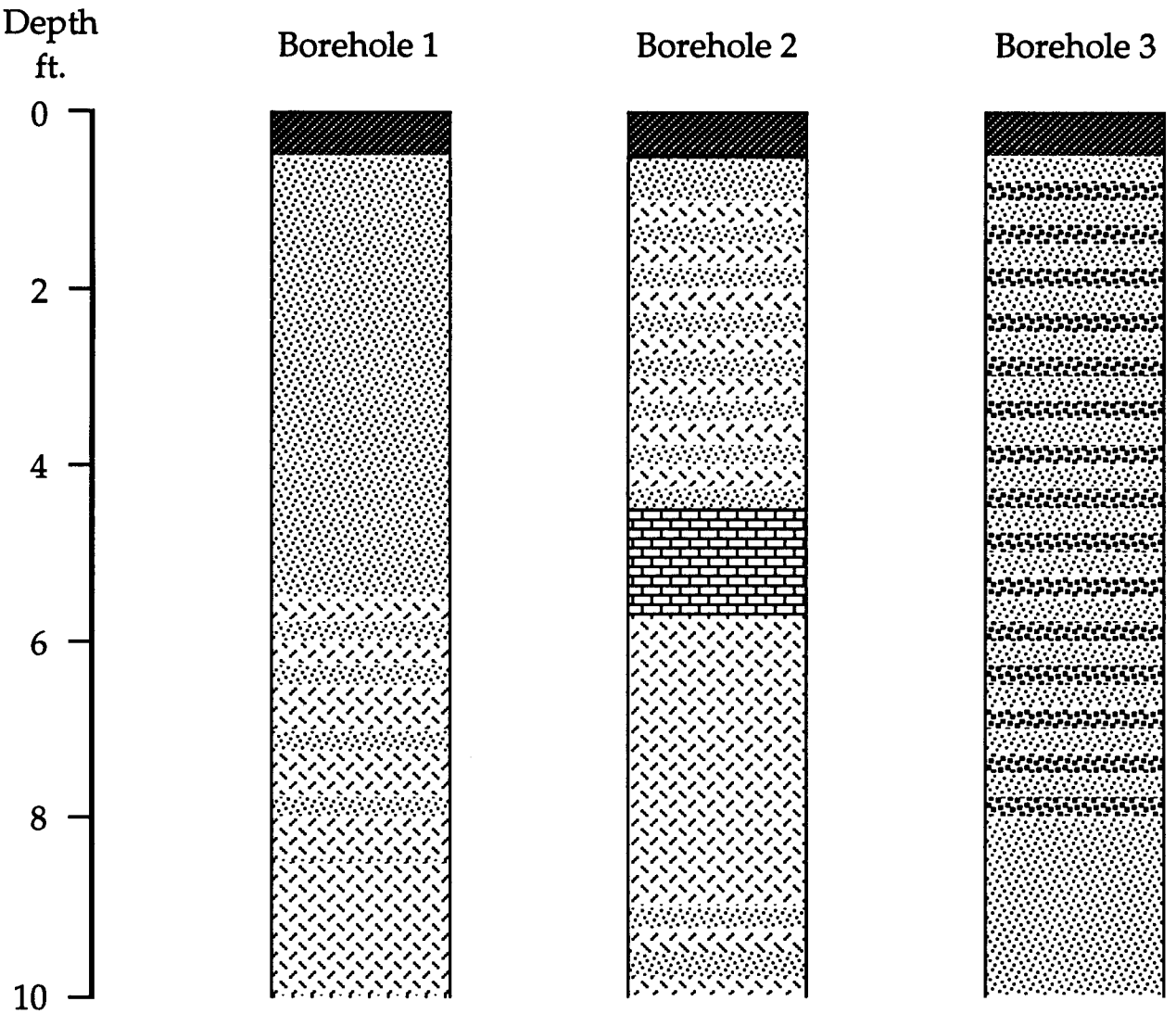
6.4.1 Volatile Organic Compounds

A series of HNU meter readings were taken at each of the boreholes in the well head and in the breathing zone for the purpose of worker safety. In borehole 3, all the well head readings were positive ranging from 0.2 to 2.4 ppm (Table 6-3).

Samples were collected from the three boreholes at the surface and at 2.5 feet and analyzed for Target List Compound Volatile Organics Compounds (TCL VOC). Following are the results of these analyses.

6.4.1.1 Borehole 1

In borehole 1, no target compounds or TIC compounds were detected at the surface.



LEGEND

- Asphalt
- Gravel
- Sand
- Clay
- Caliche

LRL Sciences, Inc.

SWMU #8
STRATIGRAPHIC COLUMN
CANNON AFB, NEW MEXICO

Project: Cannon AFB RFI	
Contract No: DACA47-93-C-009	
Prepared by: KLH	Date: 10·25·93

Fig. 6-2

Table 6-3.
HNU Meter* Readings (PPM) in Borehole Headspace
SWMU No. 8 - Oil/Water Separator No. 165

DATE: 4/15/93					
TIME	BH1	TIME	BH2	TIME	BH3
1610	0.0	1705	0.0	1745	1.2
1643	0.0	1710	0.0	1755	2.4
		1720	0.0	1758	0.8
1655	0.0	1725	0.0	1805	0.2
		1735	0.0	1810	0.4

* Model: 101, Type: OVA PID, Make: HNU

No target compounds or TIC compounds were detected at 2.5 feet. Two duplicate samples were collected with the 2.5 foot sample from borehole 1. The QC duplicate was analyzed at the same lab and the QA duplicate was analyzed at a different lab. The QC duplicate contained no target compounds or TIC compounds. The QA duplicate contained acetone and methylene chloride. Since nearly all of the samples at the QA laboratory contained these compounds, they were considered laboratory contaminants and rejected. The QA duplicate also contained marginal amounts of unidentified TIC compounds. These data were rejected during validation since there was no agreement with the QC laboratory and concentrations were marginal.

6.4.1.2 Borehole 2

In borehole 2, no target compounds or TIC compounds were detected at the surface or at 2.5 feet.

6.4.1.3 Borehole 3

In borehole 3, no target compounds or TIC compounds were detected at the surface.

No target compounds or TIC compounds were detected at 2.5 feet. Two duplicate samples were collected with the 2.5 foot sample form borehole 3. The QC duplicate contained acetone. The acetone result was rejected, however, due to co-elution with unknown contaminants. The QA duplicate once again contained acetone and methylene chloride which were considered lab contaminants due to their prevalence in nearly all the samples. A single unknown TIC compound was detected but rejected due to its marginal presence and since TIC compounds were not detected in the QC duplicate or the normal lab sample.

6.4.2 BTEX

In each borehole, two samples were collected for BTEX analysis at 5 and 10 feet of depth. In borehole 3, at 5 feet, xylenes were detected at 2.4 μg/kg (Table 6-4). This result is estimated, however, since internal standard problems occurred.

Table 6-4.
Concentration (μg/kg) of BTEX
SWMU No. 8 - Oil/Water Separator No. 165

Borehole Number	Cannon Number	Depth (ft.)	Chemical				
			Benzene	Ethly Benzene	Toluene	Xylene	BTEX Total
1	CAN008-1651-011C	5.0	2U	2U	2U	2U	2U
	CAN008-1651-012D	10.0	2U	2U	2U	2U	2U
2	CAN008-1652-011C	5.0	2U	2U	2U	2U	2U
	CAN008-1652-012D	10.0	2U	2U	2U	2U	2U
3	CAN008-1653-011C	5.0	2UJ	2UJ	2UJ	2J	2J
	CAN008-1653-012D	10.0	2U	2U	2U	2U	2U

Duplicate samples or laboratory repeat samples are presented only if they are different from the original sample and not rejected.
J = estimate
R = rejected
U = not detected at CRQL
UJ = estimated as non-detect at CRQL

6.4.3 Priority Metals

Total metals concentrations, using the RCRA SW-846 test methods for the analysis of metals in soils, were determined for the eight TCLP metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) plus nickel. These are the priority metals. Samples were collected for priority metals analysis at the surface, 2.5, 5, and 10 feet.

In the following presentation of metals results, only metals concentrations in excess of background concentrations are presented. No background data was collected for this investigation, therefore, background concentrations were taken from Concentrations of Selected Naturally Occurring Chemical Constituents in Soil and Groundwater at Cannon Air Force Base Clovis, New Mexico, March 1993 prepared by Woodward-Clyde. For a discussion of Woodward-Clydes background determination see Section 1.7.

6.4.3.1 Borehole 1

In the surface sample, no priority metals were detected above background.

At 2.5 feet (CAN008-1651-022B), nickel was detected at 31.6 mg/kg (Table 6-5). The QA/QC field duplicated samples were collected at this depth. The QC duplicate (CAN008-1651-821B), analyzed at the same lab as the normal sample, contained nickel at 9.1 mg/kg. The QA duplicate (CAN008-1651-721B), analyzed at a separate laboratory, contained nickel at 9.7 mg/kg. Background for nickel is 9.0 mg/kg.

At 5 feet (CAN008-1651-023C), chromium was detected at 13.2 and nickel at 11.4 mg/kg. Background for chromium and nickel are 15.5 and 9.0 mg/kg respectively.

No priority metals were detected above background at 10 feet.

6.4.3.2 Borehole 2

In the surface sample, no priority metals were detected above background.

At 2.5 feet (CAN008-1652-022B), nickel was detected at 11.0 mg/kg.

At 5 feet (CAN008-1652-023C) chromium and nickel were detected at 12.9 and 12.2 mg/kg respectively.

At 10 feet (CAN008-1652-022D), barium was detected at 712 mg/kg. Background for barium is 642 mg/kg.

6.4.3.3 Borehole 3

No priority metals were detected in the surface sample, 2.5 or 5 feet. The QA/QC field duplicates collected at 2.5 feet also contained no priority metals above background.

At 10 feet (CAN008-1653-022D), barium was detected at 812 mg/kg. This value is an estimate because the matrix spike recovery was not within control limits.

6.4.4 Summary

No VOCs were detected and no metals were detected above background in the surface samples in any of the boreholes. All three boreholes contained subsurface metals including nickel, chromium and barium. Only borehole 3 contained subsurface organics (xylenes).

DRAFT

Table 6-5

Concentration (mg/kg) of Priority Metals

SWMU No. 8 - Oil/Water Separator No. 165

Boring Number	Sample Number (CAN006-165)	Sample Depth (Feet)	Barium		Chromium	Nickel	
1	1-021A	0	203	J	12.2	8.9	U
	1-022B	2.5	194	J	9.3	**31.6**	
(QAD)	1-721B	2.5	204		12.3	**9.7**	
(QCD)	1-821B	2.5	155	J	11.3	**9.1**	
	1-023C	5	107	J	**13.2**	**11.4**	
	1-024D	10	423	J	5.7	6.3	
2	2-021A	0	198	J	11.2	7.9	
	2-022B	2.5	100	J	12.5	**11**	
	2-023C	5	71.1	J	**12.9**	**12.2**	
	2-022D	10	**712**	J	4.3	4.9	
3	3-021A	0	250	J	8.3	7.7	
	3-022B	2.5	196	J	8.3	7.4	
(QAD)	3-721B	2.5	195		12.5	8.4	
(QCD)	3-821B	2.5	208	J	8.6	7.3	
	3-023C	5	209	J	8.3	7.7	
	3-022D	10	**812**	J	2.1	2	
Background (95% UCL) (1)			642.00		12.50	9.00	

Notes:

Duplicate samples (QAD) or (QCD) samples are presented only if they are different from the original sample and not rejected.

U indicates that the compound was analyzed for, but not detected at or above the standard limit.
J indicates an estimated value.
UJ indicates the compound was analyzed for but not detected. The sample quantification limit or reported detection limit is an estimated quantity.
* R indicates that the data was rejected because of quality control measures

Boldface indicates a detection above the 95% UCL background level

Only data for metals detected above background is presented

(1) Background data is described in Section 17.0.

7.0 AIRCRAFT WASHRACK DRAIN SYSTEM (SWMU NO. 9)

7.1 SWMU Description

7.1.1 Setting

SWMU No. 9 is a drain in the center of a concrete washrack pad used for cleaning aircraft. The washrack pad slopes to this drain which discharges to Oil/Water Separator No. 165 (SWMU No. 8). The washrack pad is located near SWMU No. 8 and is proximate to the flight line. The borehole locations were chosen, in part, to detect any leakage which may have occurred around the drain fixture and the plumbing joints. Figure 7-1 shows the setting of SWMU No. 9 and the borehole locations. The driller was required to penetrate concrete and restore the surfaces with a concrete plug.

7.1.2 History of Use

The washrack drain system has been active since 1966 and is still in use. Currently, approximately four aircraft frames are cleaned per week with a water and aircraft cleaning compound solution. Washdown water, from aircraft frame cleaning operations conducted from 1984 till the present, contains a biodegradable cleaning compound that consists of 5% by weight ethylene glycol n-mono butyl ether. Prior to 1984, approximately 3,600 gallons of PD-680 and 1,700 gallons of aircraft cleaning compound drained into Oil/Water Separator No. 165 (SWMU No. 8), which empties into the Storm Water Drainage Area (SWMU No. 85). This washrack pad is also used currently as a staging area for mobilization exercises/air shipments.

7.1.3 Past Investigations

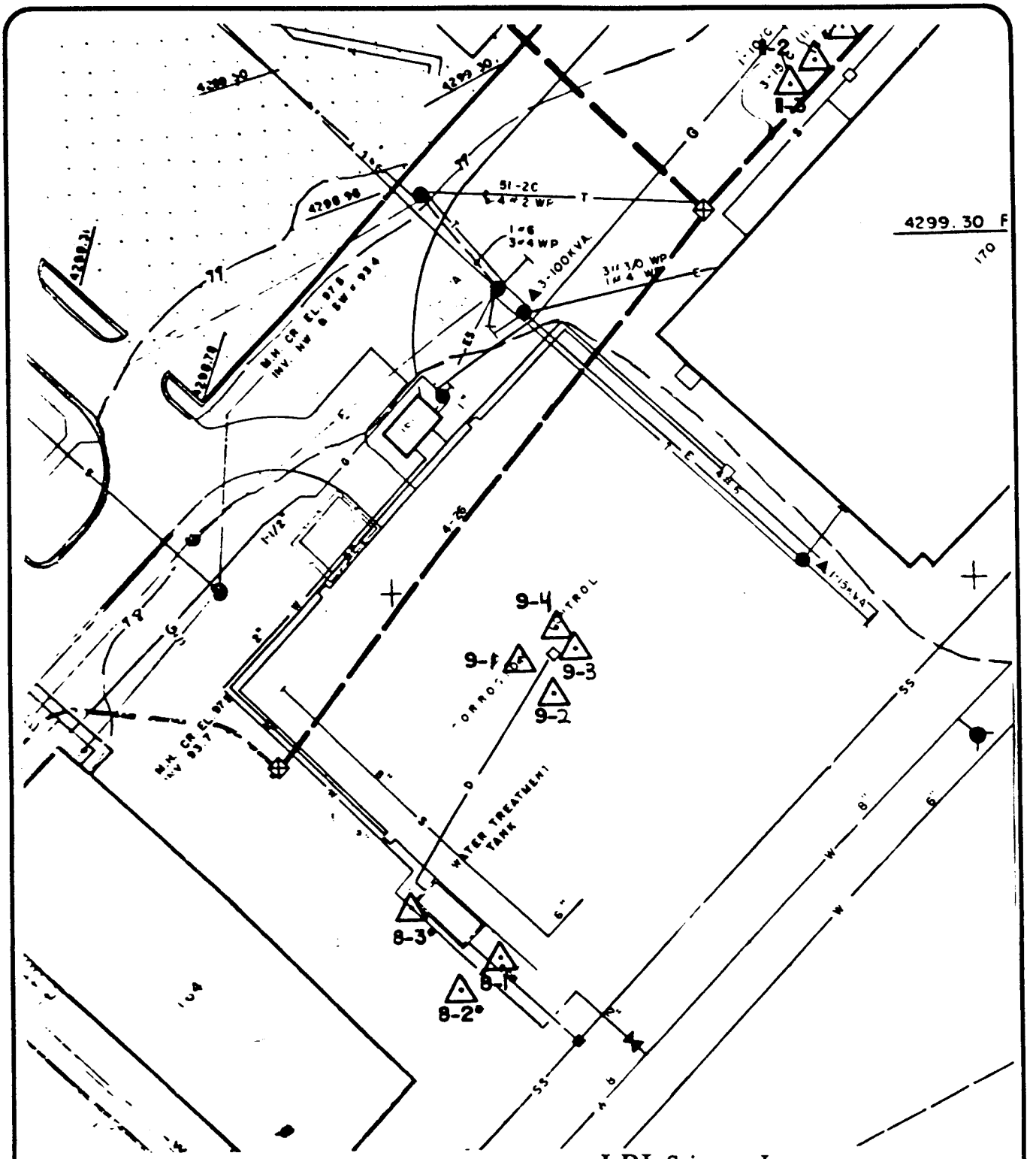
No previous studies of SWMU No. 9 or the oil/water separator (SWMU No. 8) that receives effluent from SWMU No. 9 were found.

7.1.4 Land Use and Demography

This SWMU is in an area of the base that is commonly frequented by personnel. However, the drain leads underground and the area is currently covered by asphalt.

7.2 Field Investigation

Preparation for the drilling and sampling activities occurred April 15, 1993. This included using a concrete saw to cut the cement/concrete ramp and then a jack hammer to breakout the concrete and rebar down to the soil. The drilling and sampling activities occurred the following day, April 16, 1993 at 0840. The activities at SWMU No. 9, as outlined in the FSP (LRL, 1993), consisted of drilling 4 boreholes, collecting 8 surface samples, 32 normal subsurface samples, 8 duplicate subsurface samples and 6 QA/QC samples. Table 7-1 summarizes the field sampling program at SWMU No. 9. Table 7-2 summarizes the various samples collected and analyses performed.



Boring No.	Elevation (ft.)
1	4296.98
2	4297.00
3	4297.11
4	4297.04

N

▲ — Borehole

LRL Sciences, Inc.

SWMU #9
AIRCRAFT WASHRACK DRAIN
CANNON AFB, NEW MEXICO

Project: Cannon AFB RFI	
Contract No: DACA47-93-C-009	
Prepared by: KLH	Date: 10-25-93

Fig. 7-1

Table 7-1.
Summary of Drilling and Sampling
SWMU No. 9 - Aircraft Wash Drain (AWD)

Borehole Number	Sampling Depth (ft.-BGS)	Drilling/ Sampling Methods	Drillrig Used	Borehole Diameter (in.)	Ground Elevation	Date Grouted
1	0	NA/SSS	NA	NA	4296.98	4/16/93
	5.0	HSA/SS	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
	15.0	HSA/SS	CME-75	8.0		
	20.0	HSA/SS	CME-75	8.0		
2	0	NA/SSS	NA	NA		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SS	CME-75	8.0	4297.00	4/16/93
	15.0	HSA/SBC	CME-75	8.0		
	20.0	HSA/SBC	CME-75	8.0		
3	0	NA/SSS	NA	NA	4297.11	4/16/93
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SS	CME-75	8.0		
	15.0	HSA/SS	CME-75	8.0		
	20.0	HSA/SS	CME-75	8.0		
4	0	NA/SSS	NA	NA	4297.04	4/16/93
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
	15.0	HSA/SS	CME-75	8.0		
	20.0	HSA/SS	CME-75	8.0		

HSA = Hollow Stem Auger
HA = Hand Auger
SBC = Split Barrel Continuous Sampler
SS = Split Spoon
SSS = Stainless Steel Spoon

Table 7-2.
Summary of Sampling and Analyses
SWMU No. 9 - Aircraft Wash Drain (AWD)

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
1	0	CAN009-AWD1-021A	N	SOIL	0905	PM	6010/7000S
		CAN009-AWD1-031A	N	SOIL	0905	TCL VOC	8240
	5.0	CAN009-AWD1-011C	N	SOIL	0920	BTEX	8020
		CAN009-AWD1-022C	N	SOIL	0920	PM	6010/7000S
	10.0	CAN009-AWD1-023D	N	SOIL	0930	PM	6010/7000S
		CAN009-AWD1-032D	N	SOIL	0925	TCL VOC	8240
		CAN009-AWD1-821D	QCD	SOIL	0930	PM	6010/7000S
		CAN009-AWD1-831D	QCD	SOIL	0925	TCL VOC	8240
		CAN009-AWD1-721D	QAD	SOIL	0925	PM	6010/7000S
		CAN009-AWD1-731D	QAD	SOIL	1050	TCL VOC	
	15.0	CAN009-AWD1-012E	N	SOIL	0940	BTEX	8020
		CAN009-AWD1-024E	N	SOIL	0940	PM	6010/7000S
	20.0	CAN009-AWD1-013F	N	SOIL	0955	BTEX	8020
		CAN009-AWD1-025F	N	SOIL	0955	PM	6010/7000S

Table 7-2. (Continued)
Summary of Sampling and Analyses
SWMU No. 9 - Aircraft Wash Drain (AWD)

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
2	0	CAN009-AWD2-021A	N	SOIL	1030	PM	6010/7000S
		CAN009-AWD2-031A	N	SOIL	1030	TCL VOC	8240
	5.0	CAN009-AWD2-011C	N	SOIL	1045	BTEX	8020
		CAN009-AWD2-022C	N	SOIL	1045	PM	6010/7000S
	10.0	CAN009-AWD2-023D	N	SOIL	1050	PM	6010/7000S
		CAN009-AWD2-032D	N	SOIL	1050	TCL VOC	8240
		CAN002-AWD2-821D	QCD	SOIL	1050	PM	6010/7000S
		CAN009-AWD2-831D	QCD	SOIL	1050	TCL VOC	8240
		CAN009-AWD2-721D	QAD	SOIL	1050	PM	6010/7000S
		CAN009-AWD2-731D	QAD	SOIL	1050	TCL VOC	8240
	15.0	CAN009-AWD2-012E	N	SOIL	1100	BTEX	8020
		CAN009-AWD2-024E	N	SOIL	1100	PM	6010/7000S
	20.0	CAN009-AWD2-013F	N	SOIL	1110	BTEX	8020
		CAN009-AWD2-025F	N	SOIL	1110	PM	6010/7000S

Table 7-2. (Continued)
Summary of Drilling and Sampling
SWMU No. 9 - Aircraft Wash Drain (AWD)

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
3	0	CAN009-AWD3-021A	N	SOIL	1155	PM	6010/7000S
		CAN009-AWD3-031A	N	SOIL	1155	TCL VOC	8240
	5.0	CAN009-AWD3-011C	N	SOIL	1205	BTEX	8020
		CAN009-AWD3-022C	N	SOIL	1205	PM	6010/7000S
	10.0	CAN009-AWD3-023D	N	SOIL	1215	PM	6010/7000S
		CAN009-AWD3-032D	N	SOIL	1215	TCL VOC	8240
	15.0	CAN009-AWD3-012E	N	SOIL	1226	BTEX	8020
		CAN009-AWD3-024E	N	SOIL	1226	PM	6010/7000S
	20.0	CAN009-AWD3-013F	N	SOIL	1240	BTEX	8020
		CAN009-AWD3-025F	N	SOIL	1240	PM	6010/7000S
4	0	CAN009-AWD4-021A	N	SOIL	1440	PM	6010/7000S
		CAN009-AWD4-031A	N	SOIL	1440	TCL VOC	8240
	5.0	CAN009-AWD4-011C	N	SOIL	1455	BTEX	8020
		CAN009-AWD4-022C	N	SOIL	1455	PM	6010/7000S
	10.0	CAN009-AWD4-023D	N	SOIL	1510	PM	6010/7000S
		CAN009-AWD4-032D	N	SOIL	1510	TCL VOC	8240
	15.0	CAN009-AWD4-012E	N	SOIL	1520	BTEX	8020
		CAN009-AWD4-024E	N	SOIL	1520	PM	6010/7000S
	20.0	CAN009-AWD4-013F	N	SOIL	1530	BTEX	8020
		CAN009-AWD4-025F	N	SOIL	1530	PM	6010/7000S

Table 7-2. (Concluded)
Summary of Sampling and Analyses
SWMU No. 9 - Aircraft Wash Drain (AWD)

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
		CAN009-AWD0-431Z	QC	WATER	1440	TCL VOC	8240
		CAN009-AWD0-321Z	QC	WATER	1535	PM	6010/7000S
		CAN009-AWD0-331Z	QC	WATER	1545	TCL VOC	8240
		CAN009-AWD0-231Z	QC	WATER	1545	TCL VOC	8240
		CAN009-AWD0-621Z	QC	WATER	1535	PM	6010/7000S
		CAN009-AWD0-631Z	QC	WATER	1545	TCL VOC	8240

BTEX = Benzene, Toluene, Ethyl Benzene, Xylene
ft-BGS = feet below ground surface
N = Normal soil sample
PM = Priority metals = 8 TCLP metals + Ni
TCL VOC = Target Compound List Volatile Organic Compound
+ = Metals analyzed using the 7000 Series include: mercury, selenium, and arsenic.

QAD = Duplicate soil sample (analyzed at different laboratory from normal samples).
QCD = Duplicate soil sample analyzed at same laboratory as normal samples.
QC = Quality control water sample (ambient blank, trip blank, etc.)
TAL Metals = Target analyte list metals

7.2.1 Sampling Objectives

Borehole locations, sampling depth, and parameters for analysis were selected, to the greatest extent possible, to determine if a release from the washrack drain or the pipe joints has occurred. The boreholes were moved from the FSP selected locations to avoid the drain and drainline leading to Oil/Water Separator No. 165 (SWMU No. 8). They were also moved closer in toward the drain grill. Borehole locations are shown in Figure 7-1.

7.2.2 Surface and Subsurface Soil Investigation

Four boreholes were drilled at this SWMU using a CME-75 hollow stem auger drill rig. Borehole 1 was drilled 9 feet west of the drain. Borehole 2 was drilled 11 feet 6 inches south of the drain. Borehole 3 was drilled 7 feet east of the drain. Borehole 4 was drilled 7 feet 6 inches northeast of the drain. Drilling was advanced to the depth of 20 feet. Samples were collected at the surface, 5, 10, 15 and 20 feet in depth. A stainless steel spoon was employed for taking surface samples. A split spoon sampler was used for subsurface sample collection except at depths where duplicate samples were also taken. At those depth a split barrel continuous sampler was employed. Samples were collected at discrete depths and locations. No composite samples were taken. Samples were analyzed for BTEX, priority metals and TCL VOC. Duplicates, rinsate blanks, ambient blanks and decontamination water samples were also submitted to the laboratory for this SWMU site.

7.3 Physical Characteristics

This section provides a discussion of the surface water drainage, groundwater, soils, and geology at the Aircraft Wash Drain based on the lithologic descriptions of split barrel continuous samples and other observations from this investigation. Some information was obtained from other published documents.

7.3.1 Surface Water Drainage

A topographic/surface drainage map in addition to text found in Installation Restoration Program Records Search, August 1983, prepared by CH_2M Hill indicates that surface water drainage in the vicinity of this SWMU is directed topographically and through a series of ditches to Stormwater Collection Point (SWMU No. 85). SWMU No. 85 is an ephemeral lake basin (playa) located in the southwest corner of the base. Stormwater can also enter the pad drain which flows to SWMU No. 85.

7.3.2 Groundwater

Depth to groundwater at Cannon AFB is approximately 250 feet or greater. Groundwater recharge rates for the High Plains Region are typically low. Localized recharge rates for Curry County range from 0.75 - 12.22 mm/yr (Stone, 1985). EPA, 1987 DRASTIC reports recharge rates of 1 in/yr. Section 1.4.3.5 of this report includes a discussion of groundwater hydrology for Cannon AFB.

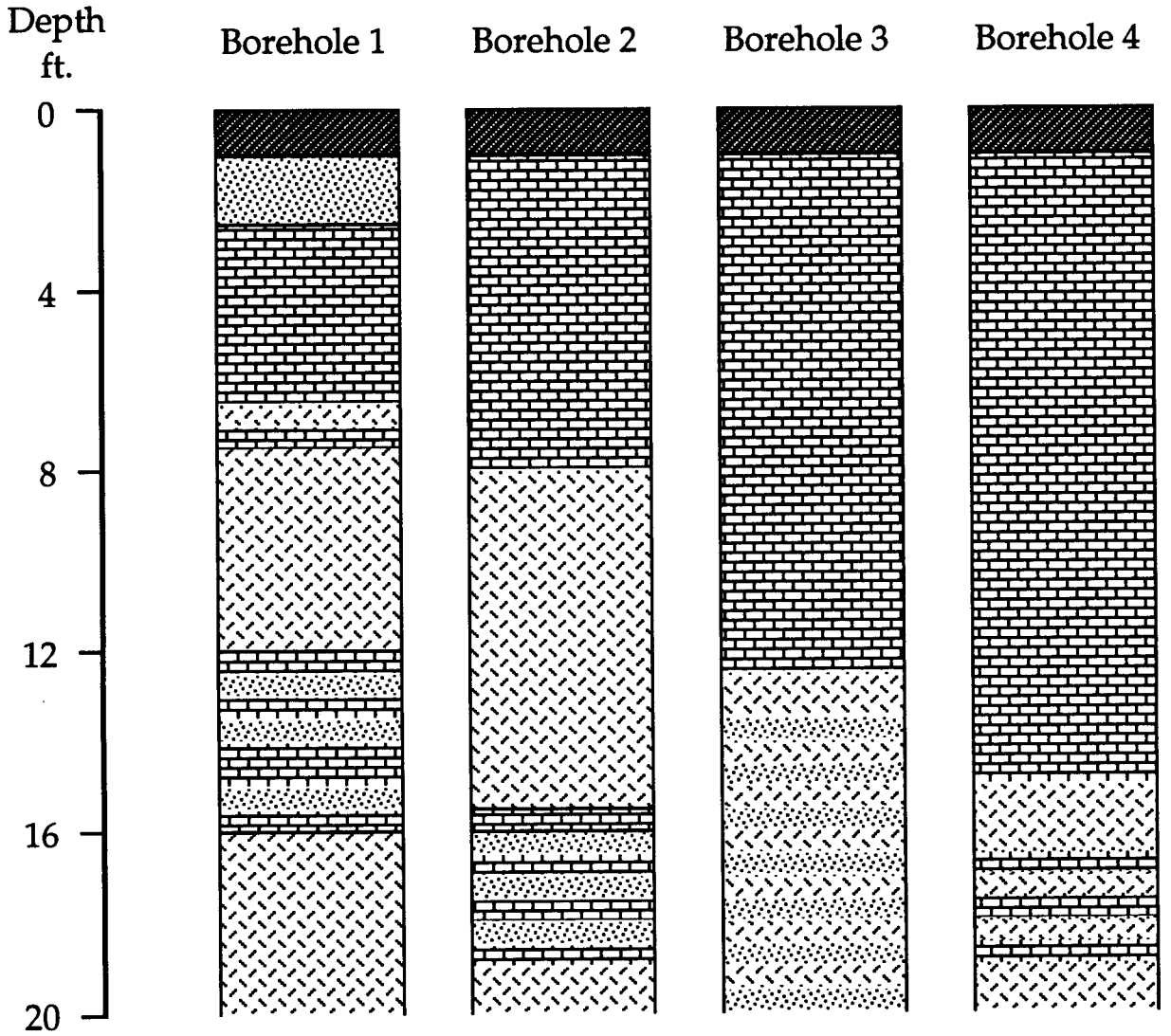
7.3.3 Soils and Geology

The near surface (upper twenty feet) stratigraphy in the area surrounding the aircraft washrack drain system consist of Tertiary Miocene to Pliocene fluvial deposits of the Ogallala Formation. The soils have been described as a fine sandy loam (Ab) of the Amarillo soil group (USDA, 1993). Interpretations and correlation on the fluvial deposits for this area are based on split spoon samples collected during the drilling process. The soils consist of very fine to fine-grained, moderate to well sorted, immature to submature (textural), unconsolidated, calcareous, reddish brown to tan, clays, silts, and sands. Thin to moderately thin layers of caliche material were interbedded throughout much of the samples collected. The sands were comprised of angular to subangular grains with varying amounts of silts, clays, and calcium carbonate (caliche) material. This description of lithology (Figure 7-2) is simliar to the description of soils given by the USDA Draft Soil Survey, 1993. The thickness of this particular unit remains unknown, due to the fact that boring levels did not exceed twenty feet. The total thickness of the Ogallala Formation beneath the aircraft drain system is not presently known, but regional information based on Curry County reports have suggested thicknesses of approximately 320-400 feet. No groundwater was encountered while drilling at these four borehole locations. The minimum depth of the High Plains aquifer is reported to be greater than 250 feet below ground surface.

7.4 Nature and Extent of Contamination

7.4.1 Volatile Organic Compounds

A series of HNU meter readings were taken in the well head and in the breathing zone for each borehole for worker safety purposes. Well head readings were positive for all boreholes, particularly boreholes 1 and 2, ranging from 0.2 - 480 ppm (Table 7-3). A single reading of 4.0 occurred in the breathing zone of borehole 1. Due to the high HNU readings for boreholes 1 and 2, modified level C personal protection was employed in the immediate area of boreholes 1 and 2.



LEGEND

- Asphalt
- Sand
- Clay
- Caliche

LRL Sciences, Inc.

SWMU #9
STRATIGRAPHIC COLUMN
CANNON AFB, NEW MEXICO

Project: Cannon AFB RFI	
Contract No: DACA47-93-C-009	
Prepared by: KLL	Date: 10-25-93

Fig. 7-2

Table 7-3.
HNU Meter* Readings (PPM) in Borehole Headspace
SWMU No. 9 - Aircraft Washrack Drain System

DATE: 4/16/93							
TIME	BH1	TIME	BH2	TIME	BH3	TIME	BH4
0900	4.2	1036	40.0	1150	1.0	1440	9.0
0905	80.0	1039	30.0	1155	0.8	1445	10.0
0910	40.0	104.3	0.0	1210	0.0	1455	2.0
0930	22.0	1052	2.0	1220	0.0	1459	0.4
0945	1.0	1053	0.0	1255	0.0	1507	0.2
0958	1.6	1101	0.0			1529	3.0
1013	480.0						

* Model: 101, Type: OVA PID, Make: HNU

Samples were collected from all four boreholes, at the surface and at 10 feet, and analyzed for Target Compound List Volatile Organic Compounds (TCL VOC). Following are the results of these analyses:

7.4.1.1 Borehole 1

In borehole 1, acetone and tetrachloroethene were detected in the surface sample (CAN009-AWD1-031A) at 28 μg/kg and 14 μg/kg respectively (Table 7-4). Xylene was also detected below the CRQL but rejected due to co-elution with unknown contaminants. TIC compounds were also detected.

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Table 7-4.
Concentration (μg/kg) of Volatile Organic Compounds
SWMU No. 9 - Aircraft Washrack Drain System

Borehole Number	Cannon Number	Depth (ft.)	Chemical			
			Toluene	Acetone	Xylene	Tetrachloro ethene
1	CAN009-AWD1-031A	Surface	11U	28	R	14
	CAN009-AWD1-032D	10.0	12U	12U	12U	12U
2	CAN009-AWD2-031A	Surface	56U	56U	56U	56U
	CAN009-AWD2-032D	10.0	11U	16	11U	11U
	CAN009-AWD2-831D			11U (QCD)		
3	CAN009-AWD3-031A	Surface	58U	250	58U	58U
	CAN009-AWD3-032D	10.0	11U	R	11U	11U
4	CAN009-AWD4-031A	Surface	43J	170	52J	58U
	CAN009-AWD4-032D	10.0	11U	11U	11U	11U

Duplicate samples or laboratory repeat samples are presented only if they are different from the original sample and not rejected.

J = estimate
R = rejected
U = not detected at CRQL
UJ = estimated as non-detect at CRQL
QCD = duplicate analyzed at the same lab as the normal sample.

At 10 feet no target compounds were detected. TIC compounds were detected but rejected since there was no correlation between these data and the QA/QC duplicates also collected at this depth. The QC duplicate, which was analyzed at the same lab as the normal sample, contained no target compounds and no TIC compounds. The QA duplicate, which was analyzed at a different lab than the normal sample, contained acetone and methylene chloride. These two analytes appear in nearly all the samples from the QA lab and and have been rejected as laboratory contaminants. There were no TIC compounds detected.

7.4.1.2 Borehole 2

In borehole 2, no target compounds were detected in the surface sample but TIC compounds were present.

Acetone was detected at 16 μg/kg in the sample collected at 10 feet (CAN009-AWD2-032D) but did not appear in the QC duplicate. The QA duplicate contains both acetone and methylene chloride, however, due to the prevalence of these two compounds at the QA laboratory, they were considered laboratory contaminants. The 10 foot sample contained one TIC compound

which was rejected since no TIC compounds were detected in either the QC duplicate or the QA duplicate.

7.4.1.3 Borehole 3

In borehole 3, acetone was detected in the surface sample (CAN009-AWD3-031A) at 250 μg/kg. TIC compounds were also detected.

At 10 feet acetone was detected but rejected due to co-elution of some contaminant. No TIC compounds were detected.

7.4.1.4 Borehole 4

In borehole 4, acetone was detected at 170 μg/kg in the surface sample (CAN009-AWD4-031A). Toluene and xylene were also detected below the CRQL. TIC compounds were detected.

At 10 feet no target compounds or TIC compounds were detected.

7.4.2 BTEX

In each borehole two samples were collected for BTEX analysis. Samples were collected at 5 and 10 feet of depth. No BTEX compounds were detected in any of the samples. QA/QC BTEX duplicates were not collected and therefore not analyzed.

7.4.3 Priority Metals

Total metals concentrations, using the RCRA SW-846 test methods for the analysis of metals in soils, were determined for the eight TCLP metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) plus nickel. These are the priority metals. Samples were collected for priority metals analysis at the surface, 2.5, 5, and 10 feet.

In the following presentation of metals results, only metals concentrations in excess of background concentrations are presented. No background data was collected for this investigation, therefore, background concentrations were taken from Concentrations of Selected Naturally Occurring Chemical Constituents in Soil and Groundwater at Cannon Air Force Base Clovis, New Mexico, March 1993 prepared by Woodward-Clyde. For a discussion of Woodward-Clydes background data see Section 1.7.

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7.4.3.1 Borehole 1

In the surface sample (CAN009-AWD1-021A), barium was detected at 840 mg/kg but was qualified as an estimate due to lack of agreement with the laboratory duplicate (Table 7-5). The chromium concentration was 19.5 mg/kg but was qualified as an estimate since the ICP Serial Dilution %D was outside control limits. Background concentrations for barium and chromium are 642 mg/kg and 12.5 mg/kg respectively.

The sample collected at 5 feet contained no metals in excess of the background concentrations.

The sample collected at 10 feet (CAN009-AWD1-023D) contained barium above background at 1380 mg/kg. This value was qualified as an estimate since it was not in agreement with the laboratory duplicate. The QC/QA field duplicate samples were also collected at this depth. The QC field duplicate concentration for barium did not exceed the background concentration but the QA field duplicate (CAN009-AWD1-721D) did at 1240 mg/kg. Background concentration for barium is 642 mg/kg.

The samples collected at 15 feet and 20 feet contained no metals in excess of the background concentrations.

7.4.3.2 Borehole 2

The surface sample (CAN009-AWD2-021A) contained chromium above background at 22.3 mg/kg. This value is an estimate because the ICP Serial Dilution %D exceeded control limits.

The samples collected at 5, 10, 15 and 20 feet contained no metals in excess of the background concentrations. The QC and the QA field duplicates, both taken at 10 feet, also contained no metals in excess of the background concentrations.

7.4.3.3 Borehole 3

The surface sample (CAN-009-AWD3-021A) contained nickel at 10.5 mg/kg and chromium at 17.7 mg/kg. The chromium concentration is an estimate because the ICP Serial Dilution %D exceeded the control limits. The background concentration for nickel is 9.0 mg/kg and for chromium, 12.5 mg/kg.

The samples collected at 5, 10, 15, and 20 feet contained no metals in excess of the background concentrations.

7.4.3.4 Borehole 4

The surface sample (CAN009-AWD4-021A) contained nickel at 10.0 mg/kg and chromium at 26.9 mg/kg. The chromium concentration is an estimate because the ICP Serial Dilution %D exceeded the control limits.

Table 7-5
Concentration (mg/kg) of Priority Metals
SWMU No. 9 - Aircraft Wash Drain System

Boring Number	Sample Number (CAN009-AWD)	Sample Depth (Feet)	Barium		Chromium		Nickel
1	1-021A	0	**840**	J	19.5	J	5.9
	1-022C	5	161	J	8.1	J	7.3
	1-023D	10	1380	J	3.2	J	3.6
(QAD)	1-721D	10	1240		5		4.5
(QCD)	1-821D	10	181	J	5.8	J	5.1
	1-024E	15	100	J	7.3	J	6.8
	1-025F	20	97.7	J	4.3	J	3
2	2-021A	0	623	J	22.3	J	7.7
	2-022C	5	149	J	11.3	J	8.4
	2-023D	10	256	J	5.6	J	5.9
(QAD)	2-721D	10	207		7.5		5.8
(QCD)	2-821D	10	171	J	6.1	J	6.4
	2-024E	15	99.4	J	8	J	6.5
	2-025F	20	532	J	5.8	J	4.8
3	3-021A	0	603	J	17.7	J	10.5
	3-022C	5	220	J	5.1	J	6.1
	3-023D	10	274	J	5.3	J	5.7
	3-024E	15	184	J	7.2	J	6.7
	3-025F	20	253	J	5.9	J	4.3
4	4-021A	0	457	J	26.9	J	10
	4-022C	5	215	J	13.1	J	8.5
	4-023D	10	820	J	5.1	J	4.4
	4-024E	15	86.7	J	8	J	7.4
	4-025F	20	55.6	J	6.1		4.3
Background (95% UCL) (1)			642.00		12.50		9.00

Notes:

Duplicate samples (QAD) or (QCD) samples are presented only if they are different from the original sample and not rejected.

U indicates that the compound was analyzed for, but not detected at or above the standard limit.
J indicates an estimated value.
UJ indicates the compound was analyzed for but not detected. The sample quantification limit or reported detection limit is an estimated quantity.
* R indicates that the data was rejected because of quality control measures

Boldface indicates a detection above the 95% UCL background level

Only data for metals detected above background is presented

(1) Background data is described in Section 17.0.

The sample collected at 5 feet (CAN009-AWD4-022C), contained chromium at 13.1 mg/kg. This value is an estimate since the ICP Serial Dilution %D exceeded the control limits.

The sample collected at 10 feet (CAN009-AWD4-023D) contained barium above background at 820 mg/kg. This value is an estimate since it was not in agreement with the laboratory duplicate.

At 15 and 20 feet no priority metals were detected above background.

7.4.4 Summary

Several organics and metals occur in one or more of the surface samples of all four boreholes (acetone, tetrachloroethane, toluene, xylene, chromium, nickel and barium). Barium, chromium and acetone occurred again at 5 to 10 feet. Below 10 feet, no metals were detected above background.

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8.0 OIL/WATER SEPARATOR (SWMU NO. 11/SITE NO. 170)

8.1 SWMU Description

8.1.1 Setting

Oil/Water Separator No. 170 is located on the west side of Building 170. The separator is a 3-compartment underground unit, with a 700 gallon main compartment and a 280 gallon oil compartment. The unit is constructed of concrete. The opening to the separator is surrounded on all sides by asphalt. Borehole locations were selected, in part, to avoid underground utilities and the building. Figure 8-1 shows the SWMU setting and borehole locations. The driller was required to penetrate asphalt and restore the surface with concrete plugs.

8.1.2 History of Use

This oil/water separator was active from 1963 until 1989. The recovered oils were directed to the 280 gallon holding tank and the waste water is dischared to the Sanitary Sewer Line (SWMU No. 98) which ultimately discharged into one of two sewage lagoons (SWMU Nos. 101 and 102). The unit received wash water generated from aircraft maintenance operations, which contained petroleum, synthetic lubricating oils and dirt.

8.1.3 Past Investigations

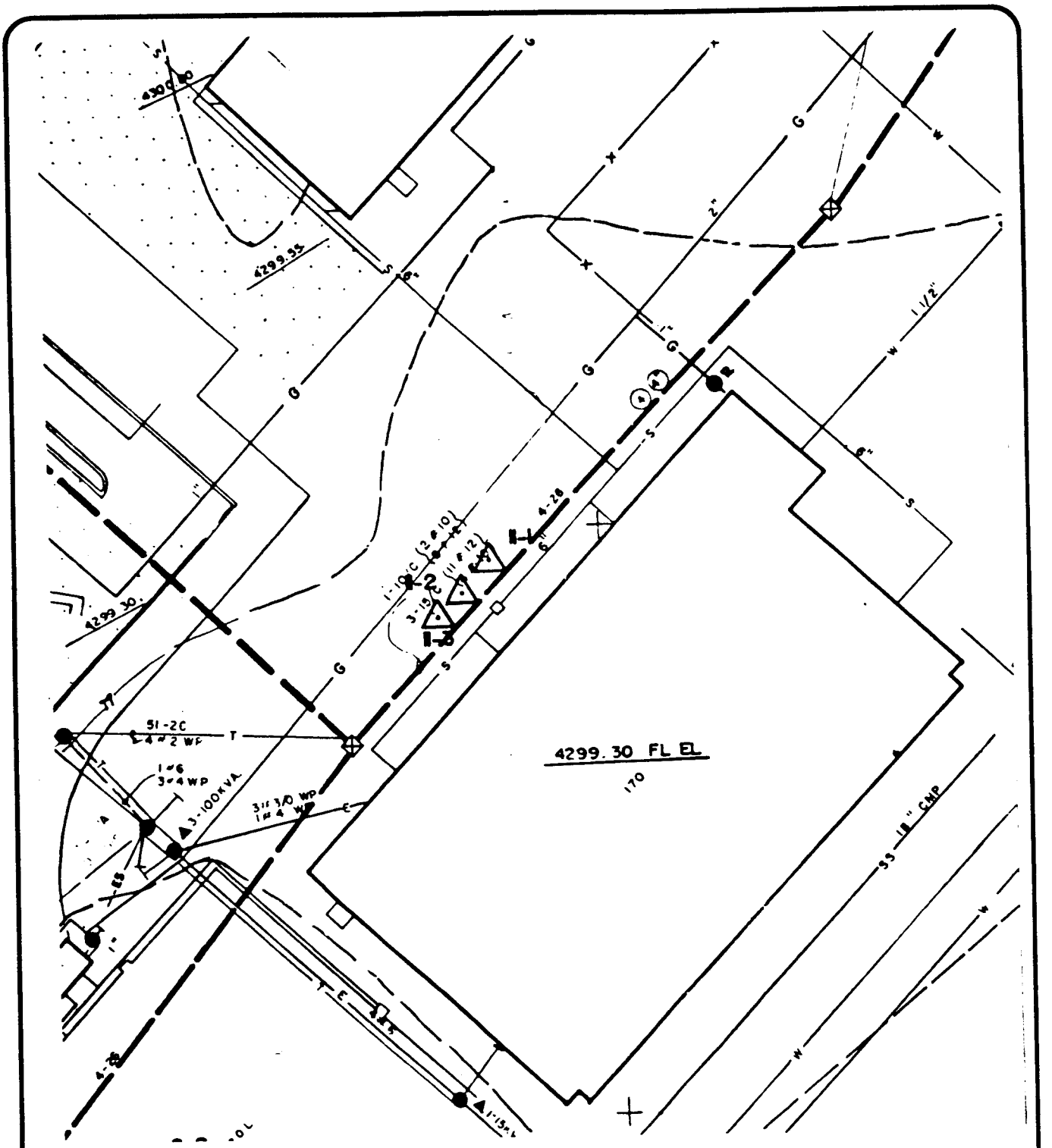
This oil/water separator was not included in a 1988 study conducted by the Tulsa District Corps of Engineers which sampled the influent and effluent of a number of oil/water separators at Cannon Air Force Base. Therefore no previous data is available.

8.1.4 Land Use and Demography

This SWMU is located in an area of the base which is commonly used by base personnel. However, the separator has been removed and the area is currently covered by asphalt.

8.2 Field Investigation

Drilling and sampling activities at this SWMU occurred April 12, 1993 at 0820. The activities at SWMU No. 11 as outlined in the FSP (LRL, 1993) consisted of drilling 3 boreholes, and collecting 6 surface samples, 18 subsurface samples, 4 QA/QC duplicate samples and 6 QA/QC water samples. Table 8-1 summarizes the drilling and sampling methods, along with sampling frequency conducted at SWMU 11. Table 8-2 summarizes the various samples collected and analyses performed.



▲ — Borehole

Boring No.	Elevation (ft.)
1	4298.81
2	4298.76
3	4298.76

N

LRL Sciences, Inc.

SWMU #11
OIL/WATER SEPARATOR - 170
CANNON AFB, NEW MEXICO

Project: Cannon AFB RFI	
Contract No: DACA47-93-C-009	
Prepared by: KLH	Date: 10-25-93

Fig. 8-1

Table 8-1.
Summary of Drilling and Sampling
SWMU No.11 - Oil/Water Separator No. 170

Borehole Number	Sampling Depth (ft.-BGS)	Drilling/ Sampling Methods	Drillrig Used	Borehole Diameter (in.)	Ground Elevation	Date Grouted
1	0	NA/SSS	NA	NA	4298.81	4/14/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
2	0	NA/SSS	NA	NA	4298.76	4/14/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
3	0	NA/SSS	NA	NA	4298.76	4/14/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		

HSA = Hollow Stem Auger
HA = Hand Auger
SBC = Split Barrel Continuous Sampler
SS = Split Spoon
SSS = Stainless Steel Spoon

Table 8-2.
Summary of Sampling and Analyses
SWMU No. 11 - Oil/Water Separator No. 170

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
1	0	CAN011-1701-021A	N	SOIL	0940	PM	6010\7000S+
		CAN011-1701-031A	N	SOIL	0940	TCL VOC	8240
	2.5	CAN011-1701-011B	N	SOIL	0950	BTEX	8020
		CAN011-1701-022B	N	SOIL	0950	PM	6010\7000S
	5.0	CAN011-1701-012C	N	SOIL	1007	BTEX	8020
		CAN011-1701-023C	N	SOIL	1007	PM	6010\7000S
	10.0	CAN011-1701-024D	N	SOIL	1005	PM	6010\7000S
		CAN011-1701-032D	N	SOIL	1005	TCL VOC	8240
		CAN011-1701-821D	QCD	SOIL	1005	PM	6010\7000S
		CAN011-1701-831D	QCD	SOIL	1005	TCL VOC	8240
		CAN011-1701-721D	QAD	SOIL	1005	PM	6010\7000S
		CAN011-1701-731D	QAD	SOIL	1005	TCL VOC	8240
2	0	CAN011-1702-021A	N	SOIL	1025	PM	6010\7000S
		CAN011-1702-031A	N	SOIL	1025	TCL VOC	8240
	2.5	CAN011-1702-011B	N	SOIL	1035	BTEX	8020
		CAN011-1702-022B	N	SOIL	1035	PM	6010\7000S
	5.0	CAN011-1702-012D	N	SOIL	1045	BTEX	8020
		CAN011-1702-023D	N	SOIL	1045	PM	6010\7000S
	10.0	CAN011-1702-024D	N	SOIL	1047	PM	6010\7000S
		CAN011-1702-032D	N	SOIL	1047	TCL VOC	8240

Table 8-2. (Concluded)
Summary of Sampling and Analyses
SWMU No. 11 - Oil/Water Separator No. 170

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
3	0	CAN011-1703-021A	N	SOIL	1105	PM	6010\7000S
		CAN011-1703-031A	N	SOIL	1105	TCL VOC	8240
	2.5	CAN011-1703-011B	N	SOIL	1115	BTEX	8020
		CAN011-1703-022B	N	SOIL	1115	PM	6010/7000S
	5.0	CAN011-1703-012D	N	SOIL	1020	BTEX	8020
		CAN011-1703-023D	N	SOIL	1025	PM	6010\7000S
	10.0	CAN011-1703-024D	N	SOIL	1027	PM	6010\7000S
		CAN011-1703-032D	N	SOIL	1023	TCL VOC	8240
		CAN011-1700-431Z	QC	WATER	1015	TCL VOC	8240
		CAN011-1700-321Z	QC	WATER	1150	PM	6010\7000S
		CAN011-1700-331Z	QC	WATER	1145	TCL VOC	8240
		CAN011-1700-231Z	QC	WATER	1147	TCL VOC	8240
		CAN011-1700-621Z	QC	WATER	1150	PM	6010\7000S
		CAN011-1700-631Z	QC	WATER	1150	TCL VOC	8240

BTEX = Benzene, Toluene, Ethyl Benzene, Xylene
ft-BGS = feet below ground surface
N = Normal soil sample
PM = Priority metals = 8 TCLP metals + Ni
TCL VOC = Target Compound List Volatile Organic Compounds
+ = Metals analyzed using the 7000 Series include: mercury, selenium, and arsenic.

QAD = Duplicate soil sample (analyzed at different laboratory from normal samples).
QCD = Duplicate soil sample analyzed at same laboratory as normal samples.
QC = Quality control water sample (ambient blank, trip blank, etc.)
TAL Metals = Target analyte list metals

8.2.1 Sampling Objectives

Borehole locations, sampling depth, and parameters for analysis were selected, to the greatest extent possible, to determine if a release from the oil/water separator has occurred. Borehole locations were changed from the original FSP locations in order to avoid the sewer line and the building. ? shows the borehole locations.

8.2.2 Surface and Subsurface Soil Investigation

Three boreholes were drilled at this SWMU. Borehole 1 was drilled to the north of the separator. Borehole 2 was drilled to the northwest of the separator. Borehole 3 was drilled to the west of the separator. Drilling was advanced to a depth of 10 feet. Samples were collected at the surface, 2.5, 5 and 10 feet in depth. Surface samples were collected with a stainless steel trowel. Subsurface samples were collected using a split barrel continuous sampler. Samples were collected at discrete depths and locations. No composite samples were taken. Samples were analyzed for BTEX, priority metals and TCL VOC. Duplicates, rinsate blanks, ambient blanks and decontamination water samples were also submitted to the laboratory for this SWMU site.

8.3 Physical Characteristics

This section provides a discussion of the surface water drainage, groundwater, soils and geology at the No. 170 oil/water separator based on a review of information from previous investigations at Cannon AFB and from the lithologic descriptions from a split barrel continuous sampler.

8.3.1 Surface Water Drainage

A topographic/surface drainage map in addition to text found in Installation Restoration Program Records Search, August 1983 prepared by CH_2M Hill indicates that surface water drainage in the vicinity of SWMU No. 11 is directed topographically and through a series of ditches to Stormwater Collection Point (SWMU No. 85). SWMU No. 85 is an ephemeral lake basin (playa) located in the southwest corner of the base.

8.3.2 Groundwater

Depth to groundwater at Cannon AFB is approximately 250 feet or greater. Groundwater recharge rates for the High Plains Region are typically low. Localized recharge rates for Curry County range from 0.75 - 12.22 mm/yr (Stone, 1985). EPA, 1987 DRASTIC reports recharge rates of 1 in/yr. Section 1.4.3.5 of this report includes a discussion of groundwater hydrology for Cannon AFB.

8.3.3 Soils and Geology

The near surface (upper ten feet) stratigraphy in the area surrounding this SWMU consist of Tertiary Miocene to Pliocene fluvial deposits of the Ogallala Formation. The soils have been described as a fine sandy loam (Ab) of the Amarillo soil group (USDA draft "Soil Survey"

1993). Interpretations and correlation on the fluvial deposits for this area are based on split spoon samples collected during the drilling process. The soils consist of very fine to fine-grained, moderate to well sorted, submature to mature (textural), unconsolidated, calcareous, red to dark red, clays, silts, and sand. Thin to moderately thin layers and nodules of caliche material were interbedded throughout much of the samples collected. The sands were comprised of angular to subangular grains with varying amounts of silts, clays, and calcium carbonate (caliche) material. This description of lithology (Figure 8-2) is simuliar to the description of soils given by the USDA Draft Soil Survey, 1993. The thickness of this particular unit remains unknown, due to the fact that boring levels did not exceed ten feet. The total thickness of the Ogallala Formation beneath this SWMU is not presently known, but regional information based on Curry County reports have suggested thicknesses of approximately 320-400 feet. No groundwater was encountered while drilling at these three borehole locations. The minimum depth of the High Plains aquifer is reported to be greater than 250 feet below ground surface.

8.4 Nature and Extent of Contamination

8.4.1 Volatile Organic Compounds

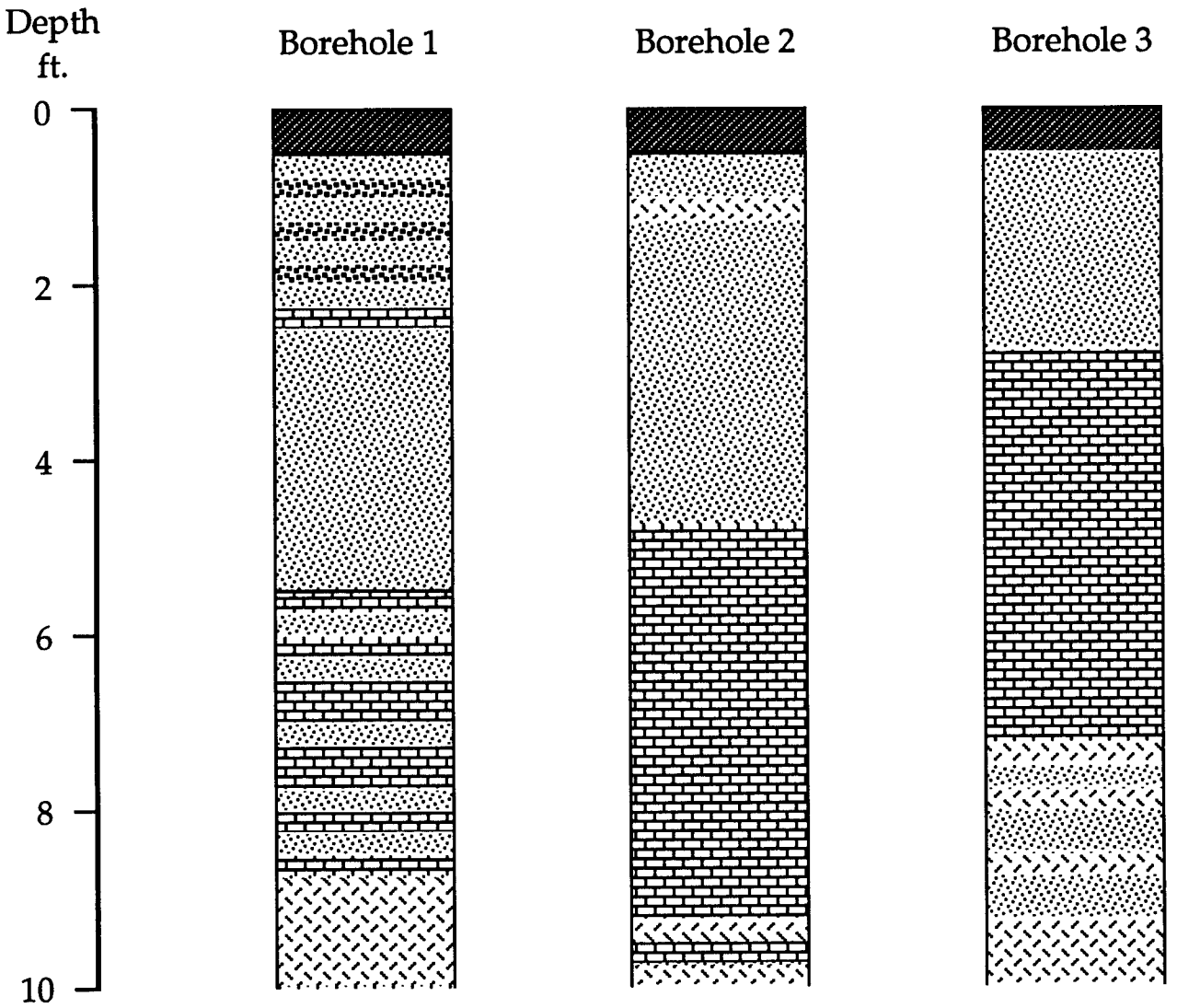
A series of HNU meter readings were taken in the well head and in the breathing zone of each borehole for worker safety purposes. In all three boreholes there were some positive readings in the wellhead ranging from 0.0 to 6.0 ppm (Table 8-3). All readings from the breathing zone were 0.0.

Table 8-3.
HNU Meter* Readings (PPM) in Borehole Headspace
SWMU No. 11 - Oil/Water Separator No. 170

DATE: 4/12/93					
TIME	BH1	TIME	BH2	TIME	BH3
0943	5.0	1026	5.0	1105	6.0
0948	0.0	1035	6.0	1109	1.0
1003	0.5	1041	2.0	1117	0.0
1008	1.5	1053	2.0		

* Model: 101, Type: OVA PID, Make: HNU

Samples were collected from all four boreholes, at the surface and at 10 feet, and analyzed for Target Compound List Volatile Organic Compounds (TCL VOC). Following are the results of these analyses.



LEGEND

- Asphalt
- Gravel
- Sand
- Clay
- Caliche

LRL Sciences, Inc.

SWMU 11
STRATIGRAPHIC COLUMN
CANNON AFB, NEW MEXICO

Project: Cannon AFB RFI	
Contract No: DACA47-93-C-009	
Prepared by: KLH	Date: 10-25-93

Fig. 8-2

8.4.1.1 Borehole 1

In borehole 1, the surface sample and a laboratory repeat analysis of the surface sample yielded no target compounds. However, both samples contained TIC compounds.

At 10 feet, no target compounds or TIC compounds were detected. QA and QC duplicate samples were taken in association with this sample. The QC duplicate, which was analyzed at the same lab did not contain target or TIC compounds. The QA sample, analyzed at another lab, contained acetone, methylene chloride and 2-butanone. The prevalence of methylene chloride and acetone in nearly all the QA lab samples suggests that they are laboratory contaminants. Therefore, they have been rejected. 2-butanone was also rejected since it is a common laboratory contaminant and since there were no detections of this compound at the QC lab.

8.4.1.2 Borehole 2

In borehole 2, methylene chloride was detected in the surface sample (CAN011-1702-031A) but was qualified as an estimate since the value was below the CRQL (Table 8-4). Acetone was detected but qualified as a non-detect since it also appeared in the method blank. TIC compounds were detected.

At 10 feet (CAN011-1702-032D), methylene chloride was detected below the CRQL. No TIC compounds were detected.

Table 8-4.
Concentration (μg/kg) of Volatile Organic Compounds
SWMU No. 11 - Oil/Water Separator No. 170

Borehole Number	Cannon Number	Depth (ft.)	Chemical	
			Toluene	Methylene Chloride
1	CAN011-1701-031A	Surface	58U	58U
	CAN011-1701-032D	10.0	11U	11U
2	CAN011-1702-031A	Surface	11U	6J
	CAN011-1702-032D	10.0	10U	6J
3	CAN011-1703-031A	Surface	13	11U
	CAN011-1703-032D	10.0	11U	11U

Duplicate samples or laboratory repeat samples are presented only if they are different from the original sample and not rejected.
J = estimate
R = rejected
U = not detected at CRQL
UJ = estimated as non-detect at CRQL

8.4.1.3 Borehole 3

In borehole 3, the surface sample (CAN011-1703-031A) contained toluene at 13 μg/kg. This sample also contained TIC compounds.

At 10 feet, no target or TIC compounds were detected.

8.4.2 BTEX

In each borehole, 2 samples were collected for BTEX analysis at 2.5 and 10 feet of depth. No BTEX compounds were detected in any of the samples. QA/QC duplicate samples were not collected and therefore QA/QC BTEX analyses were not performed.

8.4.3 Priority Metals

Total metals concentrations, using the RCRA SW-846 test methods for the analysis of metals in soils, were determined for the eight TCLP metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) plus nickel. These are the priority metals. Samples were collected for priority metals analysis at the surface, 2.5, 5, and 10 feet.

In the following presentation of metals results, only metals concentrations in excess of background concentrations are presented. No background data was collected for this investigation, therefore, background concentrations were taken from Concentrations of Selected Naturally Occurring Chemical Constituents in Soil and Groundwater at Cannon Air Force Base Clovis, New Mexico, March 1993 prepared by Woodward-Clyde. For a discussion of Woodward-Clydes background data see Section 1.7.

8.4.3.1 Borehole 1

No metals were detected above background in the surface sample.

At 2.5 feet (CAN011-1701-022B) nickel was detected at 9.6 mg/kg (Table 8-5). The background value for nickel is 9.0 mg/kg.

At 5 and 10 feet no metals were detected above the background level. The QA and QC duplicates were collected at 10 feet. The QA duplicate (CAN011-1701-721D), which was analyzed at a different lab from the normal sample, contained mercury above background at 0.26 mg/kg.

Table 8-5
Concentration (mg/kg) of Priority Metals
SWMU No. 11 - Oil/Water Separator No. 170

Boring Number	Sample Number (CAN011-170)	Sample Depth (Feet)	Chromium		Mercury		Nickel	
1	1-021A	0	14.3	UJ	0.02	U	4.9	J
	1-022B	2.5	11.1	UJ	0.02	U	**9.6**	
	1-023C	5	5.3	UJ	0.02	U	4.5	J
	1-024D	10	6.7	UJ	0.1	U	4.6	J
(QAD)	1-721D	10	5.3		**0.26**		4.7	
(QCD)	1-821D	10	5.1	UJ	0.01	U	4.2	J
2	2-021A	0	9.2	UJ	0.03	U	5.2	J
	2-022B	2.5	8.4	UJ	0.02	U	**9.6**	J
	2-023C	5	5.6	UJ	0.02	U	3.6	J
	2-024D	10	3.7	UJ	0.03	U	3.2	
3	3-021A	0	15.1	UJ+	0.02	U	7.3	J
	3-022B	2.5	8	UJ	0.1	U	**10.6**	J
	3-023C	5	3.1	UJ	0.01	U	5.1	J
	3-024D	10	1.1	UJ	0.01	U	3.8	J
Background (95% UCL) (1)			12.50		0.13		9.00	

Notes:

Duplicate samples (QAD) or (QCD) samples are presented only if they are different from the original sample and not rejected.

U indicates that the compound was analyzed for, but not detected at or above the standard limit.
J indicates an estimated value.
UJ indicates the compound was analyzed for but not detected. The sample quantification limit or reported detection limit is an estimated quantity.
* R indicates that the data was rejected because of quality control measures

Boldface indicates a detection above the 95% UCL background level

Only data for metals detected above background is presented
(1) Background data is described in Section 17.0.

8.4.3.2 Borehole 2

No metals were detected above background levels in the surface sample.

At 2.5 feet (CAN011-1702-022B), nickel was detected at 9.6 mg/kg.

At 5 and 10 feet, no metals were detected above the background level.

8.4.3.3 Borehole 3

No metals were detected above background levels in the surface sample.

At 2.5 feet (CAN011-1703-022B), nickel was detected at 10.6 mg/kg. This value is an estimate since the matrix spike recovery was was not within control limits.

At 5 and 10 feet, no metals were detected above background levels.

8.4.4 Summary

TIC compounds were detected in the surface sample of all three boreholes. At the surface of borehole 2, methylene chloride was detected. At the surface of borehole 3, toluene was detected. No metals were detected above background at the surface. Nickel occurred at 2.5 feet in all three boreholes. Mercury and methylene chloride were identified at 10 feet.

DRAFT

9.0 OIL/WATER SEPARATOR (SWMU NO. 16/SITE NO. 680)

9.1 SWMU Description

9.1.1 Setting

The oil/water separator No. 680 was located on the southeast corner of building 680. The separator was a three compartment underground unit, with a skimmer, a 584 gallon main compartment and a 140 gallon oil compartment. The unit was constructed of concrete. The separator was excavated in 1991 during building renovations and the area is now inside a garage covered by concrete. A new unit sits approximately 15 feet to the east of this SWMU. Outside to the southeast of the corner of the building, a hand auger was used for drilling and sample collection due to a concentration of underground and overhead utility lines. Although the original locations of the boreholes, as planned in the FSP, included a borehole inside the garage, information provided by Cannon AFB engineers indicated that this SWMU was originally either under the rear wall of the building or ouside of it. Therefore, all boreholes were drilled outside. Figure 9-1 shows the setting and borehole locations.

9.1.2 History of Use

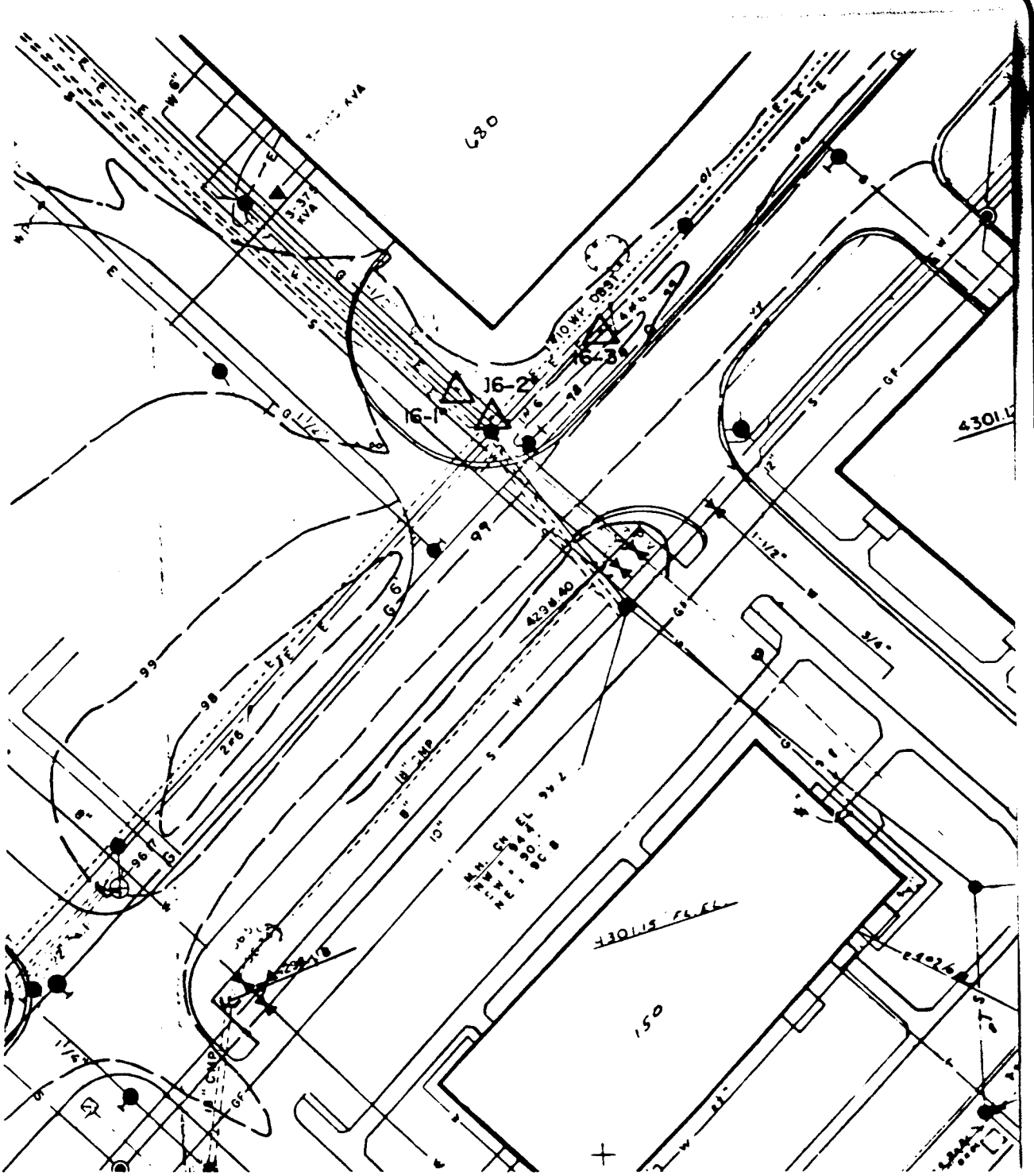
Oil/water separator No. 680 was active from 1965 to 1991 and was excavated in April 1991. While in use, the recovered oils were directed to the 140 gallon holding tank and the waste water was discharged to the Sanitary Sewer Line (SWMU No. 98). Historically, the facility discharging into the separator was used for washing aircraft and maintenance operations. Aircraft fuels and fluids were disposed in accordance with the base waste generation reporting procedures.

9.1.3 Past Investigations

In 1987-1988 the Tulsa District Corps of Engineers conducted a study of a number of oil/water separators on the base. The results of analyses performed on the influent and effluent from this separator are found in Cannon Air Force Base Oil/Water Separators Sampling and Analytical Report, June 1988. The following compounds were present in the influent and/or effluent of this separator: 4-methyl-2-pentanone, naphthalene, 2-methylnaphthalene, xylene, lead, nickel bis(2-ethylhexyl)phthalate, 1,4-dichlorobenzene, 4-methylphenol.

9.1.4 Land Use and Demography

This SWMU is in an area of the base commonly used by base personnel. This separator has been removed and the area is covered partially by a wall of the building and partially by grass.



▲ — Borehole

Boring No.	Elevation (ft.)
1	4302.10
2	4301.63
3	4300.86

N

LRL Sciences, Inc.

SWMU #16
OIL/WATER SEPARATOR - 680
CANNON AFB, NEW MEXICO

Project: Cannon AFB RFI	
Contract No: DACA47-93-C-009	
Prepared by: KLH	Date: 10-25-93

Fig. 9-1

9.2 Field Investigation

Activities at SWMU No. 16 began April 10, 1993 beginning at 0805. Due to the density of buried utilities and overhead wires, a hand auger was employed for drilling. The activities at this SWMU consisted of hand augering 3 boreholes and collecting 6 surface samples, 18 normal subsurface samples, 4 QA/QC duplicate samples and 6 QA/QC water samples. Table 9-1 summarizes the field sampling program at SWMU 16. Table 9-2 summarizes the various samples collected and analyses performed.

9.2.1 Sampling Objectives

Borehole locations, sampling depth, and parameters for analysis were selected, to the greatest extent possible, to determine if a release from the oil/water separator has occurred. Boreholes 1 and 2 were moved from the original FSP locations in order to accomodate the location, as recalled by base engineers, of the former oil/water separator. Borehole locations are shown in ?.

9.2.2 Surface and Subsurface Soil Investigation

Borehole 1 was augered to the west of the former separator. Borehole 2 was augered to the southwest of the former separator and borehole 3 was augered to the northeast of the former separator. Augering was advanced to a depth of 10 feet. Samples were collected at the surface, 2.5, 5 and 10 feet in depth. Surface samples were collected using a stainless steel spoon and subsurface samples were collected from the hand auger. Samples were collected at discrete depths and locations. No composite samples were taken. Samples were analyzed for BTEX, priority metals and TCL VOCs. Duplicates, rinsate blanks, ambient blanks, decontamination water, and trip blanks were also submitted to the laboratory for this SWMU. The trip blanks and ambient blanks were inadvertently opened at SWMU No. 1 but were still included for analysis.

9.3 Physical Characteristics

This section provides a discussion of the surface water drainage, groundwater, soils and geology at the No. 680 oil/water separator based on a review of information from previous investigations at Cannon AFB and from the lithologic descriptions of the soil samples taken from the hand auger.

9.3.1 Surface Water Drainage

A topographic/surface drainage map in addition to text found in Installation Restoration Program Records Search, August 1983 prepared by CH_2M Hill indicates that surface water drainage in the vicinity of SWMU No. 16 is directed topographically and through a series of ditches to Stormwater Collection Point (SWMU No. 85). SWMU No. 85 is an ephemeral lake basin (playa) located in the southwest corner of the base.

Table 9-1.
Summary of Drilling and Sampling
SWMU No.16 - Oil/Water Separator No. 680

Borehole Number	Sampling Depth (ft.-BGS)	Drilling/ Sampling Methods	Drillrig Used	Borehole Diameter (in.)	Ground Elevation	Date Grouted
1	0	NA/SS	NA	NA	4298.81	4/10/93
	2.5	HA/SBC	NA	8.0		
	5.0	HA/SBC	NA	8.0		
	10.0	HA/SBC	NA	8.0		
2	0	NA/SS	NA	NA	4298.76	4/10/93
	2.5	HA/SBC	NA	8.0		
	5.0	HA/SBC	NA	8.0		
	10.0	HA/SBC	NA	8.0		
3	0	NA/SS	NA	NA	4300.86	4/10/93
	2.5	HA/SBC	NA	8.0		
	5.0	HA/SBC	NA	8.0		
	10.0	HA/SBC	NA	8.0		

HSA = Hollow Stem Auger
HA = Hand Auger
SBC = Split Barrel Continuous Sampler
SS = Split Spoon
SSS = Stainless Steel Spoon

Table 9-2.
Summary of Sampling and Analyses
SWMU No. 16 - Oil/Water Separator No. 680

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
1	0	CAN016-6801-021A	N	SOIL	0830	PM	6010\7000S+
		CAN016-6801-031A	N	SOIL	0830	TCL VOC	8240
	2.5	CAN016-6801-022B	N	SOIL	0840	PM	6010\7000S
		CAN016-6801-032B	N	SOIL	0840	TCL VOC	8240
	5.0	CAN016-6801-011C	N	SOIL	0905	BTEX	8020
		CAN016-6801-023C	N	SOIL	0905	PM	6010\7000S
	10.0	CAN016-6801-012D	N	SOIL	0920	BTEX	8020
		CAN016-6801-024D	N	SOIL	0920	PM	6010\7000S
2	0	CAN016-6802-021A	N	SOIL	0930	PM	6010\7000S
		CAN016-6802-031A	N	SOIL	0930	TCL VOC	8240
	2.5	CAN016-6802-022B	N	SOIL	0938	PM	6010\7000S
		CAN016-6802-032B	N	SOIL	0938	TCL VOC	8240
	5.0	CAN016-6802-011C	N	SOIL	0945	BTEX	8020
		CAN016-6802-023C	N	SOIL	0945	PM	6010\7000S
	10.0	CAN016-6802-012D	N	SOIL	1000	BTEX	8020
		CAN016-6802-024D	N	SOIL	1000	PM	6010\7000S

Table 9-2. (Continued)
Summary of Sampling and Analyses
SWMU No. 16 - Oil/Water Separator No. 680

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
3	0	CAN016-6803-021A	N	SOIL	1005	PM	6010\7000S
		CAN016-6803-031A	N	SOIL	1005	TCL VOC	8240
	2.5	CAN016-6803-022B	N	SOIL	1022	PM	6010\7000S
		CAN016-6803-032B	N	SOIL	1020	TCL VOC	8240
		CAN016-6803-821B	QCD	SOIL	1022	PM	6010\7000S
		CAN016-6803-831B	QCD	SOIL	1020	TCL VOC	8240
		CAN016-6803-721B	QAD	SOIL	1022	PM	6010\7000S
		CAN016-6803-731B	QAD	SOIL	1020	TCL VOC	8240
	5.0	CAN016-6803-011C	N	SOIL	1025	BTEX	8020
		CAN016-6803-023C	N	SOIL	1025	PM	6010\7000S
	10.0	CAN016-6803-012D	N	SOIL	1040	BTEX	8020
		CAN016-6803-024D	N	SOIL	1040	PM	6010\7000S

Table 9-2. (Concluded)
Summary of Sampling and Analyses
SWMU No. 16 - Oil/Water Separator No. 680

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
		CAN016-6800-431Z	QC	WATER	1100	TCL VOC	8240
		CAN016-6800-321Z	QC	WATER	1105	PM	6010\7000S
		CAN016-6800-331Z	QC	WATER	1110	TCL VOC	8240
		CAN016-6800-231Z	QC	WATER	1110	TCL VOC	8240
		CAN016-6800-621Z	QC	WATER	1105	PM	6010\7000S
		CAN016-6800-631Z	QC	WATER	1110	TCL VOC	8240

BTEX = Benzene, Toluene, Ethyl Benzene, Xylene
ft-BGS = feet below ground surface
N = Normal soil sample
PM = Priority metals = 8 TCLP metals + Ni
TCL VOC = Target Compound List Volatile Organic Compound
+ = Metals analyzed using the 7000 Series include: mercury, selenium, and arsenic.

QAD = Duplicate soil sample (analyzed at different laboratory from normal samples).
QCD = Duplicate soil sample analyzed at same laboratory as normal samples.
QC = Quality control water sample (ambient blank, trip blank, etc.)
TAL Metals = Target analyte list metals

9.3.2 Groundwater

Depth to groundwater at Cannon AFB is approximately 250 feet or greater. Groundwater recharge rates for the High Plains Region are typically low. Localized recharge rates for Curry County range from 0.75 - 12.22 mm/yr (Stone, 1985). EPA, 1987 DRASTIC reports recharge rates of 1 in/yr. Section 1.4.3.5 of this report includes a discussion of groundwater hydrology for Cannon AFB.

9.3.3 Soils and Geology

The near surface (upper ten feet) stratigraphy in the area surrounding this SWMU consist of Tertiary Miocene to Pliocene fluvial deposits of the Ogallala Formation. The soils have been described as a fine sandy loam (Ab) of the Amarillo soil group (USDA draft "Soil Survey" 1993). Interpretations and correlation on the fluvial deposits for this area are based on split spoon samples collected during the drilling process. The soils are heavily bioturbated within the first foot of section and thereafter consist of very fine to fine-grained, moderate to well sorted, submature to mature (textural), unconsolidated, calcareous, reddish brown, clays, silts, and sands. Thin to moderately thin layers of caliche material were interbedded throughout much of the samples collected. The sands were comprised of angular to subangular grains with varying amounts of silts, clays, and calcium carbonate (caliche) material. This description of lithology (Figure 9-2) is similiar to the description of soils given by the USDA Draft Soil Survey, of 1993. The thickness of this particular unit remains unknown, due to the fact that boring levels did not exceed ten feet. The total thickness of the Ogallala Formation beneath this SWMU is not presently known, but regional information based on Curry County reports have suggested thicknesses of approximately 320-400 feet. No groundwater was encountered while drilling at these three borehole locations. The minimum depth of the High Plains aquifer is reported to be greater than 250 feet below ground surface.

9.4 Nature and Extent of Contamination

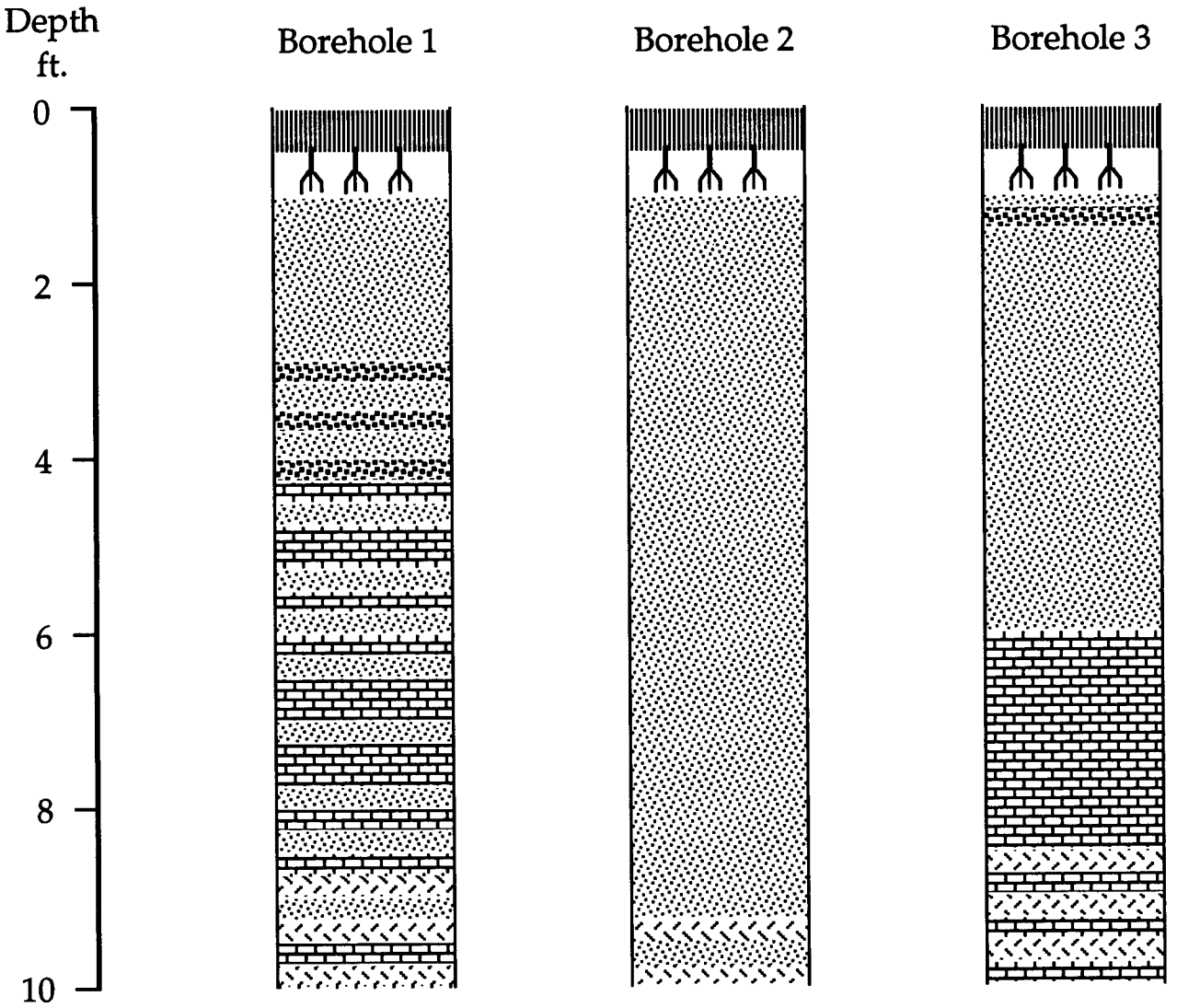
9.4.1 Volatile Organic Compounds

A series of HNU meter readings were collected in the well head and in the breathing zone for each borehole for the purpose of worker safety. No positive readings occurred.

Samples were collected from three boreholes at the surface and at 2.5 feet and analyzed for Target List Compound Volatile Organic Compounds (TCL VOC). Following are the results of these analyses.

9.4.1.1 Borehole 1

In borehole 1, no target compounds or TIC compounds were detected in the surface sample or at 2.5 feet.



LEGEND

	Grass		Sand
	Roots		Clay
	Gravel		Caliche

LRL Sciences, Inc.

SWMU 16
STRATIGRAPHIC COLUMN
CANNON AFB, NEW MEXICO

Project: Cannon AFB RFI	
Contract No: DACA47-93-C-009	
Prepared by: KLH	Date: 10-25-93

Fig. 9-2

9.4.1.2 Borehole 2

In borehole 2, no target compounds or TIC compounds were detected in the surface sample or at 2.5 feet.

9.4.1.3 Borehole 3

In borehole 3, no target compounds or TIC compounds were detected in the surface sample.

No target compounds or TIC compounds were detected at 2.5 feet. Two duplicate samples were collected with the 2.5 foot sample from borehole 3. The QC duplicate, analyzed at the same laboratory as the normal sample, contained no target compounds or TIC compounds. The QA duplicate which was analyzed at a different laboratory from the normal sample contained acetone and methylene chloride. These values have been rejected as contaminants due to their prevalence in nearly all of the QA lab samples.

9.4.2 BTEX

In each borehole, 2 samples were collected for BTEX analysis at 5 and 10 feet of depth. No BTEX compounds were detected in any of the samples. QA/QC duplicate samples for BTEX were not collected and therefore analyses were not performed.

9.4.3 Priority Metals

Total metal concentrations, using the RCRA SW-846 test methods for the analysis of metals in soils, were determined for the eight TCLP metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) plus nickel. These are the priority metals. Samples were collected for priority metals analysis at the surface, 2.5, 5, and 10 feet.

In the following presentation of metals results, only metals concentrations in excess of background concentrations are presented (Table 9-3). No background data was collected for this investigation, therefore, background concentrations were taken from Concentrations of Selected Naturally Occurring Chemical Constituents in Soil and Groundwater at Cannon Air Force Base Clovis, New Mexico, March 1993 prepared by Woodward-Clyde. For a discussion of Woodward-Clydes background data see Section 1.7.

Table 9-3
Concentration (mg/kg) of Priority Metals
SWMU No. 16 - Oil/Water Separator No. 680

Boring Number	Sample Number (CAN016-680)	Sample Depth (Feet)	Lead		Mercury		Nickel
1	1-021A	0	20.5		0.03	U	8.1
	1-022B	2.5	10.1		0.03	U	6.9
	1-023C	5	9.2		0.02	U	**9.3**
	1-024D	10	4.3		0.01	U	7
2	2-021A	0	21.5		0.1	U	7
	2-022B	2.5	16.3		0.05	U	7.9
	2-023C	5	7		0.1	U	**9.3**
	2-024D	10	8		0.01	U	3.7
3	3-021A	0	**41.3**		0.02	U	6.2
	3-022B	2.5	14.9	J	0.02	U	6.7
(QAD)	3-721B	2.5	17.7		**0.24**		5.9
(QCD)	3-821B	2.5	13.7		0.02	U	5.5
	3-023C	5	8.3		0.1	U	**9.6**
	3-024D	10	12		0.01	U	6
Background (95% UCL) (1)			25.80		0.13		9.00

Notes:

Duplicate samples (QAD) or (QCD) samples are presented only if they are different from the original sample and not rejected.

U indicates that the compound was analyzed for, but not detected at or above the standard limit.
J indicates an estimated value.
UJ indicates the compound was analyzed for but not detected. The sample quantification limit or reported detection limit is an estimated quantity.
* R indicates that the data was rejected because of quality control measures

Boldface indicates a detection above the 95% UCL background level

Only data for metals detected above background is presented

(1) Background data is described in Section 17.0.

9.4.3.1 Borehole 1

No metals were detected above the background values in the samples collected at the surface or at 2.5 feet.

In the sample collected at 5 feet (CAN016-6801-023C), nickel was detected at 9.3 mg/kg. The background value is 9.0 mg/kg.

No metals were detected above the background values in the samples collected at 10 feet.

9.4.3.2 Borehole 2

No metals were detected above the background values in the samples collected at the surface or at 2.5 feet.

In the sample collected at 5 feet (CAN016-6802-023C), nickel was detected at 9.3 mg/kg.

No metals were detected above the background values in the samples collected at 10 feet.

9.4.3.3 Borehole 3

The surface sample (CAN016-6803-021A), lead was detected at 41.3 mg/kg. The background value is 25.8 mg/kg.

No priority metals were detected above background in the sample collected at 2.5 feet or in the QC duplicate collected at this depth. The QA duplicate (CAN016-6803-721B), which was analyzed at a different laboratory from the normal sample, contained mercury at 0.24 mg/kg. The background value for mercury is 0.13 mg/kg.

At 5 feet (CAN016-6803-023C), nickel was detected at 9.6 mg/kg.

No priority metals were detected in the sample collected at 10 feet.

9.4.4 Summary

No organic compounds were detected in any of the boreholes. Nickel was detected at 5 feet in all three boreholes. Lead and mercury were detected in borehole 3 at the surface and at 2.5 feet respectively.

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10.0 OIL WATER SEPARATOR (SWMU NO. 32A/SITE NO. 186, #1-East)

10.1 SWMU Description

10.1.1 Setting

SWMU No. 32A is an oil/water separator located on the east side of Building 186, on the flightline side and adjacent to a washrack. The separator is a 2-compartment underground unit, with a 300 gallon main compartment and a 300 gallon oil compartment. The unit is constructed of concrete. The opening to the separator is covered on all sides by asphalt. Containers of used JP-4 and synthetic oil are stored nearby on carts. Two underground JP-4 filling tanks are located approximately 25 feet from the separator; these tanks were reportedly placed in vaults within the last year. Borehole locations were selected, in part, to avoid underground utilities, product supply pipes and the gasoline pump island adjacent to the separator. In addition, the boreholes were moved in closer to the separator than specified in the FSP. The driller was required to penetrate the asphalt and restore the surface with a concrete plug. Figure 10-1 shows the setting and borehole locations.

10.1.2 History of Use

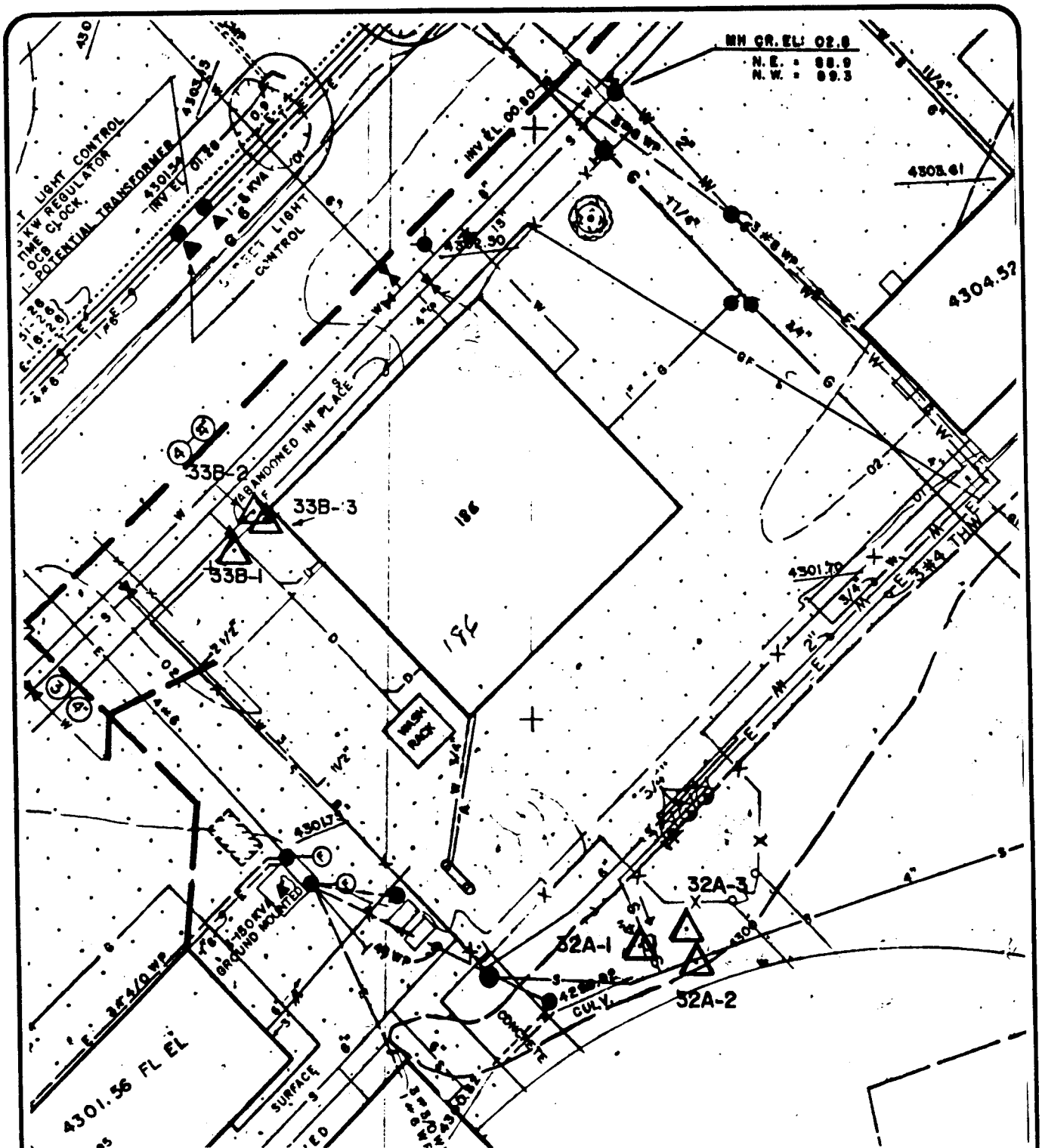
The oil/water separator No. 186 east, has been active since 1971 and is still in use, receiving wastewater from the cleaning of aircraft ground-support equipment at the washrack. The recovered oils are directed to the 300 gallon holding tank and the wastewater is discharged to the Sanitary Sewer Line (SWMU No. 98). Historically, the separator served the washrack outside of the Aerospace Ground Equipment (AGE) compound to the east of the facility. The unit received washwater generated from the cleaning of aircraft support equipment at the washrack, which contained petroleum and synthetic lubricating oils and dirt.

10.1.3 Past Investigations

In 1988 the Tulsa Corps of Engineers conducted a study of the influent and effluent from a number of oil/water separators on base. The results are reported in Cannon Air Force Base Oil/Water Separators Sampling and Analytical Report, June 1988. For Separator No. 186 the following compounds, among others, were found: benzene, toluene, xylene, naphthalene, 2-methylnaphthalene, bis(2-ethylhexyl)phthalate and lead.

10.1.4 Land Use and Demography

This SWMU is located in an area of the base which is commonly used by base personnel. However, this SWMU is underground and presently covered by asphalt.



▲ — Borehole

Boring No.	Elevation (ft.)
1	4301.44
2	4301.13
3	4301.32

N

LRL Sciences, Inc.

SWMU #32
OIL/WATER SEPARATOR - 186-1
CANNON AFB, NEW MEXICO

Project:	Cannon AFB RFI
Contract No:	DACA47-93-C-009
Prepared by: KLH	Date: 10-25-93

Fig. 10-1

10.2 Field Investigation

SWMU 32A was sampled April 12, 1993 at 1305. The activities at oil/water separator No. 186, as outline in the FSP (LRL, 1993), consisted of drilling 3 boreholes, collecting 6 surface samples, 18 subsurface samples, 4 QA/QC duplicate samples and 6 QA/QC water samples. Table 10-1 summarizes the field sampling program at SWMU 11. Table 10-2 summarizes the various samples collected and analyses performed.

10.2.1 Sampling Objectives

Borehole locations, sampling depth, and parameters for analysis were selected, to the greatest extent possible, to determine if a release from the oil/water separator has occurred. All three boreholes were moved closer in to the separator from the original locations specified in the FSP. Borehole locations are shown in Figure 10-1.

10.2.2 Surface and Subsurface Soil Investigation

Borehole 1 was drilled 6 feet to the west of the separator. Borehole 2 was drilled 8 feet to the east of the separator and borehole 3 was drilled 9 feet to the northeast of the separator. Drilling was advanced to a depth of 10 feet. Samples were collected at the surface, 2.5, 5 and 10 feet in depth. Surface samples were collected with a stainless steel spoon and subsurface samples were collected with a split barrel continuous sampler. Samples were collected as grab samples at discrete depths and locations. No composite samples were taken. Samples were analyzed for BTEX, priority metals and TCL VOCs. Duplicates, rinsate blanks, ambient blanks and decontamination water samples were also submitted to the laboratory for this SWMU site. Trip Blanks and Ambient Blanks were inadvertently opened at SWMU No. 1 but were still included for analysis.

10.3 Physical Characteristics

Following is a discussion of the surface water drainage, groundwater, soils and geology at the No. 186 east oil/water separator based on a review of information from previous investigations at Cannon AFB and from the lithologic descriptions from a split barrel continuous sampler.

10.3.1 Surface Water Drainage

A topographic/surface drainage map in addition to text found in Installation Restoration Program Records Search, August 1983 prepared by CH$_2$M Hill suggests that surface water drainage in the vicinity of SWMU No. 32A may be directed topographically and through a series of ditches to Stormwater Collection Point (SWMU No.85). SWMU No.85 is an ephemeral lake basin (playa) located in the southwest corner of the base.

Table 10-1.
Summary of Drilling and Sampling
SWMU No.32A - Oil/Water Separator No. 186, #1-East

Borehole Number	Sampling Depth (ft.-BGS)	Drilling/ Sampling Methods	Drillrig Used	Borehole Diameter (in.)	Ground Elevation	Date Grouted
1	0	NA/SSS	NA	NA	4301.44	4/14/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
2	0	NA/SSS	NA	NA	4301.13	4/14/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
					4301.32	4/14/93
3	0	NA/SSS	NA	NA		
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		

HSA = Hollow Stem Auger
HA = Hand Auger
SBC = Split Barrel Continuous Sampler
SS = Split Spoon
SSS = Stainless Steel Spoon

Table 10-2.
Summary of Sampling and Analyses
SWMU No. 32A - Oil/Water Separator No. 186, #1-East

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
1	0	CAN32A-1861-021A	N	SOIL	1405	PM	6010\7000S+
		CAN32A-1861-031A	N	SOIL	1405	TCL VOC	8240
	2.5	CAN32A-1861-011B	N	SOIL	1415	BTEX	8020
		CAN32A-1861-022B	N	SOIL	1415	PM	6010\7000S
	5.0	CAN32A-1861-023C	N	SOIL	1425	PM	6010\7000S
		CAN32A-1861-032C	N	SOIL	1425	TCL VOC	8240
		CAN32A-1861-821C	QCD	SOIL	1425	PM	6010\7000S
		CAN32A-1861-831C	QCD	SOIL	1425	TCL VOC	8240
		CAN32A-1861-721C	QAD	SOIL	1425	PM	6010\7000S
		CAN32A-1861-731C	QAD	SOIL	1425	TCL VOC	8240
	10.0	CAN32A-1861-012D	N	SOIL	1430	BTEX	8020
		CAN32A-1861-024D	N	SOIL	1430	PM	6010\7000S
2	0	CAN32A-1862-021A	N	SOIL	1505	PM	6010\7000S
		CAN32A-1862-031A	N	SOIL	1505	TCL VOC	8240
	2.5	CAN32A-1862-011B	N	SOIL	1515	BTEX	8020
		CAN32A-1862-022B	N	SOIL	1515	PM	6010\7000S
	5.0	CAN32A-1862-023C	N	SOIL	1525	PM	6010\7000S
		CAN32A-1862-032C	N	SOIL	1520	TCL VOC	8240
	10.0	CAN32A-1862-012D	N	SOIL	1523	BTEX	8020
		CAN32A-1862-024D	N	SOIL	1527	PM	6010\7000S

Table 10-2. (Concluded)
Summary of Drilling and Sampling
SWMU No. 32A - Oil/Water Separator No. 186, #1-East

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
3	0	CAN32A-1863-021A	N	SOIL	1555	PM	6010\7000S
		CAN32A-1863-031A	N	SOIL	1555	TCL VOC	8240
	2.5	CAN32A-1863-011B	N	SOIL	1605	BTEX	8020
		CAN32A-1863-022B	N	SOIL	1605	PM	6010\7000S
	5.0	CAN32A-1863-023C	N	SOIL	1620	PM	6010\7000S
		CAN32A-1863-032C	N	SOIL	1615	TCL VOC	8240
	10.0	CAN32A-1863-012D	N	SOIL	1615	BTEX	8020
		CAN32A-1863-024D	N	SOIL	1620	PM	6010\7000S
		CAN32A-1860-431Z	QC	WATER	1530	TCL VOC	8240
		CAN32A-1860-321Z	QC	WATER	1650	PM	6010\7470
		CAN32A-1860-331Z	QC	WATER	1545	TCL VOC	8240
		CAN32A-1860-231Z	QC	WATER	1545	TCL VOC	8240
		CAN32A-1860-621Z	QC	WATER	1650	PM	6010\7470
		CAN32A-1860-631Z	QC	WATER	1545	TCL VOC	8240

BTEX = Benzene, Toluene, Ethyl Benzene, Xylene
ft-BGS = feet below ground surface
N = Normal soil sample
PM = Priority metals = 8 TCLP metals + Ni
TCL VOC = Target Compound List Volatile Organic Compound
+ = Metals analyzed using the 7000 Series include: mercury, selenium, and arsenic.

QAD = Duplicate soil sample (analyzed at different laboratory from normal samples).
QCD = Duplicate soil sample analyzed at same laboratory as normal samples.
QC = Quality control water sample (ambient blank, trip blank, etc.)
TAL Metals = Target analyte list metals

10.3.2 Groundwater

Depth to groundwater at Cannon AFB is approximately 250 feet or greater. Groundwater recharge rates for the High Plains Region are typically low. Localized recharge rates for Curry County range from 0.75 - 12.22 mm/yr (Stone, 1985). EPA, 1987 DRASTIC reports recharge rates of 1 in/yr. Section 1.4.3.5 of this report includes a discussion of groundwater hydrology for Cannon AFB.

10.3.3 Soils and Geology

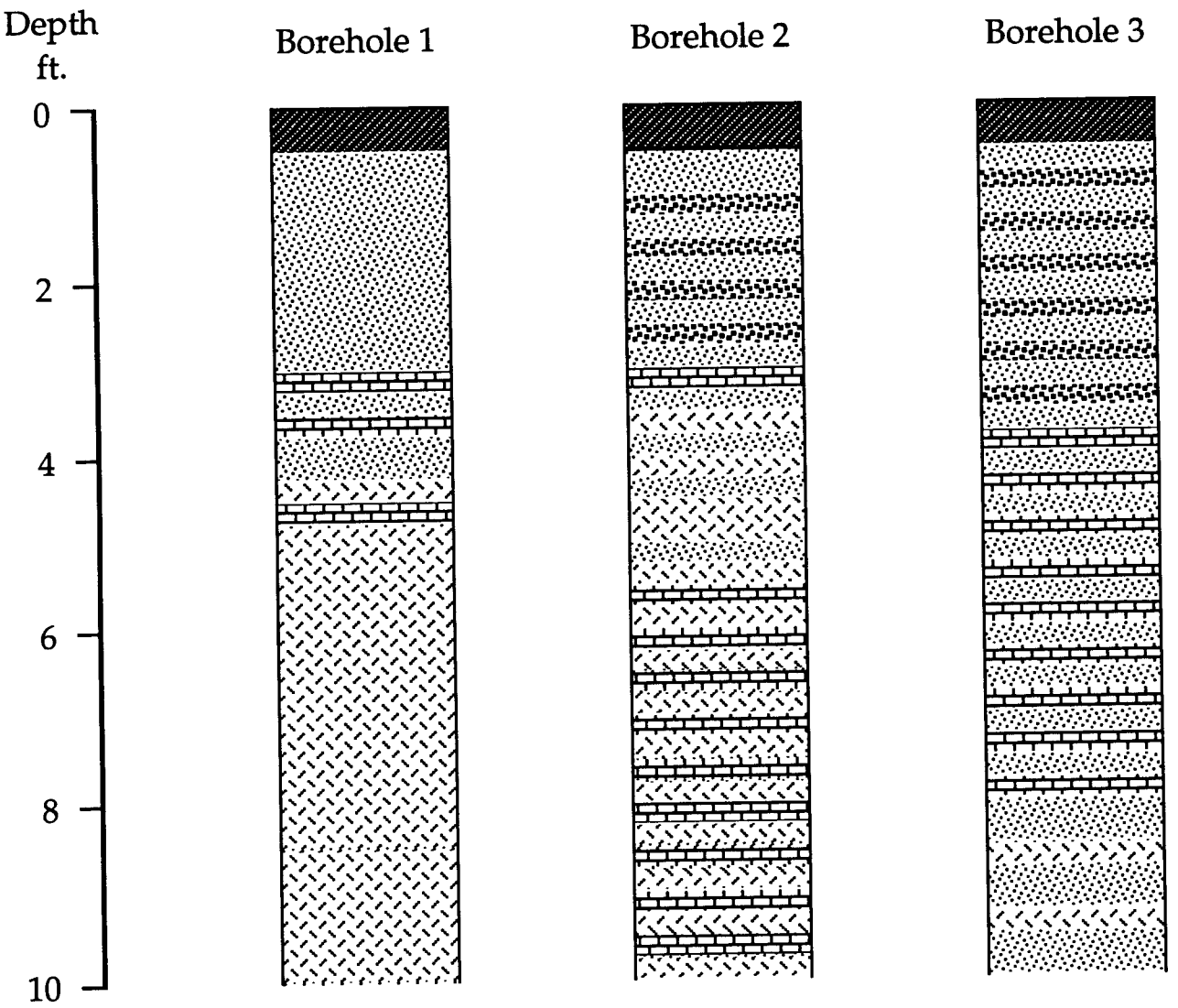
The near surface (upper ten feet) stratigraphy in the area surrounding this SWMU consist of Tertiary Miocene to Pliocene fluvial deposits of the Ogallala Formation. The soils have been described as a fine sandy loam (Ab) of the Amarillo soil group (USDA, 1993). Interpretations and correlation on the fluvial deposits for this area are based on split spoon samples collected during the drilling process. The soils consist of very fine to fine-grained, moderate to well sorted, submature to mature (textural), unconsolidated, calcareous, reddish brown, clays, silts, and sands. Thin to moderately thin layers of caliche material were interbedded throughout much of the samples collected. The sands were comprised of angular to subangular grains with varying amounts of silts, clays, and calcium carbonate (caliche) material. This description of lithology (Figure 10-2) is similiar to the description of soils given by the USDA Draft Soil Survey, 1993. The thickness of this particular unit remains unknown, due to the fact that boring levels did not exceed ten feet. The total thickness of the Ogallala Formation beneath this SWMU is not presently known, but regional information based on Curry County reports have suggested thicknesses of approximately 320-400 feet. No groundwater was encountered while drilling at these three borehole locations. The minimum depth of the High Plains aquifer is reported to be greater than 250 feet below ground surface.

10.4 Nature and Extent of Contamination

10.4.1 Volatile Organic Compounds

A series of HNU meter readings were collected in the well head and in the breathing zone for the purpose of worker safety. The highest well head readings obtained from the three boreholes respectively were 1.8, 0.6 and 0.2 ppm (Table 10-3). No positive readings occurred in the breathing zone.

Samples were collected from the three boreholes at the surface and at 5 feet and analyzed for Target List Compound Volatile Organic Compounds (TCL VOC). Following are the results of these analyses.



LEGEND

- Asphalt
- Gravel
- Sand
- Clay
- Caliche

LRL Sciences, Inc.

SWMU #32 A
STRATIGRAPHIC COLUMN
CANNON AFB, NEW MEXICO

Project:	Cannon AFB RFI
Contract No:	DACA47-93-C-009
Prepared by: KLH	Date: 10-25-93

Fig. 10-2

Table 10-3.
HNU Meter* Readings (PPM) in Borehole Headspace
SWMU No. 32A - Oil/Water Separator No. 186, #1-East

DATE:					
TIME	BH1	TIME	BH2	TIME	BH3
1354	0.0	1510	0.6	1554	0.2
1420	1.8	1513	0.0	1604	0.0
1425	0.0	1525	0.0	1610	0.0
1435	0.6			1618	0.2

* Model: 101, Type: OVA PID, Make: HNU

10.4.1.1 Borehole 1

In borehole 1, the surface sample contained no target compounds or TIC compounds.

The 5 foot sample contained no target compounds or TIC compounds. Two duplicate samples were collected in association with the 5 foot sample. The QC duplicate sample (CAN321-1861-831C), analyzed at the same lab, contained acetone at 12 μg/kg (Table 10-4). This value is an estimate since continuing calibration %D was outside QC limits. No TIC compounds were detected. The QA duplicate, analyzed at a different lab, contained methylene chloride. Due to the prevalence of this compound in nearly all of the samples run at the QA lab, it was considered a contaminant and rejected.

10.4.1.2 Borehole 2

In borehole 2, the surface sample (CAN32A-1862-031A) contained total xylene at 34 μg/kg. No TIC compounds were detected.

The sample collected at 5 feet contained no target or TIC compounds.

10.4.1.3 Borehole 3

In borehole 3, neither the surface sample or the sample collected at 5 feet contained any target compounds or TIC compounds.

Table 10-4.
Concentration (μg/kg) of Volatile Organic Compounds
SWMU No. 32A - Oil/Water Separator No. 186, #1-East

Borehole Number	Cannon Number	Depth (ft.)	Chemical	
			Acetone	Xylene
1	CAN32A-1861-031A	Surface	11UJ	11U
	CAN32A-1861-032C	5.0	12UJ	12U
	CAN321-1861-831C		12J (QCD)	
2	CAN32A-1862-031A	Surface	12UJ	34
	CAN32A-1862-032C	5.0	12UJ	12U
3	CAN32A-1863-031A	Surface	11UJ	11U
	CAN321-1863-032C	5.0	12UJ	12U

Duplicate samples or laboratory repeat samples are presented only if they are different from the original sample and not rejected.

J = estimate
R = rejected

U = not detected at CRQL
UJ = estimated as non-detect at CRQL
QAD = duplicate analyzed at the same lab as the normal sample.

10.4.2 BTEX

In each borehole, 2 samples were collected for BTEX analysis at 2.5 and 10 feet of depth. No BTEX compounds were detected in any of the samples. QA/QC duplicate samples were not collected, therefore QA/QC BTEX analyses were not performed.

10.4.3 Priority Metals

Total metals concentrations, using the RCRA SW-846 test methods for the analysis of metals in soils, were determined for the eight TCLP metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) plus nickel. These are the priority metals. Samples were collected for priority metals analysis at the surface, 2.5, 5, and 10 feet.

In the following presentation of metals results, only metals concentrations in excess of background concentrations are presented. No background data was collected for this investigation, therefore, background concentrations were taken from Concentrations of Selected Naturally Occurring Chemical Constituents in Soil and Groundwater at Cannon Air Force Base Clovis, New Mexico, March 1993 prepared by Woodward-Clyde. For a discussion of Woodward-Clydes background data see Section 1.7.

10.4.3.1 Borehole 1

No priority metals were detected above background in the surface sample.

In the sample collected at 2.5 feet (CAN32A-1861-022B) (Table 10-5), nickel was detected at 10.3 mg/kg. The background value is 9.0 mg/kg.

No priority metals were detected above background in the 5 and 10 feet samples. The QC/QA duplicates were collected at 5 feet. The QC duplicate (analyzed at the same lab) contained no priority metals above background. The QA duplicate (analyzed at a different lab) contained mercury at 0.27 mg/kg (CAN32A-1861-721C).

10.4.3.2 Borehole 2

No priority metals were detected above background in any of the samples collected in borehole 2.

10.4.3.3 Borehole 3

No metals were detected above background in the samples collected at the surface, 2.5, or 5 feet.

Barium was detected at 1480 mg/kg in the sample collected at 10 feet (CAN32A-1863-024D). This value is an estimate since matrix spike recovery was not within control limits.

10.4.4 Summary

The only analyte detected at the surface was xylene in borehole 2. Nickel and mercury are detected in the subsurface of borehole 1 and barium at 10 feet in borehole 3.

DRAFT

Table 10-5
Concentration (mg/kg) of Priority Metals
SWMU No.32A - Oil/Water Separator No. 186 East

Boring Number	Sample Number (CAN32A-186)	Sample Depth (Feet)	Barium		Mercury		Nickel	
1	1-021A	0	140	J	0.01	U	5.5	
	1-022B	2.5	84.4	J	0.02	U	**10.3**	
	1-023C	5	122	J	0.1	U	4.6	J
(QAD)	1-721C	5	161		**0.27**		6.5	
(QCD)	1-821C	5	82.2	J	0.01	U	5	J
	1-024D	10	81.9	J	0.01	U	4.6	J
2	2-021A	0	505	J	0.01	U	4.6	J
	2-022B	2.5	83.1	J	0.02	U	8.4	J
	2-023C	5	91	J	0.01	U	5.3	J
	2-024D	10	38.3	J	0.01	U	5.1	J
3	3-021A	0	346	J	0.01	U	4.8	J
	3-022B	2.5	121	J	0.02	U	4.6	J
	3-023C	5	123	J	0.01	U	4.7	J
	3-024D	10	**1480**	J	0.01	U	6	J
Background (95% UCL) (1)			642.00		0.13		9.00	

Notes:

Duplicate samples (QAD) or (QCD) samples are presented only if they are different from the original sample and not rejected.

U indicates that the compound was analyzed for, but not detected at or above the standard limit.
J indicates an estimated value.
UJ indicates the compound was analyzed for but not detected. The sample quantification limit or reported detection limit is an estimated quantity.
* R indicates that the data was rejected because of quality control measures

Boldface indicates a detection above the 95% UCL background level

Only data for metals detected above background is presented

(1) Background data is described in Section 17.0.

11.0 OIL WATER SEPARATOR (SWMU NO. 33B/SITE NO. 186, #2-West)

11.1 SWMU DESCRIPTION

11.1.1 Setting

The oil/water separator No. 186 west, is located on the southwest corner of Building 186. The separator is a 2-compartment underground unit, with a 584 gallon main compartment and a 140 gallon oil compartment. The unit is constructed of concrete. The opening to the separator is surrounded on all sides by asphalt. The driller was required to penetrate the surface with a mechanical auger/drill and restore the surface with concrete plugs. Borehole locations were selected, in part, to avoid utilities, a perimeter fence and Building 186. Figure 11-1 shows the SWMU setting and borehole locations.

11.1.2 History of Use

The oil/water separator No. 186 west, has been active since 1971 and is still in use, receiving wastewater from aircraft maintenance operations. The recovered oils are directed to the 140 gallon holding tank and the wastewater is discharged to the Sanitary Sewer Line (SWMU No. 98). Historically, the separator served the washrack outside of the Aerospace Ground Equipment (AGE) compound to the east of the facility. The unit received washwater generated from aircraft maintenance operations, which contained petroleum and synthetic lubricating oils and dirt.

11.1.3 Past Investigations

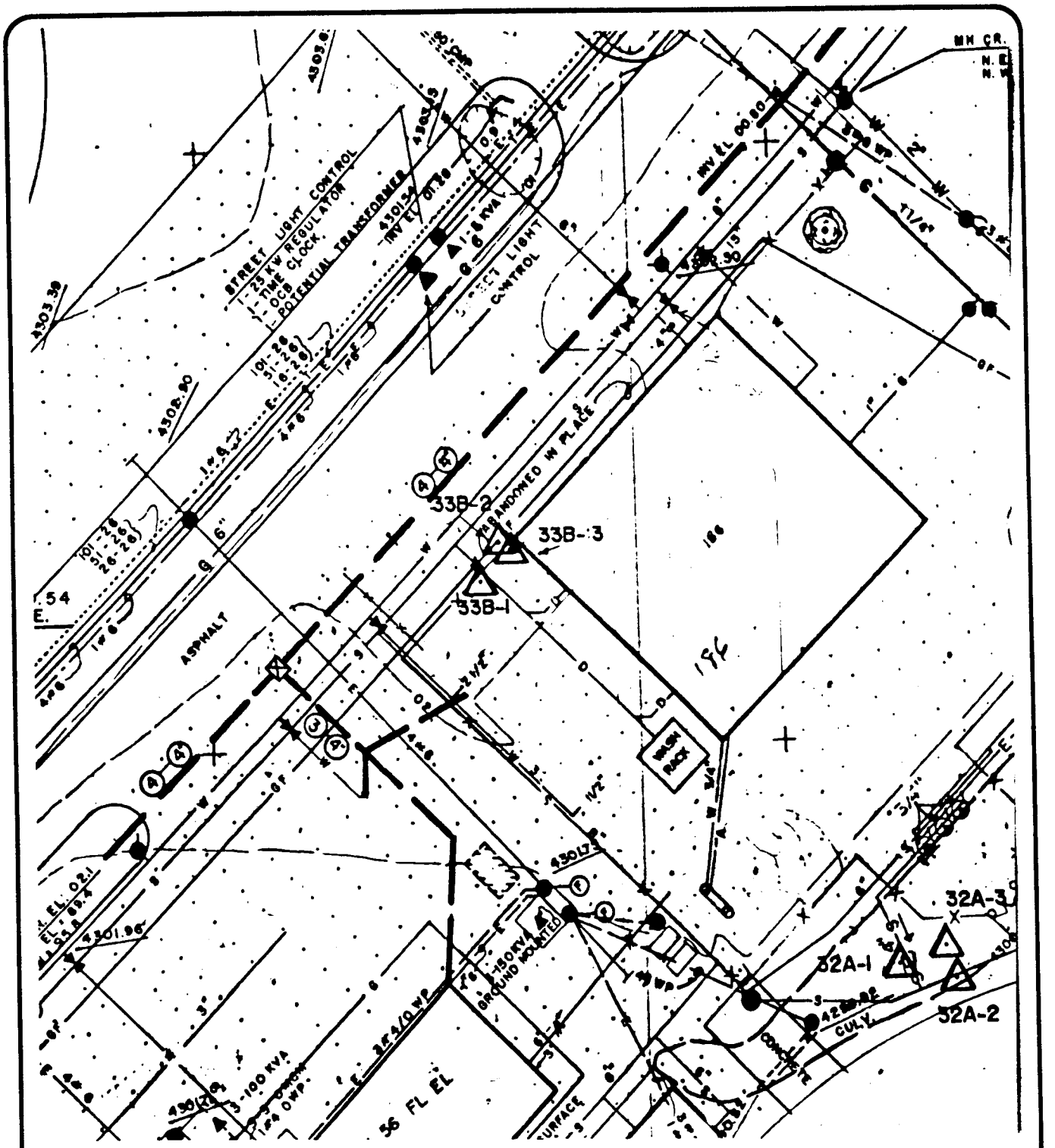
In 1987-1988 the Tulsa District Corps of Engineers conducted a study of a number of oil/water separators on the base. The results of analyses performed on the influent and effluent from this separator are found in Cannon Air Force Base Oil/Water Separators Sampling and Analytical Report, June 1988. The following compounds were present in the influent and/or effluent of this separator: benzene, toluene, ethylbenzene, xylene, naphthalene, 2-methylnaphthalene, bis(2-ethylhexyl)phthalate, lead, nickel and chromium.

11.1.4 Land Use and Demography

This SWMU is located in an area of the base which is commonly used by base personnel. This SWMU is underground but not covered by asphalt.

11.2 Field Investigation

This SWMU was sampled April 12, 1993 at 1710. The activities at SWMU No. 33B as outlined in the FSP (LRL, 1993) consisted of drilling 3 boreholes, and collecting 6 surface samples, 18 subsurface samples, 4 QA/QC duplicate samples and 6 QA/QC water samples. Table 11-1 summarizes the field sampling program at SWMU 33B. Table 11-2 summarizes the various samples collected and analyses performed.



▲ — Borehole

Boring No.	Elevation (ft.)
1	4302.69
2	4302.72
3	4302.82

N

LRL Sciences, Inc.

SWMU #33
OIL/WATER SEPARATOR - 186-2
CANNON AFB, NEW MEXICO

Project:	Cannon AFB RFI
Contract No:	DACA47-93-C-009
Prepared by: KLH	Date: 10-25-93

Fig. 11-1

Table 11-1.
Summary of Drilling and Sampling
SWMU No. 33B - Oil/Water Separator No. 186, #2-West

Borehole Number	Sampling Depth (ft.-BGS)	Drilling/ Sampling Methods	Drillrig Used	Borehole Diameter (in.)	Ground Elevation	Date Grouted
1	0	NA/SSS	NA	NA	4302.69	4/14/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
2	0	NA/SSS	NA	NA	4302.72	4/14/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
3	0	NA/SSS	NA	NA	4302.82	4/14/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		

HSA = Hollow Stem Auger
HA = Hand Auger
SBC = Split Barrel Continuous Sampler
SS = Split Spoon
SSS = Stainless Steel Spoon

Table 11-2.
Summary of Sampling and Analyses
SWMU No. 33B - Oil/Water Separator No. 186, #2-West

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
1	0	CAN33B-1861-021A	N	SOIL	1740	PM	6010\7000S+
		CAN33B-1861-031A	N	SOIL	1740	TCL VOC	8240
	2.5	CAN33B-1861-011B	N	SOIL	1745	BTEX	8020
		CAN33B-1861-022B	N	SOIL	1745	PM	6010\7000S
	5.0	CAN33B-1861-012C	N	SOIL	1755	BTEX	8020
		CAN33B-1861-023C	N	SOIL	1755	PM	6010\7000S
	10.0	CAN33B-1861-024D	N	SOIL	1755	PM	6010\7000S
		CAN33B-1861-032D	N	SOIL	1755	TCL VOC	8240
2	0	CAN33B-1862-021A	N	SOIL	1840	PM	6010\7000S
		CAN33B-1862-031A	N	SOIL	1840	TCL VOC	8240
	2.5	CAN33B-1862-011B	N	SOIL	1850	BTEX	8020
		CAN33B-1862-022B	N	SOIL	1850	PM	6010\7000S
	5.0	CAN33B-1862-012C	N	SOIL	1900	BTEX	8020
		CAN33B-1862-023C	N	SOIL	1900	PM	6010\7000S
	10.0	CAN33B-1862-024D	N	SOIL	1900	PM	6010\7000S
		CAN33B-1862-032D	N	SOIL	1900	TCL VOC	8240
		CAN33B-1862-821D	QCD	SOIL	1900	PM	6010\7000S
		CAN33B-1862-831D	QCD	SOIL	1900	TCL VOC	8240
		CAN33B-1862-721D	QAD	SOIL	1900	PM	6010\7000S
		CAN33B-1862-731D	QAD	SOIL	1900	TCL VOC	8240

Table 11-2. (Continued)
Summary of Sampling and Analyses
SWMU No. 33B - Oil/Water Separator No. 186, #2-West

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
3	0	CAN33B-1863-021A	N	SOIL	1930	PM	6010\7000S
		CAN33B-1863-031A	N	SOIL	1930	TCL VOC	8240
	2.5	CAN33B-1863-011B	N	SOIL	1937	BTEX	8020
		CAN33B-1863-022B	N	SOIL	1937	PM	6010\7000S
	5.0	CAN33B-1863-012C	N	SOIL	1945	BTEX	8020
		CAN33B-1863-023C	N	SOIL	1945	PM	6010\7000S
	10.0	CAN33B-1863-024D	N	SOIL	1945	PM	6010\7000S
		CAN33B-1863-032D	N	SOIL	1945	TCL VOC	8240
		CAN33B-1863-821D	QCD	SOIL	1945	PM	6010\7000S
		CAN33B-1863-831D	QCD	SOIL	1945	TCL VOC	8240
		CAN33B-1863-721D	QAD	SOIL	1945	PM	6010\7000S
		CAN33B-1863-731D	QAD	SOIL	1945	TCL VOC	8240

Table 11-2. (Concluded)
Summary of Sampling and Analyses
SWMU No. 33B - Oil/Water Separator No. 186, #2-West

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
		CAN33B-1860-431Z	QC	WATER	1900	TCL VOC	8240
		CAN33B-1860-321Z	QC	WATER	2000	PM	6010\7000S
		CAN33B-1860-331Z	QC	WATER	2000	TCL VOC	8240
		CAN33B-1860-231Z	QC	WATER	2000	TCL VOC	8240
		CAN33B-1860-621Z	QC	WATER	2000	PM	6010\7000S
		CAN33B-1860-631Z	QC	WATER	2000	TCL VOC	8240

BTEX = Benzene, Toluene, Ethyl Benzene, Xylene
ft-BGS = feet below ground surface
N = Normal soil sample
PM = Priority metals = 8 TCLP metals + Ni
TCL VOC = Target Compound List Volatile Organic Compound
+ = Metals analyzed using the 7000 Series include: mercury, selenium, and arsenic.

QAD = Duplicate soil sample (analyzed at different laboratory from normal samples).
QCD = Duplicate soil sample analyzed at same laboratory as normal samples.
QC = Quality control water sample (ambient blank, trip blank, etc.)
TAL Metals = Target analyte list metals

11.2.1 Sampling Objectives

Borehole locations, sampling depth, and parameters for analysis were selected, to the greatest extent possible, to determine if a release from the oil/water separator has occurred. All three boreholes were moved closer to the separator then originally specified in the FSP. In addition, after drilling had begun, borehole 2 had to be moved again due to contact with a concrete object at 2 feet. Borehole locations are shown in Figure 11-1.

11.2.2 Surface and Subsurface Soil Investigation

Three boreholes were drilled at this SWMU using a CME-75 hollow stem auger drill rig. Borehole 1 was drilled 4 feet to the southwest of the unit. Borehole 2 was drilled 4 feet to the north of the unit and borehole 3 was drilled 3 feet to the northeast of the unit. Drilling was advanced to a depth of 10 feet. Samples were collected at the surface, 2.5, 5, and 10 feet in depth. A stainless steel spoon was employed for taking surface samples. A split barrel continuous sampler was employed for collection of all subsurface samples. Samples were collected at discrete depths and locations. No composite samples were taken. Samples were analyzed for BTEX, priority metals and TCL VOCs. Duplicates, rinsate blanks, ambient blanks and decontamination water samples were also submitted to the laboratory for this SWMU site.

11.3 Physical Characteristics

This section provides a discussion of the surface water drainage, groundwater, soils and geology at the No. 186 #2-west oil/water separator based on a review of information from previous investigations at Cannon AFB and from the lithologic descriptions of split barrel continuous samples from this investigation.

11.3.1 Surface Water Drainage

A topographic/surface drainage map in addition to text found in Installation Restoration Program Records Search, August 1983 prepared by CH_2M Hill suggests that surface water drainage in the vicinity of this SWMU may be directed topographically and through a series of ditches to Stormwater Collection Point (SWMU No. 85). SWMU No. 85 is an ephemeral lake basin (playa) located in the southwest corner of the base.

11.3.2 Groundwater

Depth to groundwater at Cannon AFB is approximately 250 feet or greater. Groundwater recharge rates for the High Plains Region are typically low. Localized recharge rates for Curry County range from 0.75 - 12.22 mm/yr (Stone, 1985). EPA, 1987 DRASTIC reports recharge rates of 1 in/yr. Section 1.4.5 of this report includes a discussion of groundwater hydrology for Cannon AFB.

11.3.3 Soils and Geology

The near surface (upper ten feet) stratigraphy in the area surrounding this SWMU consist of Tertiary Miocene to Pliocene fluvial deposits of the Ogallala Formation. The soils have been described as a fine sandy loam (Ab) of the Amarillo soil group (USDA, 1993). Interpretations and correlation on the fluvial deposits for this area are based on split spoon samples collected during the drilling process. The soils consist of very fine to fine-grained, well sorted, submature to mature (textural), unconsolidated, calcareous, reddish brown, clays, silts, and sands. Thin to moderately thin layers and nodules of caliche material were interbedded throughout much of the samples collected. The sands were comprised of angular to subangular grains with varying amounts of silts, clays, and calcium carbonate (caliche) material. This description of lithology (Figure 11-2) is simuliar to the description of soils given by the USDA Draft Soil Survey, 1993. The thickness of this particular unit remains unknown, due to the fact that boring levels did not exceed ten feet. The total thickness of the Ogallala Formation beneath this SWMU is not presently known, but regional information based on Curry County reports have suggested thicknesses of approximately 320-400 feet. No groundwater was encountered while drilling at these three borehole locations. The minimum depth of the High Plains aquifer is to be greater than 250 feet below ground surface.

11.4 Nature and Extent of Contamination

11.4.1 Volatile Organic Compounds

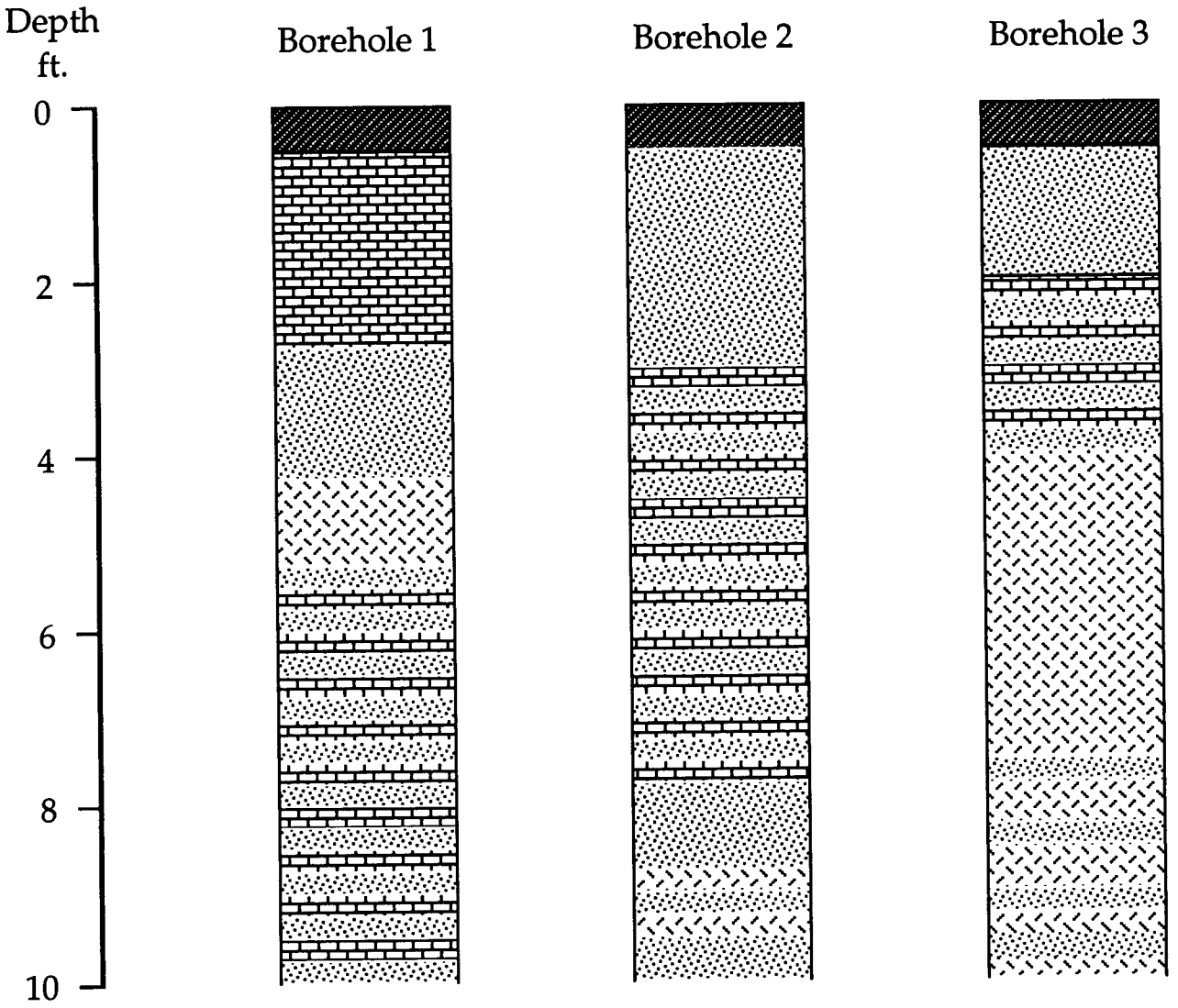
A series of HNU meter readings were collected in the well head and in the breathing zone for the purpose of worker safety. There were no positive results at borehole 1. Borehole 2 headspace readings ranged from 0.2 to 7.2 ppm (Table 11-3). Borehole 3 had readings that ranged from 0.0 to 0.4 ppm. No positive readings occurred in any of the breathing zones.

Table 11-3.
HNU Meter* Readings (PPM) in Borehole Headspace
SWMU No. 33B - Oil/Water Separator No. 186, #2-West

DATE: 4/12/93

TIME	BH1	TIME	BH2	TIME	BH3
1354	0.0	1510	0.6	1554	0.2
1420	1.8	1513	0.0	1604	0.0
1425	0.0	1525	0.0	1610	0.0
1435	0.6			1618	0.2

* Model: 101, Type: OVA PID, Make: HNU



LEGEND

- Asphalt
- Sand
- Clay
- Caliche

LRL Sciences, Inc.

SWMU #33 B
STRATIGRAPHIC COLUMN
CANNON AFB, NEW MEXICO

Project: Cannon AFB RFI	
Contract No: DACA47-93-C-009	
Prepared by: KLH	Date: 10-25-93

Fig. 11-2

Samples were collected from the three boreholes at the surface and at 10 feet and analyzed for Target List Compound Volatile Organic Compounds (TCL VOC). Following are the results of these analyses.

11.4.1.1 Borehole 1

In borehole 1, acetone was detected below the CRQL (Table 11-4) in the surface sample (CAN33B-1861-031A) and in the sample collected at 10 feet (CAN33B-1861-032D). There were no TIC compounds detected.

Table 11-4.
Concentration (μg/kg) of Volatile Organic Compounds
SWMU No. 33B - Oil/Water Separator No. 186 (#2-West)

BOREHOLE NUMBER	CANNON NUMBER	DEPTH (ft.)	CHEMICAL	
			ACETONE	XYLENE
1	CAN33B-1861-031A	Surface	8J	11U
	CAN33B-1861-032D	10.0	12J	13U
2	CAN33B-1862-031A	Surface	15J	12U
	CAN33B-1862-032D	10.0	12UJ	12U
	CAN33B-1862-831D		13 (QCD)	
3	CAN33B-1863-031A	Surface	7J	6J
	CAN3B-1863-032D	10.0	7J	12U
	CAN33B-1863-831D		15 (QCD)	

Duplicate samples or laboratory repeat samples are presented only if they are different from the original sample and not rejected.

J = estimate
R = rejected

U = not detected at CRQL
UJ = estimated as non-detect at CRQL
QCD = duplicate analyzed at the same laboratory as the normal sample

11.4.1.2 Borehole 2

In borehole 2, acetone was detected at 15 μg/kg in the surface sample (CAN33B-1862-031A).

This value is an estimate since continuing calibration %D was outside QC limits.

At 10 feet, no volatile organics were detected in the normal sample. QA/QC duplicates were collected at this depth. The QC duplicate was analyzed at the same lab and the QA duplicate was analyzed at a different lab. The QC duplicate contained acetone at 13 μg/kg. No TIC compounds were detected. The QA duplicate contained acetone and methylene chloride. Since

nearly all of the samples at the QA laboratory contained these compounds, they were considered laboratory contaminants.

11.4.1.3 Borehole 3

In borehole 3, acetone and xylene were detected below the CRQL in the surface sample (CAN33B-1863-031A). TIC compounds were also detected.

At 10 feet, acetone was detected below the CRQL (CAN33B-1863-032D). No TIC compounds were detected. A set of QA/QC duplicates were collected at this depth. The QC duplicate contained acetone at 15 μg/kg (CAN33B-1863-831D) and no TIC compounds. The QA duplicate contained acetone and methylene chloride. Due to the prevalence of these two compounds in nearly all of the QA lab samples these values have been rejected as contaminants. No TIC compounds were detected.

11.4.2 BTEX

In each borehole, two samples were collected for BTEX analysis at 2.5 and 5 feet of depth. In borehole 1, at 5 feet (CAN33B-1861-012C), toluene was detected at 7.0 μg/kg (Table 11-5). No other samples contained positive results.

Table 11-5.
Concentration (μg/kg) of BTEX
SWMU No. 33B - Oil/Water Separator No. 186, #2-West

Borehole Number	Cannon Number	Depth (ft.)	Chemical				
			Benzene	Ethly Benzene	Toluene	Xylene	BTEX Total
1	CAN33B-1861-011B	2.5	2U	2U	2U	2U	2U
	CAN33B-1861-012C	5.0	2U	2U	7	2U	7
2	CAN33B-1862-011B	2.5	2U	2U	2U	2U	2U
	CAN33B-1862-012C	5.0	2U	2U	2U	2U	2U
3	CAN33B-1863-011B	2.5	2U	2U	2U	2U	2U
	CAN33B-1863-012C	5.0	2U	2U	2U	2U	2U

Duplicate samples or laboratory repeat samples are presented only if they are different from the original sample and not rejected.
J = estimate
R = rejected
U = not detected at CRQL
UJ = estimated as non-detect at CRQL

11.4.3 Priority Metals

Total metal concentrations, using the RCRA SW-846 test methods for the analysis of metals in soils, were determined for the eight TCLP metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) plus nickel. These are the priority metals. Samples were collected for priority metals analysis at the surface, 2.5, 5, and 10 feet.

In the following presentation of metals results, only metal concentrations in excess of background concentrations are presented. No background data was collected for this investigation, therefore, background concentrations were taken from Concentrations of Selected Naturally Occurring Chemical Constituents in Soil and Groundwater at Cannon Air Force Base Clovis, New Mexico, March 1993 prepared by Woodward-Clyde. For a discussion of Woodward-Clydes background data see Section 1.7.

11.4.3.1 Borehole 1

No priority metals were detected above background in any of the samples collected at this borehole.

11.4.3.2 Borehole 2

In the surface sample (CAN33B-1862-021A), chromium was detected at 53.5 mg/kg (Table 11-6). No priority metals were detected at any other depth or in the QA/QC duplicates done for this borehole.

11.4.3.3 Borehole 3

In the surface sample (CAN33B-1863-021A), chromium was detected at 41.3 mg/kg and nickel was detected at 9.4 mg/kg. This nickel value is an estimate since matrix spike recovery was not within control limits. Background for these metals are 12.5 and 9.0 mg/kg, respectively.

In the sample collected at 2.5 feet (CAN33B-1863-022B) arsenic was detected at 32.4 mg/kg. This value is an estimate because the laboratory control sample and matrix spike recoveries were not within control limits.

No priority metals were detected above background at 5 feet.

In the sample collected at 10 feet (CAN33B-1863-024D), barium was detected at 654 mg/kg. This value is an estimate since matrix spike recoveries were not within control limits. Background for barium is 642 mg/kg. A QA/QC duplicate pair were collected at this depth. The QC duplicate (CAN33B-1863-821D), which was analyzed at the same lab as the normal sample, contained barium at 754 mg/kg. This value is an estimate since matrix spike recovery was not within control limits. The QA duplicate (CAN33B-1863-721D) which was analyzed at a different lab from the normal sample, contained barium at 1130 mg/kg.

Table 11-6

Concentration (mg/kg) of Priority Metals

SWMU No. 33B - Oil Water Separator No. 186 West

Boring Number	Sample Number (CAN33B-186)	Sample Depth (Feet)	Arsenic		Barium		Chromium		Nickel	
1	1-021A	0	4.9	J	270	J	6.2		6.1	J
	1-022B	2.5	2.2	J	79.9	J	7		7.4	J
	1-023C	5	2.7	J	80.4	J	7.2		5.8	J
	1-024D	10	2.7	J	108	J	6.3		5.1	J
2	2-021A	0	4.4	J	435	J	**53.5**		7.6	J
	2-022B	2.5	3.3	J	99.5	J	6		7	J
	2-023C	5	2.9	J	139	J	3.6		3.3	J
	2-024D	10	3.1	J	336	J	3.3		2.7	J
(QAD)	2-721D	10	2.5		423		3.6		4	
(QCD)	2-821D	10	2.7	J	234	J	3.1	U	3.6	J
3	3-021A	0	5.2	J	560	J	**41.3**		**9.4**	J
	3-022B	2.5	**32.4**	J	53.2	J	5.8		5.9	J
	3-023C	5	2.1	J	306	J	4.9		3.6	J
	3-024D	10	1.7	J	**654**	J	3.2	U	3.2	J
	3-721D	10	2.8		**1130**		3		3.2	
	3-821D	10	3.6	J	**754**	J	5.2		3.4	J
Background (95% UCL) (1)			15.50		642.00		12.50		9.00	

Notes:

Duplicate samples (QAD) or (QCD) samples are presented only if they are different from the original sample and not rejected.

U indicates that the compound was analyzed for, but not detected at or above the standard limit.
J indicates an estimated value.
UJ indicates the compound was analyzed for but not detected. The sample quantification limit or reported detection limit is an estimated quantity.
* R indicates that the data was rejected because of quality control measures

Boldface indicates a detection above the 95% UCL background level

Only data for metals detected above background is presented

(1) Background data is described in Section 17.0.

11.4.4 Summary

Acetone was detected in the surface sample of all three boreholes and at 10 feet in boreholes 1 and 3. Borehole 3 contained the most metals with chromium and nickel at the surface and arsenic and barium with depth.

DRAFT

12.0 OIL/WATER SEPARATOR (SWMU NO. 38/SITE NO. 194)

12.1 SWMU Description

12.1.1 Setting

Oil/Water Separator No. 194 is located on the northeast corner of Building 194. The separator is a 3-compartment underground unit, with a 584 gallon main compartment and 140 gallon oil compartment. The unit is constructed of concrete. The opening to the separator is surrounded on all sides by asphalt. Borehole locations were selected, in part, to avoid underground water, sewer, and runway lighting lines. Figure 12-1 shows the SWMU setting and borehole locations. The driller was required to penetrate asphalt and restore the surface with concrete plugs.

12.1.2 History of Use

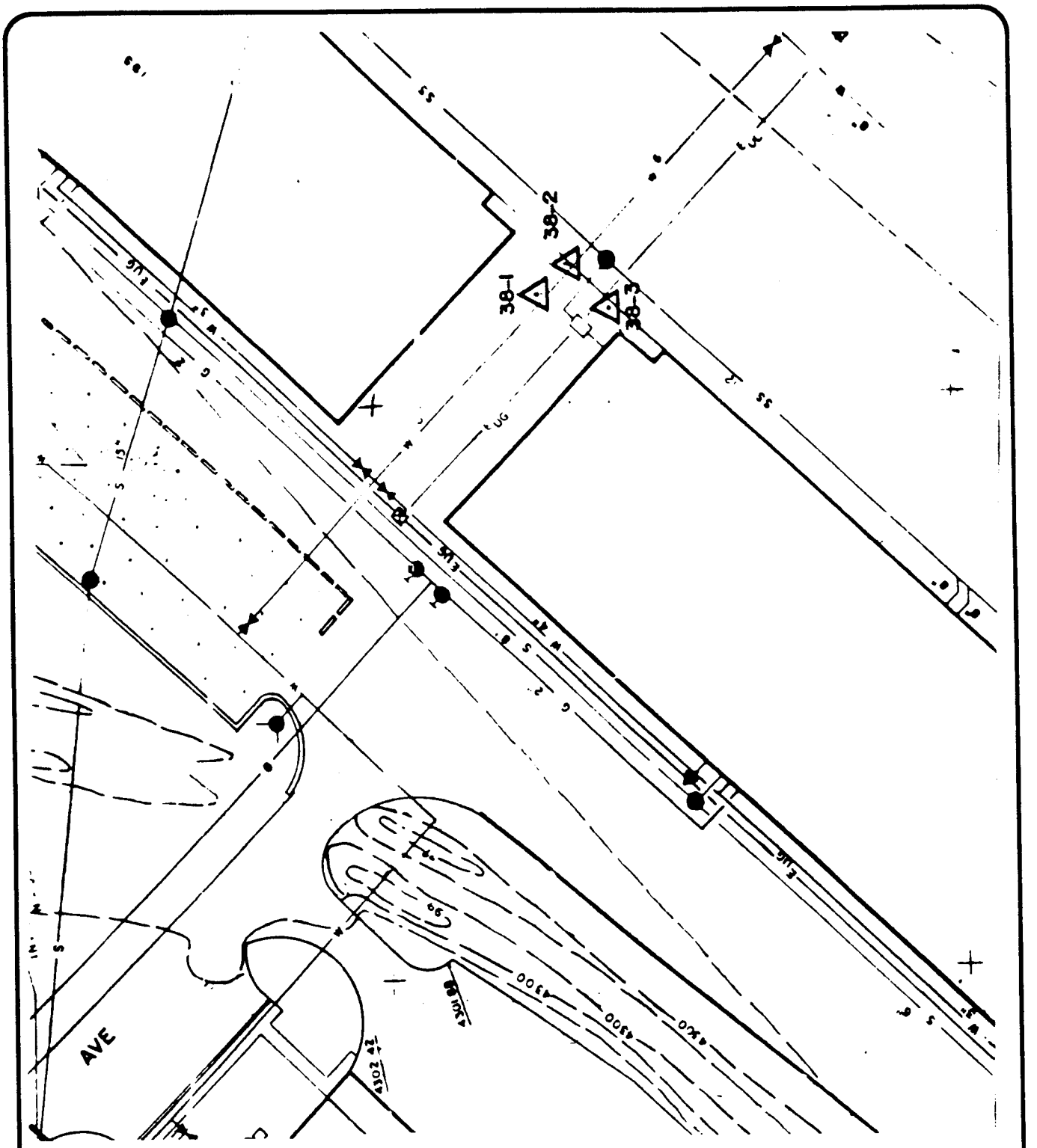
Oil/Water Separator No. 194 has been active since 1971 and is still in use, receiving washwater from aircraft maintenance operations. The recovered oils are directed to the 140 gallon holding tank and the wastewater is discharged to the Storm Drainage System which flows to Stormwater Collection Point (SWMU No. 95). Historically, the facility served by this separator has functioned as a wheel and tire shop and as an aircraft maintenance bay. The wheel and tire shop used three chemical products: PD-680, Turco stripping compound (containing 50% tetrachloro-ethylene), and Mirachem-100, all used for stripping and degreasing. The unit received washwater generated from aircraft maintenance operations, which contained petroleum and synthetic lubricating oils.

12.1.3 Past Investigations

In 1988 the Tulsa District Corps of Engineers sampled this and other oil/water separators at Cannon AFB. The results of this study were reported in Cannon Air Force Base Oil/Water Separators Sampling and Analytical Report, June, 1988. The results of this study indicated the presence of metals and organics in the liquid phase influent and/or effluent. The compounds found in either the influent, effluent or both include: benzene, toluene, ethylbenzene, xylene, naphthalene, 2-methylnaphthalene, benzoic acid, di-n-butylphthalate, bis(2-ethylhexyl)phthalate, lead, and other compounds.

12.1.4 Land Use and Demography

This SWMU is in an area of the base that is commonly frequented by personnel. However, the separator is underground and the area is currently covered by asphalt.



▲ — Borehole

Boring No.	Elevation (ft.)
1	4301.00
2	4300.94
3	4300.95

N

LRL Sciences, Inc.

SWMU #38
OIL/WATER SEPARATOR - 194
CANNON AFB, NEW MEXICO

Project: Cannon AFB RFI	
Contract No: DACA47-93-C-009	
Prepared by: KLH	Date: 10-25-93

Fig. 12-1

12.2 Field Investigation

Drilling and sampling activities at SWMU No. 38 began April 13, 1993 at 0900. The activities, as outlined in the FSP (LRL, 1993), consisted of drilling 3 boreholes, collecting 6 surface samples, 18 subsurface samples, 4 QA/QC duplicate samples and 6 QA/QC water samples. Table 12-1 summarizes the field sampling program at SWMU No. 38. Table 12-2 summarizes the various samples collected and analyses performed.

12.2.1 Sampling Objectives

Borehole locations, sampling depth, and parameters for analysis were selected, to the greatest extent possible, to determine if a release from the oil/water separator has occurred. All three boreholes were moved from their original FSP locations due to underground water, sewer, and electric lines. ? shows the borehole locations.

12.2.2 Surface and Subsurface Soil Investigation

Three boreholes were drilled at this SWMU. Borehole 1 was drilled to the northeast of the separator. Borehole 2 was drilled east of the separator. Borehole 3 was drilled southeast of the separator. Drilling was advanced to depth of 10 feet. Samples were collected at the surface, 2.5, 5 and 10 feet in depth. Surface samples were collected with a stainless steel trowel and subsurface samples were collected with a split barrel continuous sampler. Samples were collected at discrete depths and locations. No composite samples were taken. Samples were analyzed for BTEX, priority metals and TCL VOL. Duplicates, rinsate blanks, ambient blanks and decontamination water samples were also submitted to the laboratory for this SWMU site.

12.3 Physical Characteristics

This section provides a discussion of the surface water drainage, groundwater, soils and geology at the No. 194 oil/water separator based on a review of information from previous investigations at Cannon AFB and from the lithologic descriptions of split spoon samples from this investigation.

12.3.1 Surface Water Drainage

A topographic/surface drainage map in addition to text found in Installation Restoration Program Records Search, August 1983 prepared by CH_2M Hill indicates that the surface water drainage in the vicinity of SWMU No. 38 enters the base storm water drainage system and flows to the Stormwater Collection Point (SWMU No. 95). SWMU No. 95 is a stormwater collection ditch located east of the sewage lagoons.

Table 12-1.
Summary of Drilling and Sampling
SWMU No. 38 - Oil/Water Separator No. 194

Borehole Number	Sampling Depth (ft.-BGS)	Drilling/ Sampling Methods	Drillrig Used	Borehole Diameter (in.)	Ground Elevation	Date Grouted
1	0	NA/SSS	NA	NA	4301.00	4/14/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
2	0	NA/SSS	NA	NA	4300.94	4/14/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
3	0	NA/SSS	NA	NA	4300.95	4/14/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		

HSA = Hollow Stem Auger
HA = Hand Auger
SBC = Split Barrel Continuous Sampler
SS = Split Spoon
SSS = Stainless Steel Spoon

Table 12-2.
Summary of Sampling and Analyses
SWMU No. 38, Oil/Water Separator No. 194

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
1	0	CAN038-1941-021A	N	SOIL	0915	PM	6010/7000S+
		CAN039-1941-031A	N	SOIL	0915	TCL VOC	
	2.5	CAN038-1941-022B	N	SOIL	0930	PM	6010/7000S
		CAN039-1941-032B	N	SOIL	0930	TCL VOC	8240
		CAN038-1941-821B	N	SOIL	0930	PM	6010/7000S
		CAN038-1941-831B	N	SOIL	0930	TCL VOC	8240
		CAN038-1941-721B	N	SOIL	0930	PM	6010/7000S
		CAN038-1941-731B	N	SOIL	0930	TCL VOC	8240
	5.0	CAN038-1941-011C	N	SOIL	0945	BTEX	8020
		CAN038-1941-023C	N	SOIL	0947	PM	6010/7000S
	10.0	CAN038-1941-012D	N	SOIL	0945	BTEX	8020
		CAN038-1941-024D	N	SOIL	0947	PM	6010/7000S
2	0	CAN038-1942-021A	N	SOIL	1005	PM	6010/7000S
		CAN038-1942-031A	N	SOIL	1005	TCL VOC	8240
	2.5	CAN038-1942-022B	N	SOIL	1015	PM	6010/7000S
		CAN038-1942-032B	N	SOIL	1015	TCL VOC	8240
	5.0	CAN038-1942-011C	N	SOIL	1020	BTEX	8020
		CAN038-1942-023C	N	SOIL	1020	PM	6010/7000S
	10.0	CAN038-1942-012D	N	SOIL	1022	BTEX	8020
		CAN038-1942-024D	N	SOIL	1022	PM	6010/7000S

Table 12-2. (Concluded)
Summary of Sampling and Analyses
SWMU No. 38, Oil/Water Separator No. 194

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
3	0	CAN038-1943-021A	N	SOIL	1103	PM	6010/7000S
		CAN038-1943-031A	N	SOIL	1103	TCL VOC	8240
	2.5	CAQN038-1943-022B	N	SOIL	1115	PM	6010/7000S
		CAN038-1943-032B	N	SOIL	1115	TCL VOC	8240
	5.0	CAN038-1943-011C	N	SOIL	1122	BTEX	8020
		CAN038-1943-023C	N	SOIL	1122	PM	6010/7000S
	10.0	CAN038-1943-012D	N	SOIL	1124	BTEX	8020
		CAN038-1943-024D	N	SOIL	1124	PM	6010/7000S
		CAN038-1940-431Z	N	WATER	0910	TCL VOC	8240
		CAN038-1940-321Z	N	WATER	1140	PM	6010/7000S
		CAN038-1940-331Z	N	WATER	1145	TCL VOC	8240
		CAN038-1940-231Z	N	WATER	1150	TCL VOC	8240
		CAN038-1940-621Z	N	WATER	1140	PM	6010/7000S
		CAN038-1940-631Z	N	WATER	1155	TCL VOC	8240

BTEX = Benzene, Toluene, Ethyl Benzene, Xylene
ft-BGS = feet below ground surface
N = Normal soil sample
PM = Priority metals = 8 TCLP metals + Ni
TCL VOC = Target Compound List Volatile Organic Compound
\+ = Metals analyzed using the 7000 Series include: mercury, selenium, and arsenic.

QAD = Duplicate soil sample (analyzed at different laboratory from normal samples).
QCD = Duplicate soil sample analyzed at same laboratory as normal samples.
QC = Quality control water sample (ambient blank, trip blank, etc.)
TAL Metals = Target analyte list metals

12.3.2 Groundwater

Depth to groundwater at Cannon AFB is approximately 250 feet or greater. Groundwater recharge rates for the High Plains Region where Cannon AFB is located are typically low. Localized recharge rates for Curry County range from 0.75 - 12.22 mm/yr (Stone, 1985). EPA, 1987 DRASTIC reports recharge rates of 1 in/yr. Section 1.0 of this report includes a discussion of groundwater hydrology for Cannon AFB.

12.3.3 Soils and Geology

The near surface (upper ten feet) stratigraphy in the area surrounding this SWMU consist of Tertiary Miocene to Pliocene fluvial deposits of the Ogallala Formation. The soils have been described as a fine sandy loam (Ab) of the Amarillo soil group (USDA, 1993). Interpretations and correlation on the fluvial deposits for this area are based on split spoon samples collected during the drilling process. The soils consist of very fine to fine-grained, moderately sorted, submature to mature (textural), unconsolidated, calcareous, dark red-brown, clays, silts, and sands. Thin to moderately thin layers of caliche material were interbedded throughout much of the samples collected. The sands were comprised of angular to subangular grains with varying amounts of silts, clays, and calcium carbonate (caliche) material. This description of lithology (Figure 12-2) is similiar to the description of soils given by the USDA Draft Soil Survey, 1993. The thickness of this particular unit remains unknown, due to the fact that boring levels did not exceed ten feet. The total thickness of the Ogallala Formation beneath this SWMU is not presently known, but regional information based on Curry County reports have suggested thicknesses of approximately 320-400 feet. No groundwater was encountered while drilling at these three borehole locations. The minimum depth of the High Plains aquifer is believed to be 250 feet below ground surface.

12.4 Nature and Extent of Contamination

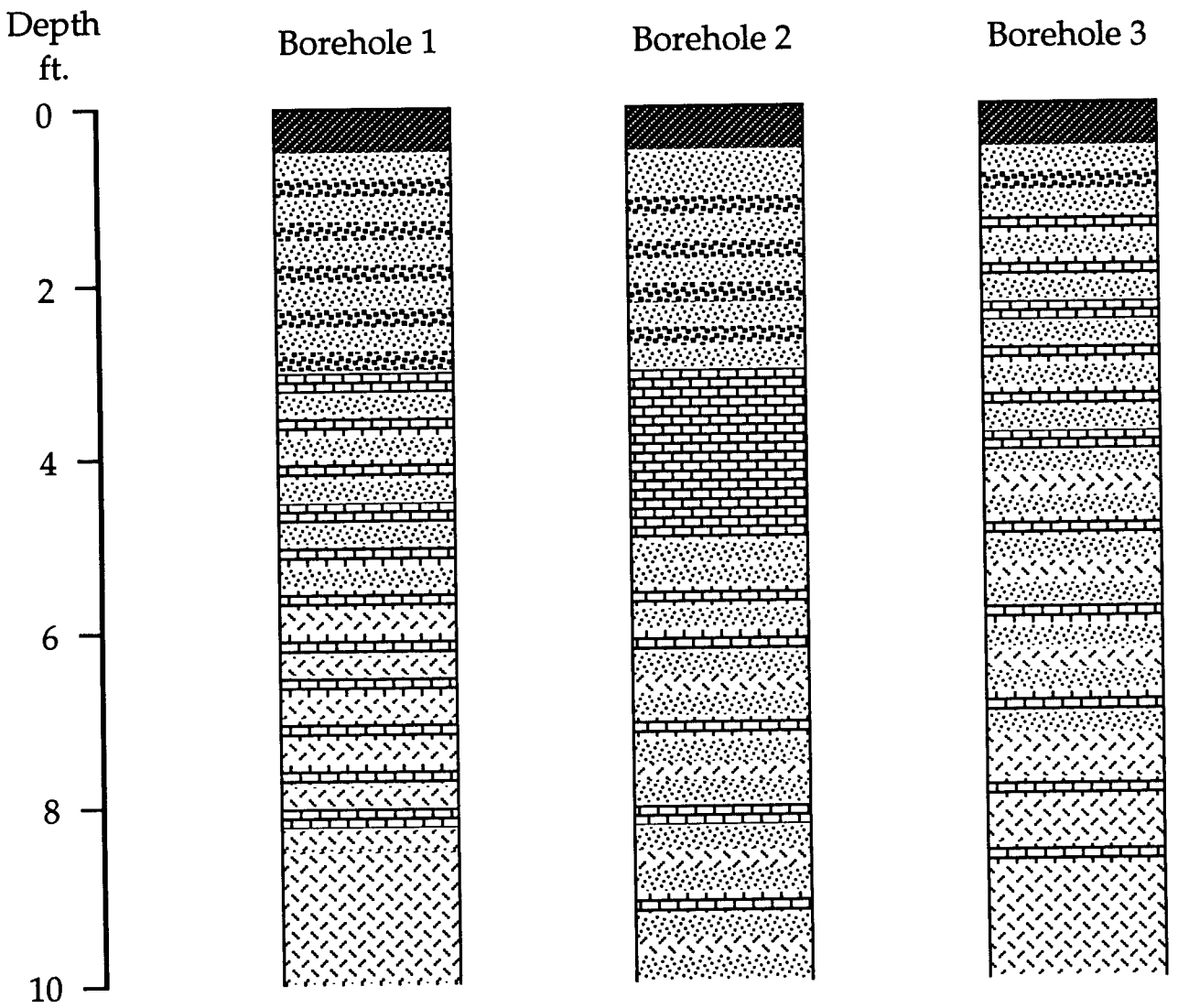
12.4.1 Volatile Organic Compounds

A series of HNU meter readings were taken at the well head and in the breathing zone of each borehole for the purpose of worker safety. Borehole 1 had positive readings ranging from 0.0 to 1.0 ppm (Table 12-3) in the well head. Boreholes 2 and 3 had no positive readings in the well head. No positive reading occurred in the breathing zone at any borehole.

Samples were collected from all three boreholes, at the surface and at 2.5 feet, and analyzed for Target Compound List Volatile Organic Compounds (TCL VOC). Following are the results of these analyses.

12.4.1.1 Borehole 1

In the surface sample (CAN038-1941-031A), acetone was detected at 13.0 μg/kg (Table 12-4). This value is an estimate since continuing calibration %D was outside control limits. One TIC compound was detected.



LEGEND

- Asphalt
- Gravel
- Sand
- Clay
- Caliche

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SWMU #38
STRATIGRAPHIC COLUMN
CANNON AFB, NEW MEXICO

Project: Cannon AFB RFI	
Contract No: DACA47-93-C-009	
Prepared by: KLH	Date: 10-25-93

Fig. 12-2

Table 12-3.
HNU Meter* Readings (PPM) in Borehole Headspace
SWMU No. 38 - Oil/Water Separator No. 194

DATE: 4/13/93

TIME	BH1	TIME	BH2	TIME	BH3
0915	0.6	1004	0.0	1101	0.0
0920	0.8	1012	0.0	1110	0.0
0924	1.0	1018	0.0	1116	0.0
0930	0.0	1024	0.0	1124	0.0
0944	0.2				

* Model: 101, Type: OVA PID, Make: HNU

Table 12-4.
Concentration (μg/kg) of Volatile Organic Compounds
SWMU No. 38 - Oil/Water Separator No. 194

BOREHOLE NUMBER	CANNON NUMBER	DEPTH (ft.)	CHEMICAL		
			ACETONE	TOLUENE	1,1,1-TRICHLOROETHANE
1	CAN038-1941-031A	Surface	13J	11U	11U
	CAN038-1941-032B	2.5	13	12U	12U
	CAN038-1941-831B		11U (QC)		
2	CAN038-1942-031A	Surface	11UJ	11U	11U
	CAN038-1942-032B	2.5	17J	12U	12U
3	CAN038-1943-031A	Surface	10UJ	5J	8J
	CAN038-1943-032B	2.5	11UJ	11U	11U

Duplicate samples or laboratory repeat samples are presented only if they are different from the original sample and not rejected.

J = estimate
R = rejected
U = not detected at CRQL
UJ = estimated as non-detect at CRQL

At 2.5 feet (CAN038-1941-032B), acetone was detected at 13.0 μg/kg. The QA/QC field duplicate samples were collected at this depth. The QC duplicate, which was analyzed at the same lab as the normal sample, contained no target compounds but did contain one TIC compound. The QA duplicate, which was analyzed at a different lab than the normal sample, contained acetone and methylene chloride. The values for these analytes have been rejected, however, due to their presence in nearly all of the samples analyzed at the QA laboratory.

12.4.1.2 Borehole 2

In the surface sample no target compounds or TIC compounds were detected.

At 2.5 feet (CAN038-1942-032B), acetone was detected at 17.0 μg/kg. This value is an estimate since continuing calibration %D was outside the control limits. One TIC compound was detected.

12.4.1.3 Borehole 3

In the surface sample (CAN038-1943-031A), 1,1,1-trichloroethane and toluene were detected below the CRQL. No TIC compounds were detected.

At 2.5 feet, no target compounds or TIC compounds were detected.

12.4.2 BTEX

In each borehole two samples were collected for BTEX analysis. Samples were collected at 5 and 10 feet of depth. No BTEX compounds were detected in any of the samples. QA/QC were not collected and therefore they were not analyzed for BTEX.

12.4.3 Priority Metals

Total metals concentrations, using the RCRA SW-846 test methods for the analysis of metals in soils, were determined for the eight TCLP metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) plus nickel. These are the priority metals. Samples were collected for priority metals analysis at the surface, 2.5, 5, and 10 feet.

In the following presentation of metals results, only metals concentrations in excess of background concentrations are presented. No background data was collected for this investigation, therefore, background concentrations were taken from Concentrations of Selected Naturally Occurring Chemical Constituents in Soil and Groundwater at Cannon Air Force Base Clovis, New Mexico, March 1993 prepared by Woodward-Clyde. For a discussion of Woodward-Clydes selection of background values, see Section 1.7.

DRAFT

12.4.3.1 Borehole 1

No priority metals were detected above background in the surface sample.

At 2.5 feet (CAN038-1941-022B), nickel was detected at 9.2 mg/kg (Table 12-5). Background for nickel is 9.0 mg/kg. The QA/QC field duplicate samples were collected at this depth. The QC duplicate, which was analyzed at the same lab as the normal sample, contained no priority metals above background. The QA duplicate (CAN038-1941-721B), which was analyzed at a different lab than the normal sample, contained chromium at 13.9 mg/kg and nickel at 10.6 mg/kg.

The 5 foot sample (CAN038-1941-023C), contained nickel at 11.0 mg/kg. This value is an estimate since the matrix spike recovery was not within control limits.

At 10 feet, no priority metals above background were detected.

12.4.3.2 Borehole 2

In the surface sample and at 2.5 feet, no priority metals were detected above background.

At 5 feet (CANO38-1942-023C), nickel was detected at 9.7 mg/kg. This value is an estimate since matrix spike recovery was not within control limits.

At 10 feet, no priority metals were detected above background.

12.4.3.3 Borehole 3

In the surface sample and at 2.5 feet, no priority metals were detected above background.

At 5 feet (CAN038-1943-023C), nickel was detected at 10.4 mg/kg. This value is an estimate since matrix spike recovery was not within control limits.

At 10 feet, no priority metals above background were detected.

12.5 Summary

From the surface to 2.5 feet several organic compounds were detected in one or more of the boreholes: acetone, 1,1,1-trichloroethane, toluene and/or TIC compounds. Borehole 1 contained nickel and chromium at 2.5 feet. All three boreholes contained nickel at 5 feet. No metals were detected above background at 10 feet.

Table 12-5
Concentration (mg/kg) of Priority Metals
SWMU No. 38 - Oil/Water Separator No. 194

Boring Number	Sample Number (CAN038-194)	Sample Depth (Feet)	Chromium		Nickel	
1	1-021A	0	10.6	UJ	7.8	J
	1-022B	2.5	10.4	UJ	**9.2**	
(QAD)	1-721B	2.5	**13.9**		**10.6**	
(QCD)	1-821B	2.5	10.2	UJ	9	J
	1-023C	5	12.1	UJ	**11**	J
	1-024D	10	3	UJ	3.7	J
2	2-021A	0	6.6	UJ	6.9	J
	2-022B	2.5	9.8	UJ	9	J
	2-023C	5	9.2	UJ	9.7	J
	2-024D	10	6.8	UJ	6.6	J
3	3-021A	0	12	UJ	7.3	J
	3-022B	2.5	8.6	UJ	6.2	J
	3-023C	5	11	UJ	**10.4**	J
	3-024D	10	3.4	UJ	3.9	J
Background (95% UCL) (1)			12.50		9.00	

Notes:

Duplicate samples (QAD) or (QCD) samples are presented only if they are different from the original sample and not rejected.

U indicates that the compound was analyzed for, but not detected at or above the standard limit.
J indicates an estimated value.
UJ indicates the compound was analyzed for but not detected. The sample quantification limit or reported detection limit is an estimated quantity.
* R indicates that the data was rejected because of quality control measures

Boldface indicates a detection above the 95% UCL background level

Only data for metals detected above background is presented

(1) Background data is described in Section 17.0.

13.0 OIL/WATER SEPARATOR (SWMU NO. 39/SITE NO. 195)

13.1 SWMU Description

13.1.1 Setting

Oil/water separator No. 195 is located on the northeast corner of Building 195. The separator is a 2-compartment underground unit, including a skimmer, with 584 gallon main compartment and a 140 gallon oil compartment. The unit is constructed of concrete. The opening to the separator is surrounded on all sides by asphalt. The driller was required to penetrate the asphalt and restore the surface with a concrete plug. Borehole locations were selected, in part, to avoid underground utilities including: water, sewer, and flight line electrical lines. Figure 13-1 shows the setting and borehole locations.

13.1.2 History of Use

Oil/water separator No. 195 has been active since 1971 and is still in use, receiving washwater from aircraft maintenance operations. The effluent contains petroleum and synthetic lubricating oils and dirt. The recovered oils are directed to the 140 gallon holding tank and the wastewater is discharged to the Storm Drainage System which flows to Stormwater Collection Point (SWMU No. 95). Historically the separator has served the munitions facility.

13.1.3 Past Investigations

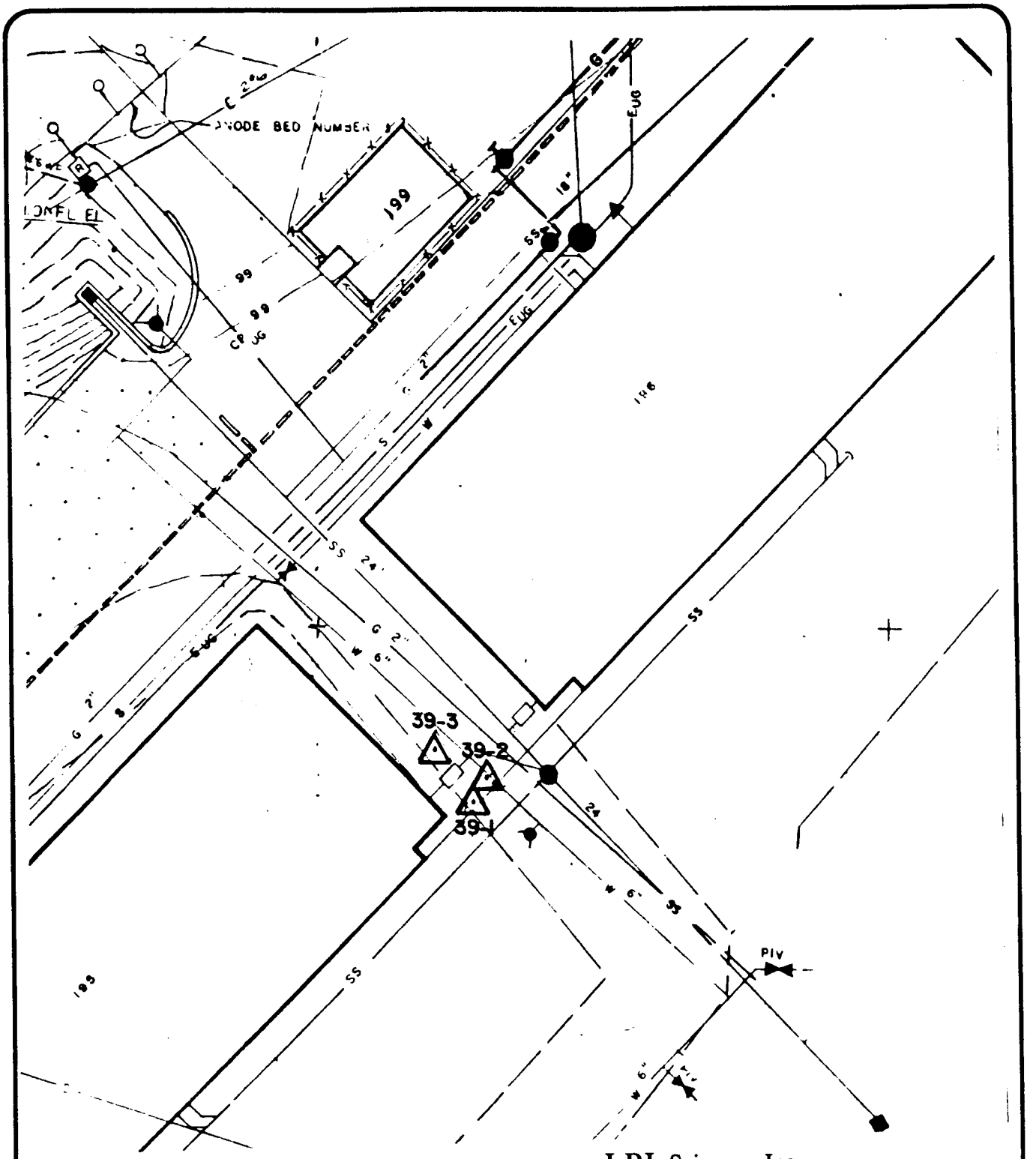
In 1987-1988 the Tulsa District Corps of Engineers sampled this and other oil/water separators at Cannon AFB. The results of this study were reported in Cannon Air Force Base Oil/Water Separators Sampling and Analytical Report, June, 1988. The results of this study indicated the presence of metals and organics in the liquid phase influent and/or effluent. The compounds found in either the influent, effluent or both include: benzene, toluene, ethylbenzene, xylene, naphthalene, 2-methylnaphthalene, benzoic acid, bis(2-ethylhexyl)phthalate, phenol, 4-methylphenol, lead, and other compounds.

13.1.4 Land Use and Demography

This SWMU is in an area of the base that is commonly frequented by personnel. However, the separator is underground and the area is currently covered by asphalt.

13.2 FIELD INVESTIGATION

Drilling and sampling activities at SWMU No.39 began April 13, 1993 at 1310. The activities, as outlined in the FSP (LRL, 1993), consisted of drilling 3 boreholes, collecting 6 surface samples, 18 subsurface samples, 4 QA/QC duplicate samples and 6 QA/QC water samples. Table 13-1 summarizes the field sampling program at SWMU No.39. Table 13-2 summarizes the various samples collected and analyses performed.



▲ — Borehole

Boring No.	Elevation (ft.)
1	4300.73
2	4300.33
3	4300.67

N

LRL Sciences, Inc.

SWMU #39
OIL/WATER SEPARATOR - 195
CANNON AFB, NEW MEXICO

Project:	Cannon AFB RFI
Contract No:	DACA47-93-C-009
Prepared by: KLH	Date: 10-25-93

Fig. 13-1

Table 13-1.
Summary of Drilling and Sampling
SWMU No. 39 - Oil/Water Separator No. 195

Borehole Number	Sampling Depth (ft.-BGS)	Drilling/ Sampling Methods	Drillrig Used	Borehole Diameter (in.)	Ground Elevation	Date Grouted
1	0	NA/SSS	NA	NA	4300.73	4/14/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
2	0	NA/SSS	NA	NA	4300.33	4/14/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
3	0	NA/SSS	CME-75	NA	4300.67	4/14/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		

HSA = Hollow Stem Auger
HA = Hand Auger
SBC = Split Barrel Continuous Sampler
SS = Split Spoon
SSS = Stainless Steel Spoon

Table 13-2.
Summary of Sampling and Analyses
SWMU No. 39 - Oil/Water Separator No. 195

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
1	0	CAN039-1951-021A	N	SOIL	1345	PM	6010\7000S
		CAN039-1951-031A	N	SOIL	1345	TCL VOC	8240
	2.5	CAN039-1951-011B	N	SOIL	1355	BTEX	8020
		CAN039-1951-022B	N	SOIL	1355	PM	6010\7000S
	5.0	CAN039-1951-023C	N	SOIL	1400	PM	6010\7000S
		CAN039-1951-032C	N	SOIL	1400	TCL VOC	8240
	10.0	CAN039-1951-012D	N	SOIL	1405	BTEX	8020
		CAN039-1951-024D	N	SOIL	1405	PM	6010\7000S
2	0	CAN039-1952-021A	N	SOIL	1430	PM	6010\7000S
		CAN039-1952-031A	N	SOIL	1430	TCL VOC	8240
	2.5	CAN039-1952-011B	N	SOIL	1440	BTEX	8020
		CAN039-1952-022B	N	SOIL	1440	PM	6010\7000S
	5.0	CAN039-1952-023C	N	SOIL	1451	PM	6010\7000S
		CAN039-1952-032C	N	SOIL	1451	TCL VOC	8240
	10.0	CAN039-1952-012D	N	SOIL	1449	BTEX	8020
		CAN039-1952-024D	N	SOIL	1449	PM	6010\7000S

Table 13-2. (Concluded)
Summary of Sampling and Analyses
SWMU No. 39 - Oil/Water Separator No. 195

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
3	0	CAN039-1953-021A	N	SOIL	1530	PM	6010\7000S
		CAN039-1953-031A	N	SOIL	1530	TCL VOC	8240
	2.5	CAN039-1953-011B	N	SOIL	1540	BTEX	8020
		CAN039-1953-022B	N	SOIL	1540	PM	6010\7000S
	5.0	CAN039-1953-023C	N	SOIL	1600	PM	6010\7000S
		CAN039-1953-032C	N	SOIL	1600	TCL VOC	8240
		CAN039-1953-821C	QCD	SOIL	1600	PM	6010\7000S
		CAN039-1953-831C	QCD	SOIL	1600	TCL VOC	8240
		CAN039-1953-721C	QAD	SOIL	1600	PM	6010\7000S
		CAN039-1953-731C	QAD	SOIL	1600	TCL VOC	8240
	10.0	CAN039-1953-012D	N	SOIL	1555	BTEX	8020
		CAN039-1953-024D	N	SOIL	1555	PM	6010/7000S
		CAN039-1950-431Z	QC	WATER	1415	TCL VOC	8240
		CAN039-1950-321Z	QC	WATER	1610	PM	6010\7000S
		CAN039-1950-331Z	QC	WATER	1615	TCL VOC	8240
		CAN039-1950-231Z	QC	WATER	1620	TCL VOC	8240
		CAN039-1950-621Z	QC	WATER	1610	PM	6010\7000S
		CAN039-1950-631Z	QC	WATER	1622	TCL VOC	8240

BTEX = Benzene, Toluene, Ethyl Benzene, Xylene
ft-BGS = feet below ground surface
N = Normal soil sample
PM = Priority metals = 8 TCLP metals + Ni
TCL-VOC = Target Compound List Volatile Organic Compound
\+ = Metals analyzed using the 7000 Series include: mercury, selenium, and arsenic.

QAD = Duplicate soil sample (analyzed at different laboratory from normal samples).
QCD = Duplicate soil sample analyzed at same laboratory as normal samples.
QC = Quality control water sample (ambient blank, trip blank, etc.)
TAL Metals = Target analyte list metals

13.2.1 Sampling Objectives

Borehole locations, sampling depth, and parameters for analysis were selected, to the greatest extent possible, to determine if a release from the oil/water separator has occurred particularly at the separator/stormwater line joints. All three borehole were moved from their original FSP locations due to underground water, sewer, and electric lines. Figure 13-1 shows the borehole locations.

13.2.2 Surface and Subsurface Soil Investigation

Three boreholes were drilled at this SWMU. Borehole 1 was drilled 7 feet to the southeast of the separator. Borehole 2 was drilled 7 feet east of the separator. Borehole 3 was drilled 8 and half feet northwest of the separator. Drilling was advanced to depth of 10 feet. Samples were collected at the surface, 2.5, 5 and 10 feet in depth. Surface samples were collected with a stainless steel trowel and subsurface samples were collected with a split barrel continuous sampler. Samples were collected at discrete depths and locations. No composite samples were taken. Samples were analyzed for BTEX, priority metals and TCL VOL. Duplicates, rinsate blanks, ambient blanks and decontamination water samples were also submitted to the laboratory for this SWMU.

13.3 Physical Characteristics

This section provides a discussion of the surface water drainage, groundwater, soils, and geology at the No.195 oil/water separator based on a review of information from previous investigations at Cannon AFB and from the lithologic descriptions of split spoon samples from this investigation.

13.3.1 Surface Water Drainage

A topographic/surface drainage map in addition to text found in Installation Restoration Program Records Search, August 1983 prepared by CH_2M Hill indicates that the surface water drainage in the vicinity of SWMU No. 39 enters the base stormwater drainage system and flows to the Stormwater Collection Point (SWMU No. 95). SWMU No. 95 is a stormwater collection ditch located east of the sewage lagoons.

13.3.2 Groundwater

Depth to groundwater at Cannon AFB is approximately 250 feet or greater. Groundwater recharge rates for the High Plains Region where Cannon AFB is located are typically low. Localized recharge rates for Curry County range from 0.75 - 12.22 mm/yr (Stone, 1985). EPA, 1987 DRASTIC reports recharge rates of 1 in/yr. Section 1.0 of this report includes a discussion of groundwater hydrology for the High Plains and Cannon AFB.

13.3.3 Soils and Geology

The near surface (upper ten feet) stratigraphy in the area surrounding this SWMU consist of Tertiary Miocene to Pliocene fluvial deposits of the Ogallala Formation. The soils have been described as a fine sandy loam (Ab) of the Amarillo soil group (USDA draft "Soil Survey" 1993). Interpretations and correlation on the fluvial deposits for this area are based on split spoon samples collected during the drilling process. The soils consist of very fine to fine-grained, moderate to well sorted, submature to mature (textural), unconsolidated, calcareous, red to brown, clays, silts, and sands. Thin to moderately thin layers and nodules of caliche material were interbedded throughout much of the samples collected. The sands were comprised of angular to subangular grains with varying amounts of silts, clays, and calcium carbonate (caliche) material. This description of lithology (Figure 13-2) is similiar to the description of soils given by the USDA Draft Soil Survey, 1993. The thickness of this particular unit remains unknown, due to the fact that boring levels did not exceed ten feet. The total thickness of the Ogallala Formation beneath this SWMU is not presently known, but regional information based on Curry County reports have suggested thicknesses of approximately 320-400 feet. No groundwater was encountered while drilling at these three borehole locations. The minimum depth of the High Plains aquifer is reported to be greater than 250 feet below ground surface.

13.4 Nature and Extent of Contamination

13.4.1 Volatile Organic Compounds

A series of HNU meter readings were taken at the well head and in the breathing zone of each borehole for the purpose of worker safety. Boreholes 1 had positive readings ranging from 0.0 to 0.2 ppm (Table 13-3) in the well head. Boreholes 2 readings ranged from 0.0 to 21.0 ppm and borehole 3 ranged from 0.0 to 0.6 ppm in the well head. No positive reading occurred in the breathing zone at any borehole.

Samples were collected from all three boreholes, at the surface and at 5 feet, and analyzed for Target Compound List Volatile Organic Compounds (TCL VOC). Following are the results of these analyses.

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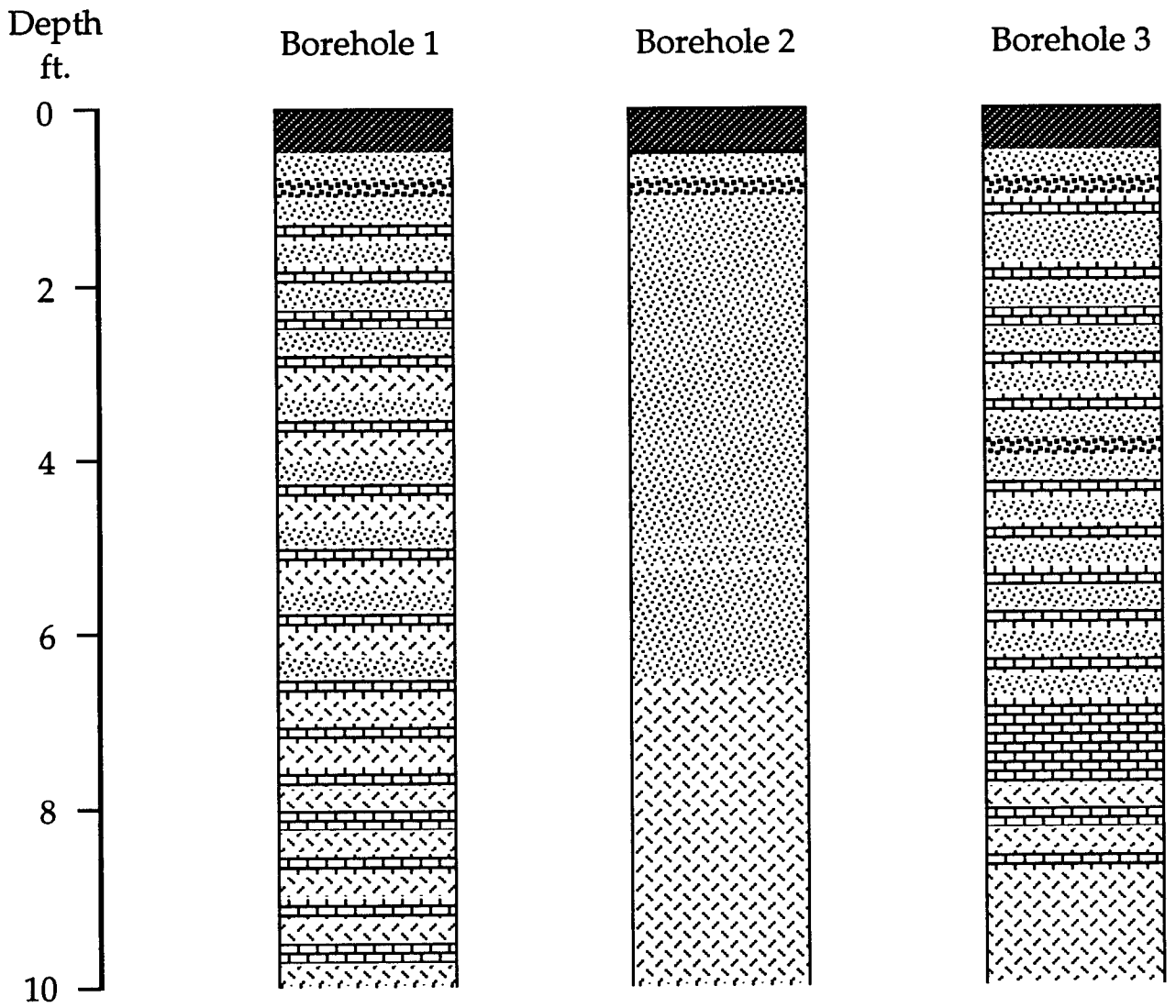

LEGEND

- Asphalt
- Gravel
- Sand
- Clay
- Caliche

LRL Sciences, Inc.

SWMU #39
STRATIGRAPHIC COLUMN
CANNON AFB, NEW MEXICO

Project: Cannon AFB RFI	
Contract No: DACA47-93-C-009	
Prepared by: KLH	Date: 10-25-93

Fig. 13-2

Table 13-3.
HNU Meter* Readings (PPM) in Borehole Headspace
SWMU No. 39 - Oil/Water Separator No. 195

DATE: 4/13/93

TIME	BH1	TIME	BH2	TIME	BH3
1340	0.0	1428	0.4	1528	0.4
1345	0.0	1436	0.0	1537	0.0
1402	0.2	1445	0.0	1547	0.0
		1450	21.0	1555	0.6

* Model: 101, Type: OVA PID, Make: HNU

Table 13-4.
Concentration (μg/kg) of Volatile Organic Compounds
SWMU No. 39 - Oil/Water Separator No. 195

BOREHOLE NUMBER	CANNON NUMBER	DEPTH (ft.)	CHEMICAL	
			ACETONE	TOLUENE
1	CAN039-1951-031A	Surface	R	12J
	CAN039-1951-032C	5.0	R	12U
2	CAN039-1952-031A	Surface	5J	10U
	CAN039-1952-032C	5.0	38	12U
3	CAN039-1953-031A	Surface	10U	10U
	CAN039-1953-032C	5.0	9J	12U
	CAN039-1953-831C		11U (QCD)	

Duplicate samples or laboratory repeat samples are presented only if they are different from the original sample and not rejected.

J = estimate
R = rejected

U = not detected at CRQL
UJ = estimated as non-detect at CRQL
QCD = duplicate analyzed at the same laboratory as the normal sample.

13.4.1.1 Borehole 1

In the surface sample (CAN039-1951-031A), toluene was detected at 12.0 μg/kg. This value is an estimate since internal standard recoveries were outside QC limits. Methylene chloride was detected but due to its presence in the blank, was considered a non-detect. Acetone was detected also but rejected due to contaminant co-elution. No TIC compounds were detected.

At 5 feet, methylene chloride was detected but due to its presence in the blank, was considered a non-detect. Acetone was detected also but rejected due to contaminant co-elution. No TIC compounds were detected.

13.4.1.2 Borehole 2

In the surface sample (CAN039-1952-031A), acetone was detected below the CRQL. No TIC compounds were detected.

At 5 feet (CAN039-1952-032C), acetone was detected at 38.0 μg/kg. No TIC compounds were detected.

13.4.1.3 Borehole 3

In the surface sample, no target compounds or TIC compounds were detected.

At 5 feet (CAN039-1953-032C), acetone was detected below the CRQL. The QA/QC duplicate samples were collected at this depth. The QC duplicate, which was analyzed at the same lab as the normal sample, contained no target compounds or TIC compounds. The QA duplicate, which was analyzed at a different lab than the normal sample, contained acetone, methylene chloride and 2-butanone. Methylene chloride and acetone occur in nearly all of the samples analyzed at the QA lab and were therefore rejected as a contaminant. 2-butanone, a common laboratory contaminant, did not occur in any of the samples analyzed at the QC laboratory and was therefore rejected in the QA laboratory data.

13.4.2 BTEX

In each borehole two samples were collected for BTEX analysis. Samples were collected at 2.5 and 10 feet of depth. No BTEX compounds were detected in any of the samples. QA/QC samples were not collected and therefore were not analyzed for BTEX.

13.4.3 Priority Metals

Total metals concentrations, using the RCRA SW-846 test methods for the analysis of metals in soils, were determined for the eight TCLP metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) plus nickel. These are the priority metals. Samples were collected for priority metals analysis at the surface, 2.5, 5, and 10 feet.

In the following presentation of metals results, only metals concentrations in excess of background concentrations are presented. No background data was collected for this investigation, therefore, background concentrations were taken from Concentrations of Selected Naturally Occurring Chemical Constituents in Soil and Groundwater at Cannon Air Force Base Clovis, New Mexico, March 1993 prepared by Woodward-Clyde. For a discussion of Woodward-Clydes background data see Section 1.7.

13.4.3.1 Borehole 1

No priority metals were detected above background in the surface sample or at 2.5 feet.

At 5 feet (CAN039-1951-023C), lead and nickel were detected at 163 and 9.32 mg/kg, respectively (Table 13-5). The value for lead is an estimate since laboratory control sample recoveries were not within control limits. Background for lead is 25.8 mg/kg and for nickel, 9.0 mg/kg.

No priority metals were detected above background at 10 feet.

13.4.3.2 Borehole 2

In the surface sample, no priority metals were detected above background.

At 2.5 feet (CAN039-1952-022B), nickel was detected at 9.7 mg/kg.

At 5 feet (CANO39-1952-023C), lead was detected at 52.0 mg/kg. This value is an estimate since laboratory control sample recoveries were not within control limits.

At 10 feet, no priority metal were detected above background.

13.4.3.3 Borehole 3

In the surface sample, no priority metals were detected above background.

At 2.5 feet (CAN039-1953-022B), nickel was detected at 9.1 mg/kg.

At 5 feet, no priority metals were detected above background. The QA/QC field duplicate samples were collected at this depth. The QC duplicate (CAN039-1953-821C), which was analyzed at the same lab as the normal sample, contained nickel at 10.2 mg/kg. The QA duplicate (CAN039-1953-721C), which was analyzed at a different lab than the normal sample, contained chromium at 14.9 mg/kg and nickel at 11.8 mg/kg.

At 10 feet (CAN039-1953-024D), barium was detected at 2,200 mg/kg. This value is an estimate since matrix spike recovery was not within control limits.

Table 13-5
Concentration (mg/kg) of Priority Metals
SWMU No. 39 - Oil Water Separator No. 195

Boring Number	Sample Number (CAN039-195)	Sample Depth (Feet)	Barium		Chromium		Lead		Nickel
1	1-021A	0	341	J	6.4	J	5.2	J	5.8
	1-022B	2.5	81.5	J	9.9	J	8.1	J	8.3
	1-023C	5	89.7	J	10.2	J	**163**	J	**9.3**
	1-024D	10	530	J	3.6	J	4.2	J	5.2
2	2-021A	0	464	J	10.5	J	4.2	J	4.3
	2-022B	2.5	79.8	J	12.5	J	6.7	J	**9.7**
	2-023C	5	66.4	J	8.8	J	**52**	J	8.7
	2-024D	10	187	J	4.9	J	5.2	J	5.2
3	3-021A	0	589	J	10.9	J	5.5	J	5.5
	3-022B	2.5	79.1	J	11.8	J	7.5	J	**9.1**
	3-023C	5	93.2	J	9.9	J	8.4	J	8.5
(QAD)	3-721C	5	113		**14.9**		9		**11.8**
(QCD)	3-821C	5	102	J	11.2	J	9.1	J	**10.2**
	3-024D	10	**2200**	J	3.7	J	3.6	J	4.3
Background (95% UCL) (1)			642.00		12.50		25.80		9.00

Notes:

Duplicate samples (QAD) or (QCD) samples are presented only if they are different from the original sample and not rejected.

U indicates that the compound was analyzed for, but not detected at or above the standard limit.
J indicates an estimated value.
UJ indicates the compound was analyzed for but not detected. The sample quantification limit or reported detection limit is an estimated quantity.
* R indicates that the data was rejected because of quality control measures

Boldface indicates a detection above the 95% UCL background level

Only data for metals detected above background is presented

(1) Background data is described in Section 17.0.

13.4.4 Summary

Organic compounds were detected at the surface in boreholes 1 and 2 and were detected at 5 feet in boreholes 2 and 3. Nickel occurred at 2.5 feet in boreholes 2 and 3. All three boreholes contained metals at 5 feet including: nickel, lead, and chromium. Barium was detected at 10 feet only in borehole 3.

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14.0 ABOVEGROUND & UNDERGROUND STORAGE TANKS (SWMU NO. 48A&B/SITE UST)

14.1 SWMU Description

14.1.1 Setting

SWMU No. 48A is the previous location of a 20,000 gallon underground storage tank, removed in December 1988. SWMU No. 48B is the previous location of an aboveground 2,000 gallon storage tank of steel construction, reportedly removed in 1992. When in place, the tanks were located adjacent to each other within a 40-foot by 20-foot fence, near the corner of Argentia and Torch streets. The area was recently paved for use as a parking lot. The driller was required to penetrate asphalt and restore the surface with concrete plugs. Borehole locations were selected, in part, by using HNU meter. Figure 14-1 shows the setting and borehole locations.

14.1.2 History of Use

This SWMU was active from approximately 1941 to 1985. It was used as a gas station from 1941 to 1965 and used as waste oil storage from 1965 to 1985. The underground storage tank received waste oils, spent solvents, paint thinners, and recovered fuels, and the above ground storage tank served as an overflow tank for the underground tank. The spent products were stored in the tanks and were periodically removed by a contractor. Both tanks and associated piping have been removed.

14.1.3 Past Investigation

No data from previous investigations are available for this SWMU.

14.1.4 Land Use and Demography

This SWMU is in an area of the base that is commonly frequented by base personnel. However, the tanks have been removed and the area is covered by asphalt.

14.2 Field Investigation

Drilling and sampling activities at SWMU 48A&B began April 14-15, 1993 at 0915 hours. The activities, as outlined in the FSP (LRL, 1993), consisted of drilling 5 boreholes, collecting 10 surface samples, 40 subsurface samples, 8 QA/QC duplicate samples, and 6 QA/QC water samples. Table 14-1 summarizes the field sampling program at SWMU No.48A&B. Table 14-2 summarizes the various samples collected and analyses performed.

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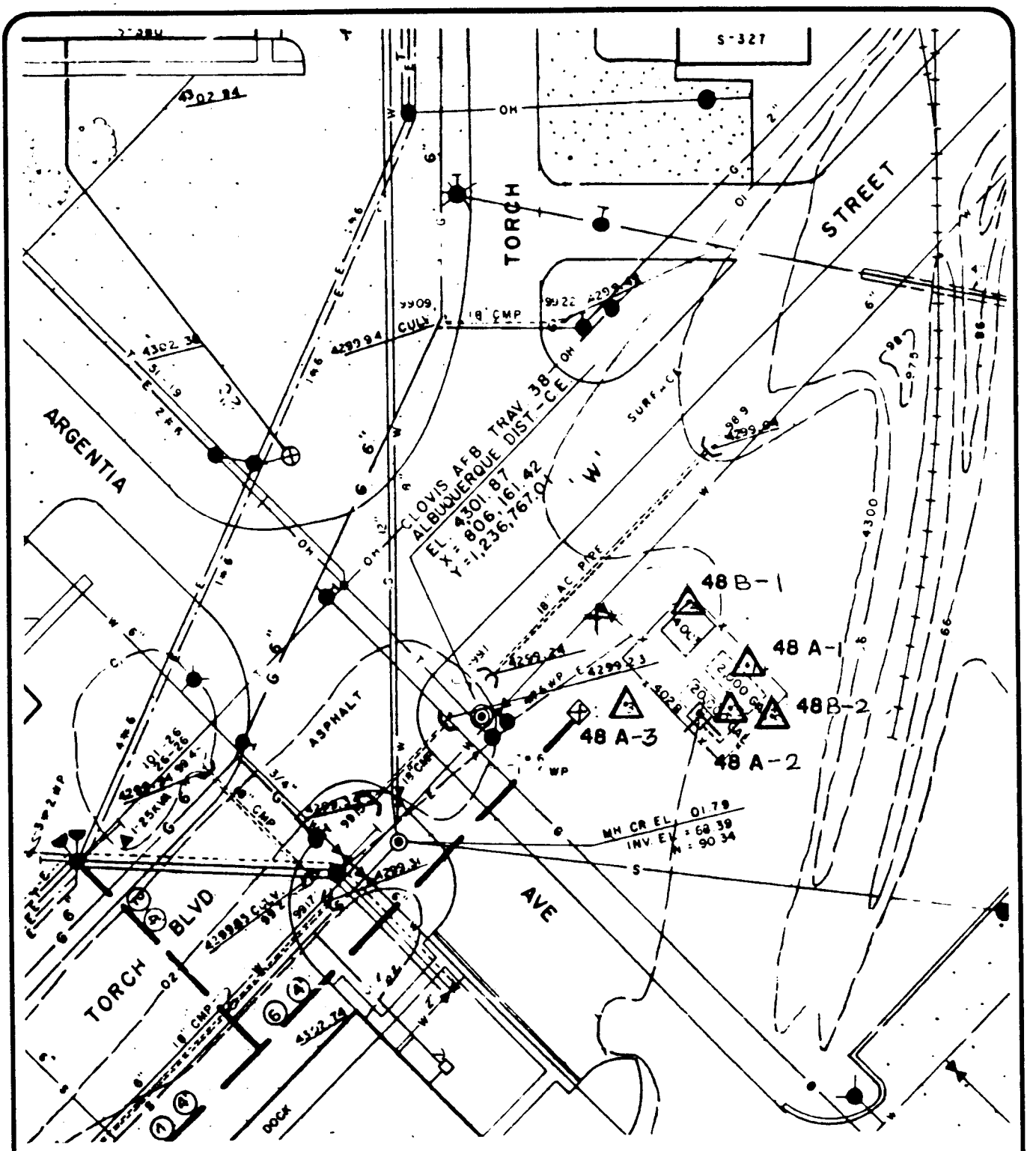


Boring No.	Elevation
48 A - 1	4300.70
48 A - 2	4300.90
48 A - 3	4300.74
48 B - 1	4300.63
48 B - 2	4301.06

N

▲ — Borehole

LRL Sciences, Inc.

SWMU #48 A & B

CANNON AFB, NEW MEXICO

Project:	Cannon AFB RFI
Contract No:	DACA47-93-C-009
Prepared by: KLH	Date: 11-5-93

Fig. 14-1

Table 14-1.
Summary of Drilling and Sampling
SWMU No. 48A&B - UST

Borehole Number	Sampling Depth (ft.-BGS)	Drilling/ Sampling Methods	Drillrig Used	Borehole Diameter (in.)	Ground Elevation	Date Grouted
(48A)						
1	0	NA/SSS	NA	NA		
	5.0	HSA/SBC	CME-75	8.0	4300.70	4/15/93
	10.0	HSA/SS	CME-75	8.0		
	20.0	HSA/SS	CME-75	8.0		
	30.0	HSA/SS	CME-75	8.0		
2	0	NA/SSS	NA	NA	4300.90	4/15/93
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SS	CME-75	8.0		
	20.0	HSA/SS	CME-75	8.0		
	30.0	HSA/SS	CME-75	8.0		

Table 14-1. (Concluded)
Summary of Drilling and Sampling
SWMU No. 48A&B - UST

Borehole Number	Sampling Depth (ft.-BGS)	Drilling/ Sampling Methods	Drillrig Used	Borehole Diameter (in.)	Ground Elevation	Date Grouted
3	0	NA/SSS	NA	NA	4300.74	4/15/93
	5.0	HSA/SS	CME-75	8.0		
	10.0	HSA/SS	CME-75	8.0		
	20.0	HSA/SS	CME-75	8.0		
	30.0	HSA/SS	CME-75	8.0		
(48B) 1	0	NA/SSS	NA	NA	4300.63	4/16/93
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SS	CME-75	8.0		
	20.0	HSA/SS	CME-75	8.0		
	30.0	HSA/SS	CME-75	8.0		
2	0	NA/SSS	NA	NA	4301.06	4/16/93
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SS	CME-75	8.0		
	20.0	HSA/SS	CME-75	8.0		
	30.0	HSA/SS	CME-75	8.0		

HSA = Hollow Stem Auger
HA = Hand Auger
SBC = Split Barrel Continuous Sampler
SS = Split Spoon
SSS = Stainless Steel Spoon

Table 14-2.
Summary of Sampling and Analyses
SWMU No. 48A and B
Underground Oil Storage Tank - 48A

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
1	0	CAN48A-UST1-021A	N	SOIL	0925	PM	6010/7000S+
		CAN48A-UST1-O31A	N	SOIL	0925	TCL VOC	8240
	5.0	CAN48A-UST1-022C	N	SOIL	0940	PM	6010/7000S
		CAN48A-UST1-032C	N	SOIL	0935	TCL VOC	8240
		CAN48A-UST1-821C	QCD	SOIL	0940	PM	6010/7000S
		CAN48A-UST1-831C	QCD	SOIL	0935	TCL VOC	8240
		CAN48A-UST1-721C	QAD	SOIL	0940	PM	6010/7000S
		CAN48A-UST1-731C	QAC	SOIL	0935	TCL VOC	8240
	10.0	CAN48A-UST1-011D	N	SOIL	0945	BTEX	8020
		CAN48A-UST1-O23D	N	SOIL	0945	PM	6010/7000S
	20.0	CAN48A-UST1-012F	N	SOIL	1000	BTEX	8020
		CAN48A-UST1-024F	N	SOIL	1000	PM	6010/7000S
	30.0	CAN48A-UST1-013G	N	SOIL	1025	BTEX	8020
		CAN48A-UST1-025G	N	SOIL	1025	PM	6010/7000S

Table 14-2. (Continued)
Summary of Sampling and Analyses
SWMU No. 48A and B
Underground Oil Storage Tank - 48A

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
2	0	CAN48A-UST2-021A	N	SOIL	1110	PM	6010/7000S
		CAN48A-UST2-031A	N	SOIL	1110	TCL VOC	8240
	5.0	CAN48A-UST2-022C	N	SOIL	1115	PM	6010/7000S
		CAN48A-UST2-032C	N	SOIL	1115	TCL VOC	8240
	10.0	CAN48A-UST2-011D	N	SOIL	1125	BTEX	8020
		CAN48A-UST2-023D	N	SOIL	1125	PM	6010/7000S
	20.0	CAN48A-UST2-012F	N	SOIL	1155	BTEX	8020
		CAN48A-UST2-024F	N	SOIL	1155	PM	6010/7000S
	30.0	CAN48A-UST2-013G	N	SOIL	1245	BTEX	8020
		CAN48A-UST2-025G	N	SOIL	1245	PM	6010/7000S
3	0	CAN48A-UST3-021A	N	SOIL	1430	PM	6010/7000S
		CAN48A-UST3-031A	N	SOIL	1430	TCL VOC	8240
	5.0	CAN48A-UST3-022C	N	SOIL	1440	PM	6010/7000S
		CAN48A-UST3-032C	N	SOIL	1440	TCL VOC	8240
	10.0	CAN48A-UST3-011D	N	SOIL	1450	BTEX	8020
		CAN48A-UST3-023D	N	SOIL	1450	PM	6010/7000S
	20.0	CAN48A-UST3-012F	N	SOIL	1510	BTEX	8020
		CAN48A-UST3-024F	N	SOIL	1510	PM	6010/7000S
	30.0	CAN48A-UST3-013G	N	SOIL	1550	BTEX	8020
		CAN48A-UST3-025G	N	SOIL	1550	PM	6010/7000S

Table 14-2. (Continued)
Summary of Drilling and Sampling
SWMU No. 48A and B
Above Ground Overflow Capacity Tank - 48B

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
1	0	CAN48B-UST1-021A	N	SOIL	0840	PM	6010/7000S
		CAN48B-UST1-031A	N	SOIL	0840	TCL VOC	8240
	5.0	CAN48B-UST1-022C	N	SOIL	0850	PM	6010/7000S
		CAN48B-UST1-032C	N	SOIL	0850	TCL VOC	8240
	10.0	CAN48B-UST1-011D	N	SOIL	0910	BTEX	8020
		CAN48B-UST1-023D	N	SOIL	0910	PM	6010/7000S
	20.0	CAN48B-UST1-012F	N	SOIL	0940	BTEX	8020
		CAN48B-UST1-024F	N	SOIL	0940	PM	6010/7000S
	30.0	CAN48B-UST1-013G	N	SOIL	1010	BTEX	8020
		CAN48B-UST1-025G	N	SOIL	1010	PM	6010/7000S
2	0	CAN48B-UST2-021A	N	SOIL	1110	PM	6010/7000S
		CAN48B-UST2-031A	N	SOIL	1110	TCL VOC	8240
	5.0	CAN48B-UST2-022C	N	SOIL	1115	PM	6010/7000S
		CAN48B-UST2-032C	N	SOIL	1115	TCL VOC	8240
		CAN48B-UST2-821C	QCD	SOIL	1130	PM	6010/7000S
		CAN48B-UST2-831C	QCD	SOIL	1125	TCL VOC	8240
		CAN48B-UST2-721C	QAD	SOIL	1130	PM	6010/7000S
		CAN48B-UST2-731C	QAD	SOIL	1125	TCL VOC	8240
	10.0	CAN48B-UST2-011D	N	SOIL	1125	BTEX	8020
		CAN48B-UST2-023D	N	SOIL	1125	PM	6010/7000S

Table 14-2. (Concluded)
Summary of Drilling and Sampling
SWMU No. 48A and B
Above Ground Overflow Capacity Tank - 48B

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
2	20.0	CAN48B-UST2-012F	N	SOIL	1155	BTEX	8020
		CAN48B-UST2-024F	N	SOIL	1155	PM	6010/7000S
	30.0	CAN48B-UST2-013G	N	SOIL	1245	BTEX	8020
		CAN48B-UST2-025G	N	SOIL	1245	PM	6010/7000S
		CAN48C-UST0-431Z	QC	WATER	1545	TCL VOC	8240
		CAN48C-UST0-321Z	QC	WATER	1250	PM	6010/7000S
		CAN48C-UST0-331Z	QC	WATER	1245	TCL VOC	8240
		CAN48C-UST0-231Z	QC	WATER	1245	TCL VOC	8240
		CAN48C-UST0-621Z	QC	WATER	1250	PM	6010/7000S
		CAN48C-UST0-631Z	QC	WATER	1245	TCL VOC	8240

BTEX = Benzene, Toluene, Ethyl Benzene, Xylene
ft-BGS = feet below ground surface
N = Normal soil sample
PM = Priority metals = 8 TCLP metals + Ni
TCL VOC = Target Compound List Volatile Organic Compound
\+ = Metals analyzed using the 7000 Series include: mercury, selenium, and arsenic.

QAD = Duplicate soil sample (analyzed at different laboratory from normal samples).
QCD = Duplicate soil sample analyzed at same laboratory as normal samples.
QC = Quality control water sample (ambient blank, trip blank, etc.)
TAL Metals = Target analyte list metals

14.2.1 Sampling Objectives

Borehole locations, sampling depth, and parameters for analysis were selected, to the greatest extent possible, to determine if a release from the aboveground and underground tanks has occurred. The two boreholes originally intended to be drilled in the former tank locations were moved since it was determined that the concrete tank foundations had not been removed. The remaining borehole site selections were based, in part, on readings from the HNU meter. Figure 14-1 shows the borehole locations.

14.2.2 Surface and Subsurface Soil Investigation

Five boreholes were drilled at this SWMU. Borehole 1 (48A) was northeast of the general area where both tanks occurred. Borehole 2 (48A) was southeast of the SWMU. Borehole 3 (48A) was drilled southwest of the SWMU. Borehole 1 (48B) was drilled north of the area and borehole 2 (48B) was drill southeast of the SWMU. Drilling was advanced to a depth of 30 feet. Samples were collected at the surface, 5, 10, 20 and 30 feet of depth. Surface samples were collected using a stainless steel trowel. Subsurface samples to 10 feet were collected with a split barrel continuous sampler. Subsurface samples at 20 and 30 feet were collected with a split spoon sampler. Samples were collected at discrete depths and locations. No composite samples were taken. Samples were analyzed for BTEX, TAL metals, cyanide and TCL VOC. Duplicates, rinsate blanks, ambient blanks and decontamination water samples were also submitted to the laboratory for this SWMU.

14.3 Physical Characteristics

This section provides a discussion of the surface water drainage, groundwater, and soils and geology at this aboveground and underground tank site based on a review of information from previous investigations at Cannon AFB and from the lithologic descriptions of split barrel continuous sample and split spoon samples from this investigation.

14.3.1 Surface Water Drainage

A topographic/surface drainage map in addition to text found in Installation Restoration Program Records Search, August 1983 prepared by CH,M Hill indicates that the surface water drainage in the vicinity of SWMU No. 48A&B enters the base storm water drainage system and flows to the Stormwater Collection Point (SWMU No. 95). SWMU No. 95 is a stormwater collection ditch located east of the sewage lagoons.

14.3.2 Groundwater

Depth to groundwater at Cannon AFB is approximately 250 feet or greater. Groundwater recharge rates for the High Plains Region where Cannon AFB is located are typically low. Localized recharge rates for Curry County range from 0.75 - 12.22 mm/yr (Stone, 1985). EPA, 1987 DRASTIC reports recharge rates of 1 in/yr. Section 1.0 of this report includes a discussion of groundwater hydrology for the High Plains and Cannon AFB.

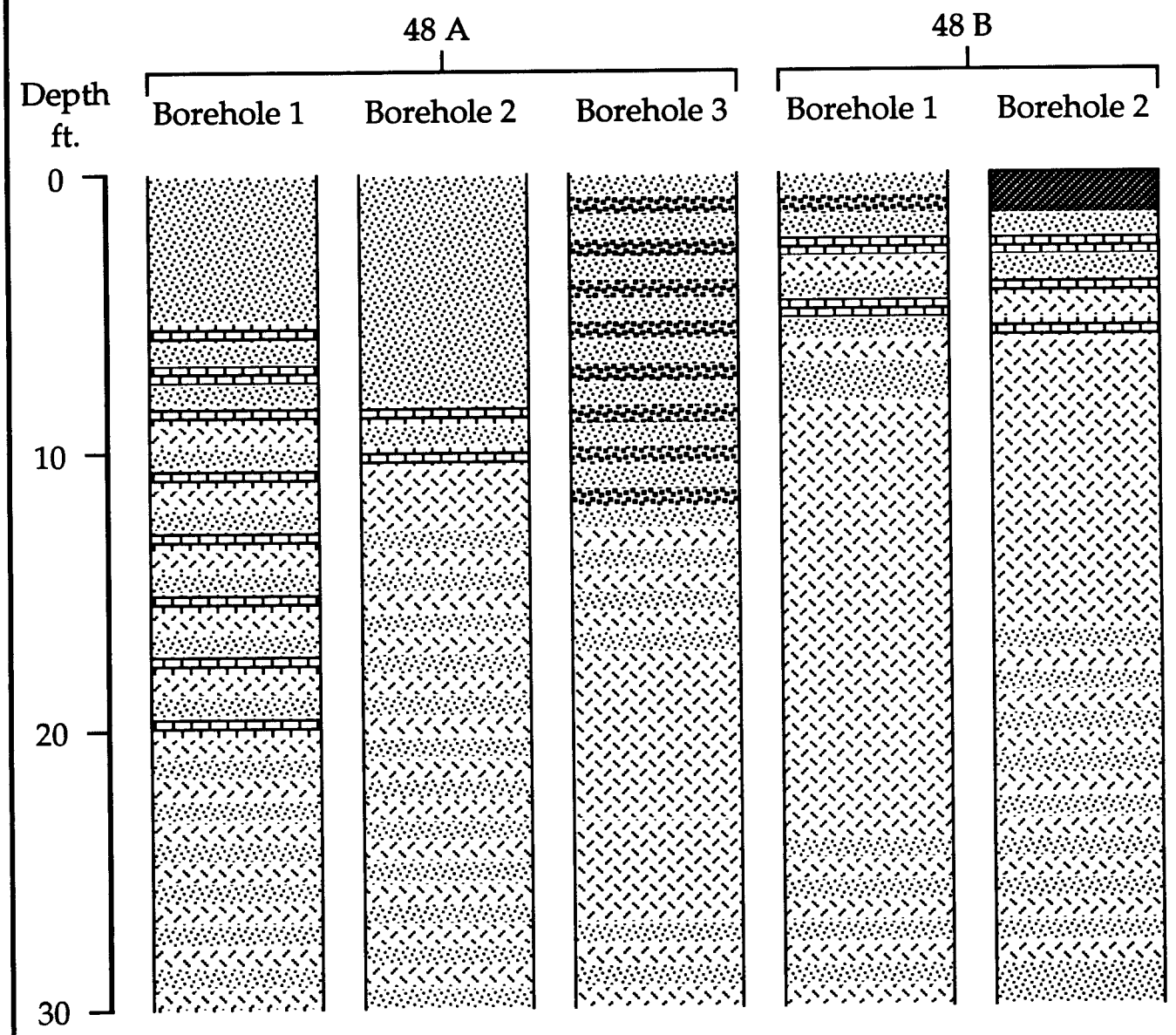
14.3.3 Soils and Geology

14.3.3.1 48A

The near surface (upper thirty feet) stratigraphy in the area surrounding the underground waste oil tank consist of Tertiary Miocene to Pliocene fluvial deposits of the Ogallala Formation. The soils have been described as a fine sandy loam (Ab) of the Amarillo soil group (USDA, 1993). Interpretations and correlation on the fluvial deposits for this area are based on split spoon samples collected during the drilling process. The soils consist of very fine to fine-grained, moderate to well sorted, submature to mature (textural), unconsolidated, calcareous, light grey to red, clays, silts, and sands. Thin to moderately thin layers and nodules of caliche material were interbedded throughout much of the samples collected. The sands were comprised of angular to subangular grains with varying amounts of silts, clays, and calcium carbonate (caliche) material. This description of lithology (Figure 14-2) is similiar to the description of soils given by the USDA Draft Soil Survey, 1993. The thickness of this particular unit remains unknown, due to the fact that boring levels did not exceed thirty feet. The total thickness of the Ogallala Formation beneath the oil tank is not presently known, but regional information based on Curry County reports have suggested thicknesses of approximately 320-400 feet. No groundwater was encountered while drilling at these three borehole locations. The minimum depth of the High Plains aquifer is reported to be greater than 250 feet below ground surface.

14.3.3.2 48B

The near surface (upper thirty feet) stratigraphy in the area surrounding the overflow capacity tank consist of Tertiary Miocene to Pliocene fluvial deposits of the Ogallala Formation. The soils have been described as a fine sandy loam (Ab) of the Amarillo soil group (USDA draft "Soil Survey" 1993). Interpretations and correlation on the fluvial deposits for this area are based on split spoon samples collected during the drilling process. The soils consist of very fine to fine-grained, well sorted, submature to mature (textural), unconsolidated, calcareous, reddish brown, clays, silts, and sand. Thin to moderately thin layers of caliche material were interbedded throughout much of the samples collected. The sands were comprised of angular to subangular grains with varying amounts of silts, clays, and calcium carbonate (caliche) material. This description of lithology (Figure 14-2) is similiar to the description of soils given by the USDA Draft Soil Survey, 1993. The thickness of this particular unit remains unknown, due to the fact that boring levels did not exceed thirty feet. The total thickness of the Ogallala Formation beneath the overflow capacity tank is not presently known, but regional information based on Curry County reports have suggested thicknesses of approximately 320-400 feet. No groundwater was encountered while drilling at these two borehole locations. The minimum depth of the High Plains aquifer is believed to be 250 feet below ground surface.



LEGEND

- Asphalt
- Gravel
- Sand
- Clay
- Caliche

LRL Sciences, Inc.

SWMU #48 A/B
STRATIGRAPHIC COLUMN
CANNON AFB, NEW MEXICO

Project: Cannon AFB RFI	
Contract No: DACA47-93-C-009	
Prepared by: KLH	Date: 11-5-93

Fig. 14-2

14.4 Nature and Extent of Contamination

14.4.1 Volatile Organic Compounds

A series of HNU meter readings were taken in the well head and in the breathing zone for each borehole for worker safety purposes. Well head reading were positive for all boreholes. Boreholes 1 and 2 had the highest readings ranging from 0.4 to 225 ppm (Table 14-3). Breathing zone readings in borehole 2 reached 8 ppm. Due to the high HNU readings for boreholes 1 and 2, modified level C personal protection was employed in the immediate area of the boreholes.

Table 14-3.
HNU Meter* Readings (PPM) in Borehole Headspace
SWMU No. 48A & B
Underground and Above Ground Storage Tanks

DATE:					
TIME	BH1	TIME	BH2	TIME	BH3
(48A)					
0923	0.4	1103	1.3	1430	4.0
0928	0.4	1120	14.0	1433	0.0
0934	225	1130	60.0	1443	0.0
0936	125	1132	40.0	1450	0.4
0940	8	1145	80.0	1459	0.0
		1212	40.0	1524	0.0
		1218		1532	0.0
		1230	50.0	1550	0.0
		1230	190.0		
(48B)					
0838	2.6	1058	0.2		
0845	1.2	1102	0.2		
0906	0.4	1112	0.4		
0913	0.2	1145	0.2		
0917	0.1	1205	0.0		
0945	0.4	1220	0.0		
		1230	0.0		

* Model: 101, Type: OVA PID, Make: HNU

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Samples were collected from all five boreholes, at the surface and at 5 feet, and analyzed for Target Compound List Volatile Organic Compounds (TCL VOC). Following are the results of these analyses:

14.4.1.1 Borehole 1 (48A)

No target compounds were detected in the surface sample. TIC compounds were detected.

In the 5 foot sample and in a repeat analysis of this sample, all data was rejected since internal standard recovery was outside control limits. The QA/QC duplicate samples were collected at this depth. The results for the QC duplicate have been rejected since internal standard recovery was outside control limits. In the QA sample, methylene chloride was detected but rejected since nearly all, the samples at the QA lab contained methylene chloride.

14.4.1.2 Borehole 2 (48A)

In the surface sample and at 5 feet, no target compounds were detected. TIC compounds were detected in both.

14.4.1.3 Borehole 3 (48A)

In the surface sample and at 5 feet, no target compounds were detected. TIC compounds were detected in the surface sample.

14.4.1.4 Borehole 1 (48B)

In the surface sample, acetone was detected but rejected due to co-elution of contaminants. No other target analyte was detected. TIC were detected.

At 5 feet (CAN48B-UST1-032C), methylene chloride was detected at 37 μg/kg. No TIC compounds were detected.

14.4.1.5 Borehole 2 (48B)

In the surface sample (CAN48B-UST2-031A), methylene chloride was detected at 150 μg/kg. Acetone was detected at 110 μg/kg. Xylene was also detected at 75 μg/kg. TIC compounds were detected.

At 5 feet (CAN48B-UST2-032C), methylene chloride and acetone were detected at 32 and 33 μg/kg, respectively. No TIC compounds were detected. QA/QC duplicates were collected at this depth. The QC duplicate (CAN48B-UST2-831C), which was analyzed at the same lab as the normal sample, contained methylene chloride and acetone at 36 and 39 μg/kg, respectively. The QA duplicate, which was analyzed at a different laboratory, contained methylene chloride and acetone, however, since all, or nearly all, the samples at the QA laboratory contained these compounds, they were rejected as laboratory contaminants.

14.4.2 BTEX

In each borehole three samples were collected for BTEX analysis. Samples were collected at 10, 20, and 30 feet of depth. QA/QA field duplicates were not collected for BTEX analysis. Following are the results of these analyses:

14.4.2.1 Borehole 1 (48A)

At 10 feet (CAN48A-UST1-011D), ethylbenzene was detected at 20 μg/kg. Xylenes were detected at 110 μg/kg.

At 20 and 30 feet, no BTEX compounds were detected.

14.4.2.2 Borehole 2 (48A)

At 10 feet (CAN48A-UST2-011D), toluene was detected at 1200 μg/kg, ethylbenzene was detected at 4200 μg/kg, and xylenes were detected at 32000 μg/kg.

At 20 feet (CAN48A-UST2-012F), ethylbenzene was detected at 16,000 μg/kg and xylenes were detected at 100,000 μg/kg.

At 30 feet, no BTEX compounds were detected.

14.4.2.3 Borehole 3 (48A)

At 10, 20 and 30 feet, no BTEX compounds were detected.

14.4.2.4 Borehole 1 (48B)

No BTEX compounds were detected at 10, 20 or 30 feet.

14.4.2.5 Borehole 2 (48B)

No BTEX compounds were detected at 10, 20 or 30 feet.

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Table 14-4.
Concentration (μg/kg) of Volatile Organic Compounds
SWMU No. 48A and 48B
Underground Waste Oil Tank (48A)
Above Ground Overflow Capacity Tank (48B)

Borehole Number	Cannon Number	Depth (ft.)	Chemical		
			Acetone	Xylene	Methylene Chloride
1	CAN48A-UST1-031A	Surface	11U	11U	11U
	CAN48A-UST1-032C	5.0	R	R	-R
2	CAN48A-UST2-031A	Surface	11U	11U	11U
	CAN48A-UST2-032C	5.0	12U	12U	20U
3	CAN48A-UST3-031A	Surface	11U	11U	14U
	CAN48A-UST3-032C	5.0	10U	11U	15U
1	CAN48B-UST1-031A	Surface	R	12U	12U
	CAN48B-UST1-032C	5.0	51U	12U	37
2	CAN48B-UST2-031A	Surface	110	75	150
	CAN48B-UST2-032C	5.0	33	12U	32
	CAN48B-UST2-831C		39 (QCD)		36 (QCD)

Duplicate samples or laboratory repeat samples are presented only if they are different from the original sample and not rejected.

J = estimate
R = rejected

U = not detected at CRQL
UJ = estimated as non-detect at CRQL
QCD = duplicate analyzed at the same laboratory as the normal sample.

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Table 14-5.
Concentration (μg/kg) of BTEX
SWMU No. 48A & B
Underground Waste Oil Tank (48A)
Above Ground Overflow Capacity Tank (48B)

Borehole Number	Cannon Number	Depth (ft.)	Chemical				
			Benzene	Ethyl Benzene	Toluene	Xylene	BTEX Total
1	CAN48A-UST1-011D	10.0	10U	20	10U	110	130
	CAN48A-UST1-012F	20.0	2U	2U	2U	2U	2U
	CAN48A-UST1-013G	30.0	2U	2U	2U	2U	2U
2	CAN48A-UST2-011D	10.0	1000U	4200	1200	32000	37400
	CAN48A-UST2-012F	20.0	10000U	16000	10000U	100000	116000
	CAN48A-UST2-013G	30.0	2U	2U	2U	2U	2U
3	CAN48A-UST3-011D	10.0	2U	2U	2U	2U	2U
	CAN48A-UST3-012F	20.0	2U	2U	2U	2U	2U
	CAN48A-UST3-013G	30.0	2U	2U	2U	2U	2U
1	CAN48B-UST1-011D	10.0	2U	2U	2U	2U	2U
	CAN48B-UST1-012F	20.0	2U	2U	2U	2U	2U
	CAN48B-UST1-013G	30.0	2U	2U	2U	2U	2U
2	CAN48B-UST2-011D	10.0	2U	2U	2U	2U	2U
	CAN48B-UST2-012F	20.0	2U	2U	2U	2U	2U
	CAN48B-UST2-013G	30.0	2U	2U	2U	2U	2U

Duplicate samples or laboratory repeat samples are presented only if they are different from the original sample and not rejected.

J = estimate
R = rejected
U = not detected at CRQL
UJ = estimated as non-detect at CRQL

14.4.3 Target Analyte List (TAL) Metals

In the following presentation of metals results, only metals concentrations in excess of background concentrations are presented. No background data was collected for this investigation, therefore, background concentrations were taken from Concentrations of Selected Naturally Occurring Chemical Constituents in Soil and Groundwater at Cannon Air Force Base Clovis, New Mexico, March 1993 prepared by Woodward-Clyde. For a discussion of Woodward-Clydes background data see Section 1.7.

Samples for metals analysis were collected at the surface, 5, 10, 20 and 30 feet.

14.4.3.1 Borehole 1 (48A)

In the surface sample (CAN48A-UST1-021A), barium was detected at 729 mg/kg (Table 14-6). This value is an estimate since matrix spike recovery was not within control limits and the ICP Serial Dilution %D were not within control limits. Calcium was detected at 224,000 mg/kg and nickel at 9.2 mg/kg. The nickel value was an estimate since the matrix spike recovery was not within control limits. Background for these metals is 642 mg/kg, 186,400 mg/kg, and 9.0 mg/kg for barium, calcium and nickel, respectively.

At 5 feet, no TAL metals were detected above background. The QA/QC duplicates were collected at this depth. The QC duplicate (CAN48A-UST1-821C), which was analyzed at the same lab as the normal sample, contained beryllium at 0.77 mg/kg and nickel at 12.9 mg/kg. The nickel value is an estimate since the matrix spike recovery was not within control limits. The QA duplicate (CAN48A-UST1-721C), cobalt was detected at 4.6 mg/kg. The background value for beryllium is 0.73 mg/kg. For cobalt, background is 4.5 mg/kg.

In the 10 foot sample (CAN48A-UST1-023D), vanadium was detected at 28.9 mg/kg. This value is an estimate since matrix spike recovery was not within control limits and the ICP Serial Dilution %D were not within control limits.

No metals were detected above background at 20 or 30 feet.

14.4.3.2 Borehole 2 (48A)

In the surface sample (CAN48A-UST2-021A), calcium was detected at 270,000 mg/kg. Nickel was detected at 9.5 mg/kg. The value for nickel is an estimate since matrix spike recovery was not within control limits.

At 5 feet, no metals were detected above background.

At 10 feet (CAN48A-UST2-023D), barium was detected at 1760 mg/kg. This value is an estimate since matrix spike recovery was not within control limits and the ICP Serial Dilution %D were not within control limits. Calcium was detected at 211,000 mg/kg.

No metals were detected above background at 20 or 30 feet.

Table 14-6
Concentrations (mg/kg) TAL Metals
SWMU No. 48 - UST Site

Boring Number	Sample Number (CAN48A-UST)	Sample Depth (Feet)	Barium		Calcium		Magnesium		Nickel		Thallium		Vanadium	
1	1-021A	0	729	J	224000		9100		9.2	J	0.33	R	10.4	J
	1-022C	5	155	J	156000		2410		7.5	J	0.34	R	10.7	J
(QAD)	1-721C	5	159		125000		3220		7.7		0.23	U	18.4	
(QCD)	1-821C	5	57.2	J	5640		2920		12.9	J	0.34	R	20.1	J
	1-023D	10	194	J	40500		3020		8.6	J	0.31	R	28.9	J
	1-024F	20	34.9	J	35500		3520		7	J	0.32	R	14.7	J
	1-025G	30	125	J	64100		10400		6.4	J	0.32	R	14.7	J
2	2-021A	0	638	J	270000		10300		9.5	J	0.34	R	11.2	J
	2-022C	5	190	J	75700		3350		8.7	J	0.37	R	17.5	J
	2-023D	10	1760	J	211000		6520		5.6	J	0.35	R	13.2	J
	2-024F	20	363	J	146000		11400		4.6	J	0.33	R	18.1	J
	2-025G	30	365	J	86000		5830		5.6	J	0.33	R	11.6	J
3	3-021A	0	705	J	230000		11600		9.3	J	0.32	R	12	J
	3-022C	5	377	J	153000		4390		7.9	J	0.33	R	15.7	J
	3-023D	10	363	J	282000		4700		3.3	J	3.2	R	8	J
	3-024F	20	673	J	150000		13399		5.5	J	0.34	R	17.6	J
	3-025G	30	39.5	J	60800		3890		4	J	0.32	R	9.7	J
	(CAN48B-UST)													
1	1-021A	0	492	J	20600	J	8660	J	8.2	J	5.4	UJ	10.2	J
	1-022C	5	1320	J	241000		3550	J	5.3	J	5.8	UJ	7.1	J
	1-023D	10	406	J	156000	J	3280	J	5.1	J	5.6	UJ	8.8	J
	1-024F	20	149	J	20400	J	16700	J	3.7	J	5.7	UJ	15.1	J
	1-025G	30	26.2	J	24400	J	3210	J	2.7	J	5.4	UJ	6.9	J
2	2-021A	0	445	J	22700	J	8250	J	7.1	J	5.3	UJ	12.5	
	2-022C	5	236	J	163000	J	2510	J	6	J	5.7	UJ	8.6	J
(QAD)	2-721C	5	258		250000		3810		4.7		0.24	U	11.2	
(QCD)	2-821C	5	153	J	276000	J	4110	J	4	J	6	UJ	7.5	
	2-023D	10	461	J	255000	J	4080	J	3.3	J	5.6	UJ	6.5	J
	2-024F	20	126	J	142000	J	14900	J	4.6	J	5.6	J	13.1	J
	2-025G	30	15.7	J	4950	J	2400	J	4	J	5.3	UJ	7.6	J
Background (95% UCL) (1)			642.00		186400.00		11790.00		9.00		1.20		25.30	

Notes:

Duplicate samples (QAD) or (QCD) samples are presented only if they are different from the original sample and not rejected.

U indicates that the compound was analyzed for, but not detected at or above the standard limit.
J indicates an estimated value.
UJ indicates the compound was analyzed for but not detected. The sample quantification limit or reported detection limit is an estimated quantity.
* R indicates that the data was rejected because of quality control measures

Boldface indicates a detection above the 95% UCL background level

Only data for metals detected above background is presented

(1) Background data is described in Section 17.0.

14.4.3.3 Borehole 3 (48A)

In the surface sample (CAN48A-UST3-021A), barium was detected at 705 mg/kg. This value is an estimate since matrix spike recovery was not within control limits and the ICP Serial Dilution %D were not within control limits. Calcium was detected at 230,000 mg/kg. Nickel was detected at 9.3 mg/kg. This value is an estimate since matrix spike recovery was not within control limits.

At 5 feet, no TAL metals were detected above background.

At 10 feet (CAN48A-UST3-023D), calcium was detected at 282,000 mg/kg. Background for calcium is 186,400 mg/kg.

At 20 feet (CAN48A-UST3-024F), barium was detected at 673 mg/kg. This value is an estimate since the matrix spike recovery was not within control limits and the ICP Serial Dilution %D were not within control limits. Magnesium was detected at 13,399 mg/kg. Background for barium and magnesium is 642 and 11,790 mg/kg respectively.

At 30 feet, no TAL metals were detected above background.

14.4.3.4 Borehole 1 (48B)

In the surface sample (CAN48B-UST1-021A), calcium was detected at 206,000 mg/kg. This value is an estimate since laboratory duplicate was not in agreement.

At 5 feet (CAN48B-UST1-022C), barium was detected at 1,320 mg/kg. This value is an estimate since the ICP Serial Dilution %D were not within control limits. Calcium was detected at 241,000 mg/kg.

At 10 feet, no TAL metals were detected above background.

At 20 feet (CAN48B-UST1-024F), magnesium was detected at 16,700 mg/kg. This value is an estimate since the laboratory duplicates were not in agreement.

At 30 feet, no TAL metals were detected above background.

14.4.3.5 Borehole 2 (48B)

In the surface sample, no TAL metals were detected above background.

At 5 feet, no TAL metals were detected above background. The QA/QC duplicates were collected at this depth. The QC duplicate (CAN48B-UST2-821C), which was analyzed at the same lab as the normal sample, contained calcium at 276,000 mg/kg. This value is an estimate since the laboratory duplicate was not in agreement. The QA duplicate (CAN48B-UST2-721C), which was analyzed at a different lab than the normal sample, contained mercury at 0.16 mg/kg and calcium at 250,000 mg/kg.

At 10 feet (CAN48B-UST2-023D), calcium was detected at 255,000 mg/kg. This value is an estimate since the laboratory duplicate was not in agreement.

At 20 feet (CAN48B-UST2-024F), magnesium was detected at 14,900 mg/kg. This value is an estimate since the laboratory duplicate was not in agreement.

At 30 feet, no TAL metals were detected above background.

14.4.4 Wet Chemistry

In boreholes 1 and 2 of 48B, samples were analyzed for cyanide, at the surface, 2.5, 5, and 10 feet. No cyanide was detected in any of the samples.

14.4.5 Summary

In the surface samples TIC compounds were detected in all the boreholes. Only borehole 2 (48B) contained other volatile organics: acetone and xylene. In the subsurface samples organics are detected in borehole 1 at 10 feet, borehole 2 at 10 and 20 feet, borehole 1 (48B) at 5 feet, and borehole 2 (48B) at 5 feet. Metals were detected in the surface samples of boreholes 1 (48A) through 3 (48A) and borehole 1 (48B). Metals were detected in the subsurface samples of all the boreholes.

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15.0 SUMP (SWMU NO. 83/SITE SUMP)

15.1 SWMU Description

15.1.1 Setting

SWMU No. 83 was a sump located approximately 120 ft. west of Building 120. Building 120 is located on the western edge of the flightline. The sump was constructed in a 12 ft. by 14 ft. concrete slab set in soil, and was overlain by a metal grate. The area was surrounded by construction activity when the FSP was being developed. When the investigative team arrived to drill and sample, the sump had been removed and a shallow pit remained in the location. The bottom of the pit had a 12" wide gravel filled trench that apparently contained oil and grease (automotive type) mixed with water. The trench appeared to be a small leach field. The borehole locations were moved from the original FSP specified locations due to construction of a pipeline trench near the former sump and to avoid a power pole and overhead power lines. Since the investigation, the pit has been backfilled and boreholes 1 and 2 have been paved over. Figure 15-1 shows the SWMU setting and borehole locations.

15.1.2 History of Use

The date of installation and initial use of the sump is unknown. Historically the sump received rain water, washwater and dilute waste oil generated from flight line operations.

15.1.3 Past Investigations

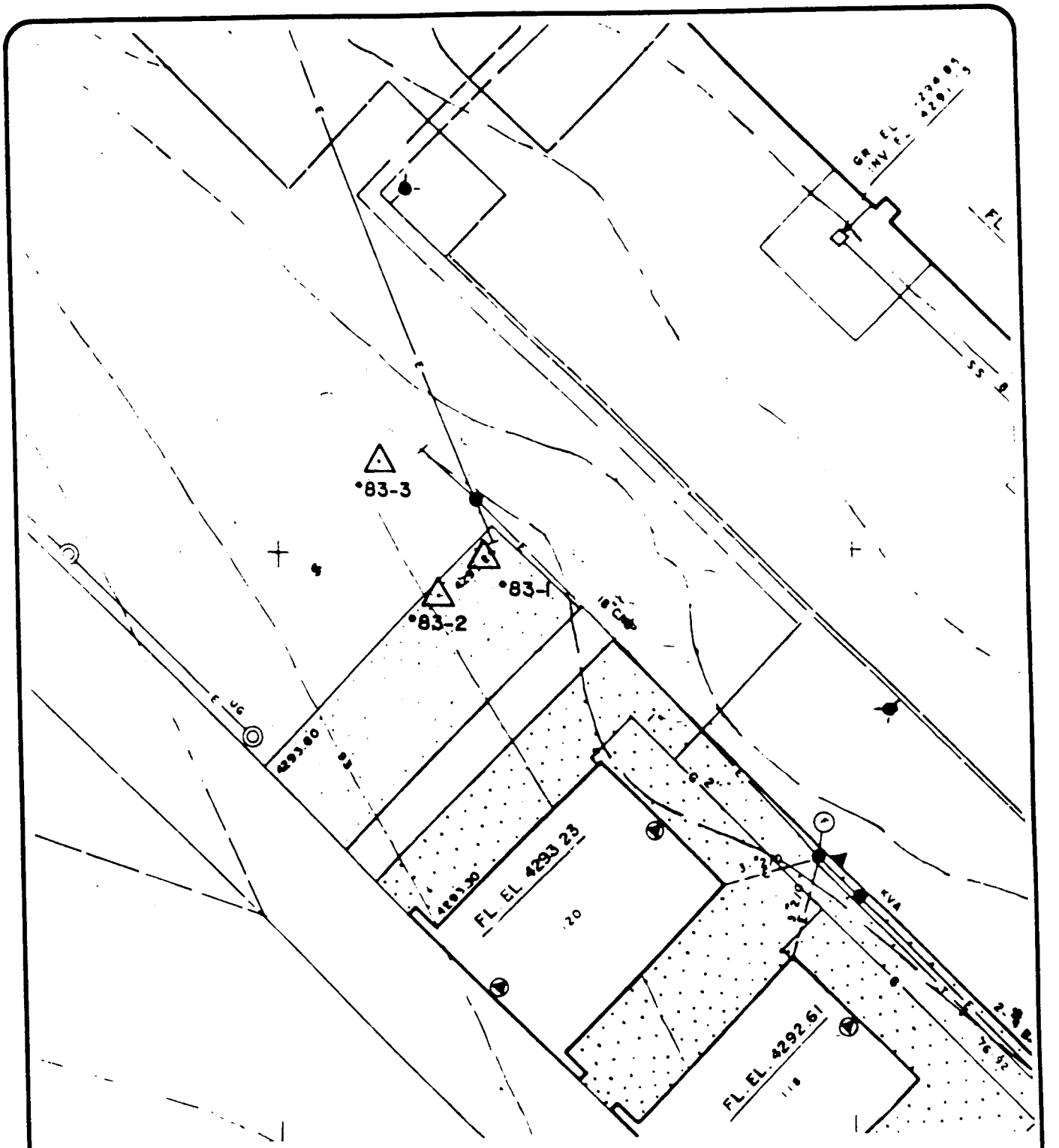
No previous investigations are available for SWMU No. 83.

15.1.4 Land Use and Demography

This SWMU is in an area of the base that is commonly frequented by personnel. However, the sump has been removed, the area backfilled and boreholes 1 and 2 have been paved over.

15.2 Field Investigation

Drilling and sampling activities at SWMU No. 83 occurred April 7, 1993 at 0850. The activities, as outlined in the FSP (LRL, 1993), consisted of drilling 3 boreholes, collecting 6 surface samples, 21 subsurface samples, 6 QA/QC duplicate samples and 8 QA/QC water samples. Table 15-1 summarizes the field sampling program at SWMU No. 83. Table 15-2 summarizes the various samples collected and analyses performed.



▲ — Borehole

Boring No.	Elevation (ft.)
1	4293.22
2	4293.35
3	4292.78

N

LRL Sciences, Inc.

SWMU #83
SUMP

CANNON AFB, NEW MEXICO

Project:	Cannon AFB RFI
Contract No:	DACA47-93-C-009
Prepared by: KLH	Date: 10-25-93

Fig. 15-1

Table 15-1.
Summary of Drilling and Sampling
SWMU No. 83 - Sump

Borehole Number	Sampling Depth (ft.-BGS)	Drilling/ Sampling Methods	Drillrig Used	Borehole Diameter (in.)	Ground Elevation	Date Grouted
1	0	NA/SSS	NA	NA	4293.22	4/07/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
2	0	NA/SSS	NA	NA	4293.35	4/07/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
3	0	NA/SSS	NA	NA	4292.78	4/07/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		

HSA = Hollow Stem Auger
HA = Hand Auger
SBC = Split Barrel Continuous Sampler
SS = Split Spoon
SSS = Stainless Steel Spoon

Table 15-2.
Summary of Sampling and Analyses
SWMU No. 83 - Sump

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
1	0	CAN083-SUM1-041A	N	SOIL	1125	TRPH	418.1
		CAN083-SUM1-051A	N	SOIL	1125	TAL	6010\9012
	2.5	CAN083-SUM1-042B	N	SOIL	1150	TRPH	418.1
		CAN083-SUM1-052B	N	SOIL	1150	TAL	6010\9012
	5.0	CAN083-SUM1-043C	N	SOIL	1148	TRPH	418.1
		CAN083-SUM1-053C	N	SOIL	1145	TAL	6010\9012
		CAN083-SUM1-031C	N	SOIL	1140	TCL VOC	8240
	10.0	CAN083-SUM1-044D	N	SOIL	1156	TRPH	418.1
		CAN083-SUM1-054D	N	SOIL	1156	TAL	6010\9012
2	0	CAN083-SUM2-041A	N	SOIL	1300	TRPH	418.1
		CAN083-SUM2-051A	N	SOIL	1300	TAL	6010\9012
	2.5	CAN083-SUM2-042B	N	SOIL	1315	TRPH	418.1
		CAN083-SUM2-052B	N	SOIL	1315	TAL	6010\9012
	5.0	CAN083-SUM2-043C	N	SOIL	1320	TRPH	418.1
		CAN083-SUM2-053C	N	SOIL	1320	TAL	6010\9012
		CAN083-SUM2-031C	N	SOIL	1310	TCL VOC	8240
		CAN083-SUM2-841C	QCD	SOIL	1320	TRPH	418.1
		CAN083-SUM2-851C	QCD	SOIL	1320	TAL	6010\9012
		CANO83-SUM2-831C	QCD	SOIL	1320	TCL VOC	8240
		CAN083-SUM2-741C	QAD	SOIL	1325	TRPH	418.1
		CAN083-SUM2-751C	QAD	SOIL	1325	TAL	6010\9012
		CAN083-SUM2-731C	QAD	SOIL	1320	TCL VOC	8240

Table 15-2. (Continued)
Summary of Sampling and Analyses
SWMU No. 83 - Sump

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
	10.0	CAN083-SUM2-044D	N	SOIL	1330	TRPH	418.1
		CAN083-SUM2-054D	N	SOIL	1330	TAL	6010\9012
3	0	CAN083-SUM3-041A	N	SOIL	NA	TRPH	418.1
		CAN083-SUM3-051A	N	SOIL	NA	TAL	6010\9012
	2.5	CAN083-SUM3-042B	N	SOIL	1420	TRPH	418.1
		CAN083-SUM3-052B	N	SOIL	1420	TAL	6010\9012
	5.0	CAN083-SUM3-043C	N	SOIL	1425	TPH	418.1
		CAN083-SUM3-053C	N	SOIL	1425	TAL	6010\9012
		CAN083-SUM3-031C	N	SOIL	1415	TCL VOC	8240
	10.0	CAN083-SUM3-044D	N	SOIL	1430	TRPH	418.1
		CAN083-SUM3-054D	N	SOIL	1430	TAL	6010\9012

Table 15-2. (Concluded)
Summary of Sampling and Analyses
SWMU No. 83 - Sump

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
		CAN083-SUM0-431Z	QC	WATER	1500	TCL VOC	8240
		CAN083-SUM0-341Z	QC	WATER	NA	TRPH	418.1
		CAN083-SUM0-321Z	QC	WATER	1415	TAL	6010\9012
		CAN083-SUM0-331Z	QC	WATER	1450	TCL VOC	8240
		CAN083-SUM0-231Z	QC	WATER	1450	TCL VOC	8240
		CAN083-SUM0-641Z	QC	WATER	1500	TRPH	418.1
		CAN083-SUM0-621Z	QC	WATER	1500	TAL	6010\9012
		CAN083-SUM0-631Z	QC	WATER	1450	TCL VOC	8240

ft-BGS = feet below ground surface
N = Normal soil sample
PM = Priority metals = 8 TCLP metals + Ni
TCL VOC = Target Compound List Volatile Organic Compound

QAD = Duplicate soil sample (analyzed at different laboratory from normal samples).
QCD = Duplicate soil sample analyzed at same laboratory as normal samples.
QC = Quality control water sample (ambient blank, trip blank, etc.)
TAL = Target analyte list metals

15.2.1 Sampling Objectives

Borehole locations, sampling depth, and parameters for analysis were selected, to the greatest extent possible, to determine if a release from the sump has occurred. All three borehole were moved from their original FSP locations due to construction and overhead electric lines. Figure 15-1 shows the borehole locations.

15.2.2 Surface and Subsurface Soil Investigation

Three boreholes were drilled at this SWMU. Borehole 1 was drilled to the southeast of the separator. Borehole 2 was drilled south of the separator. Borehole 3 was drilled to the northwest of the separator. Drilling was advanced to a depth of 10 feet. Samples were collected at the surface, 2.5, 5 and 10 feet in depth. Surface samples were collected with a stainless steel trowel and subsurface samples were collected with a split barrel continuous sampler. Samples were collected at discrete depths and locations. No composite samples were taken. Samples were analyzed for TRPH, TAL metals, cyanide and TCL VOC. Duplicates, rinsate blanks, ambient blanks and decontamination water samples were also submitted to the laboratory for this SWMU site.

15.3 Physical Characteristics

This section provides a discussion of the surface water drainage, ground water, and soils and geology at the sump based on a review of information from previous investigations at Cannon AFB and from the lithologic descriptions of split barrel continuous samples from this investigation.

15.3.1 Surface Water Drainage

A topographic/surface drainage map in addition to text found in Installation Restoration Program Records Search, August 1983 prepared by CH_2M Hill indicates that the surface water drainage in the vicinity of SWMU No. 83 enters the base storm water drainage system and flows to the Stormwater Collection Point (SWMU No. 85). SWMU No. 85 is an ephemeral lake basin (playa) located in the southwest corner of the base.

15.3.2 Groundwater

Depth to groundwater at Cannon AFB is approximately 250 feet or greater. Groundwater recharge rates for the High Plains Region where Cannon AFB is located are typically low. Localized recharge rates for Curry County range from 0.75 - 12.22 mm/yr (Stone, 1985). EPA, 1987 DRASTIC reports recharge rates of 1 in/yr. Section 1.0 of this report includes a discussion of groundwater hydrology for the High Plains and Cannon AFB.

15.3.3 Soils and Geology

The near surface (upper ten feet) stratigraphy in the area surrounding this sump consist of Tertiary Miocene to Pliocene fluvial deposits of the Ogallala Formation. The soils have been described as a fine sandy loam (Ab) of the Amarillo soil group (USDA, 1993). Interpretations and correlation on the fluvial deposits for this area are based on split spoon samples collected during the drilling process. The soils consist of very fine to fine-grained, well sorted, submature to mature (textural), unconsolidated, calcareous, reddish brown, clays, silts, and sands. Thin to moderately thin banded layers and lenses of caliche material were interbedded throughout much of the samples collected. The sands were comprised of angular to subangular grains with varying amounts of silts, clays, and calcium carbonate (caliche) material. This description of lithology (Figure 15-2) is simuliar to the description of soils given by the USDA Draft Soil Survey, 1993. The thickness of this particular unit remains unknown, due to the fact that boring levels did not exceed ten feet. The total thickness of the Ogallala Formation beneath this sump is not presently known, but regional information based on Curry County reports have suggested thicknesses of approximately 320-400 feet. No groundwater was encountered while drilling at these three borehole locations. The minimum depth of the High Plains aquifer is reported to be greater than 250 feet below ground surface.

15.4 Nature and Extent of Contamination

15.4.1 Volatile Organic Compounds

A series of HNU meter readings were taken in the well head and in the breathing zone for each borehole for worker safety purposes. No positive reading were obtained.

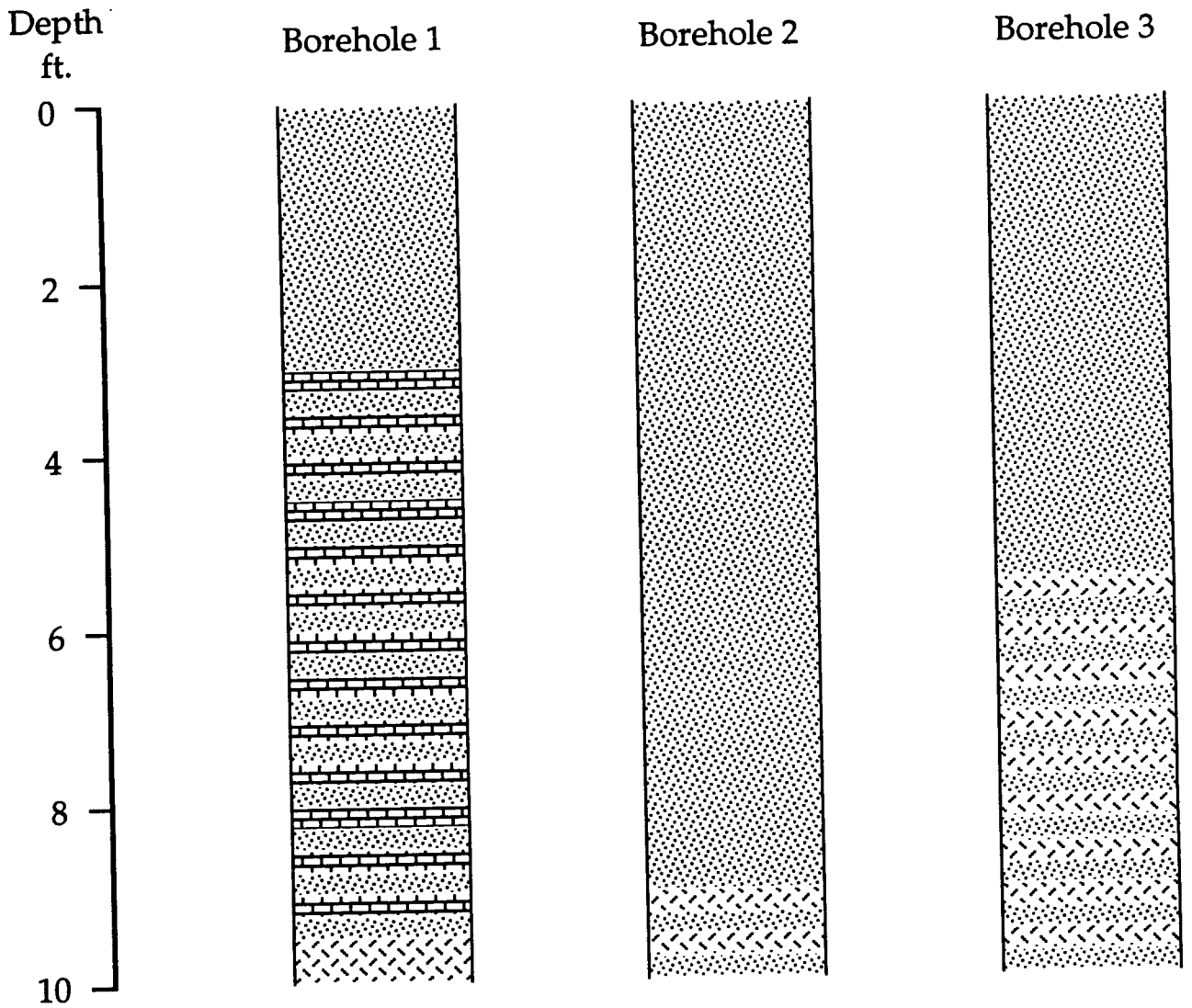
Samples were collected from all three boreholes, at 5 feet, and analyzed for Target Compound List Volatile Organic Compounds (TCL VOC). Following are the results of these analyses:

15.4.1.1 Borehole 1

In the 5 foot sample, no target compounds or TIC compounds were detected.

15.4.1.2 Borehole 2

In the 5 foot sample, no target compounds or TIC compounds were detected. The QA/QC duplicate samples were also collected. The QC duplicate, which was analyzed at the same laboratory as the normal sample, contained no target compounds and no TIC compounds. The QC duplicate, which was analyzed at a different laboratory than the normal sample, contained methylene chloride, acetone and 2-butanone, however, since nearly all of the QA laboratory samples contained methylene chloride and acetone, they have been rejected as laboratory contaminants. 2-butanone was also rejected since it is a common laboratory contaminant and there is no agreement with the data from the QC laboratory.



LEGEND

Sand

Clay

Caliche

LRL Sciences, Inc.

SWMU #83

STRATIGRAPHIC COLUMN

CANNON AFB, NEW MEXICO

Project: Cannon AFB RFI	
Contract No: DACA47-93-C-009	
Prepared by: KLH	Date: 10-25-93

Fig. 15-2

15.4.1.3 Borehole 3

In the 5 foot sample, no target compounds or TIC compounds were detected.

15.4.2 Total Recoverable Petroleum Hydrocarbons (TRPH)

Total recoverable petroleum hydrocarbons were analyzed for at the surface, 2.5, 5, and 10 feet. Following are the results of these analyses.

15.4.2.1 Borehole 1

In the surface sample (CAN083-SUM1-041A), TRPH was detected at 3,400 mg/kg (Table 15-3). At 2.5 feet (CAN083-SUM1-042B), TRPH was detected at 3,800 mg/kg. At 5 feet (CAN083-SUM1-043C), TRPH was detected at 47 mg/kg. At 10 feet, TRPH was not detected. All of these data are estimates due to procedural inconsistencies regarding blank contamination and an inability to verify instrument output of sample results because the orginal instrument printout was not provided.

Table 15-3.
Concentration (mg/kg) of Total Recoverable Petroleum Hydrocarbons
SWMU No. 83 - Sump

Borehole Number	Cannon Number	Depth (ft.)	Chemical TRPH
1	CAN083-SUM1-041A	0	3400
	CAN083-SUM1-042B	2.5	3800
	CAN083-SUM1-043C	5	47
	CAN083-SUM1-044D	10	< 10
2	CAN083-SUM2-041A	0	1600
	CAN083-SUM2-042B	2.5	5000
	CAN083-SUM2-043C	5	40
	CAN083-SUM2-044D	10	< 10
3	CAN083-SUM3-041A	0	1200
	CAN083-SUM3-042B	2.5	< 10
	CAN083-SUM3-043C	5	< 10
	CAN083-SUM3-044D	10	< 10

Duplicate samples or laboratory repeat samples are presented only if they are different from the original sample and not rejected.

J = estimate
R = rejected
U = not detected at CRQL
UJ = estimated as non-detect at CRQL

15.4.2.2 Borehole 2

In the surface sample (CAN083-SUM2-041A), TRPH was detected at 1600 mg/kg. At 2.5 feet (CAN083-SUM2-042B), TRPH was detected at 5,000 mg/kg. At 5 and 10 feet, no TRPH was detected. All data are estimates due to procedural inconsistancies regarding blank contamination and an inability to verify instrument output of sample results because the original instrument printout was not provided.

The QA/QC duplicate samples were collected at 5 feet. In the QC duplicate, which is analyzed at the same lab as the normal sample, no TRPH was detected. The QA duplicate (CAN083-SUM2-741C), contained 16 mg/kg TRPH. This value is an estimate since it is below the CRQL.

15.4.2.3 Borehole 3

In the surface sample (CAN083-SUM3-041A), TRPH was detected at 1,200 mg/kg. At 2.5, 5, and 10 feet no TRPH was detected. These data are estimates due to procedural inconsistancies regarding blank contamination and an inability to verify instrument output of sample results because the original instrument printout was not provided.

15.4.3 Target Analyte List (TAL) Metals

In the following presentation of metals results, only metals in excess of background concentrations are presented. No background data was collected for this investigation, therefore, background concentrations were taken from Concentrations of Selected Naturally Occurring Chemical Constituents in Soil and Groundwater at Cannon Air Force Base Clovis, New Mexico, March 1993 prepared by Woodward-Clyde. For a discussion of Woodward-Clydes background data see Section 1.7. A list of all metals data including those detected below the background as defined in Woodward-Clyde, 1993, are found in Volumes 3 or 4 of this report.

Samples for metals analysis were collected at the surface, 5, 10, 20 and 30 feet.

15.4.3.1 Borehole 1

In the surface sample (CAN083-SUM1-051A), only iron was detected at 4,280 mg/kg (Table 15-4).

At 2.5 feet (CAN083-SUM1-052B), silver was detected at 3.4 mg/kg. This value is an estimate since laboratory control sample %R were not within control limits. Iron was detected at 5,900 mg/kg.

At 5 feet (CAN083-SUM1-053C), aluminum was detected at 13,600 mg/kg, iron was detected at 10,400 mg/kg, nickel was detected at 10.3 mg/kg. Background values for these metals are 10,540 mg/kg, 8,720 mg/kg and 9.0 mg/kg respectively.

Table 15-4
Concentrations (mg/kg) of TAL Metals
SWMU No. 83 - SUMP

Boring Number	Sample Number (CAN063-SUM)	Sample Depth (Feet)	Aluminum	Barium	Beryllium	Cobalt	Chromium	Copper	Iron	Lead
1	1-051A	0	6250	514	0.27	1.6	6 J	10.2 J	4280	5 J
	1-052B	2.5	7210	227	0.4	2.3	6.1 J	8.2 J	5900	10.2 J
	1-053C	5	13600	74	0.7	3.9	9.9	10.5 J	10400	7.4 J
	1-054D	10	7760	**2170**	0.47	1.3 U	3.3 J	6.9 J	4180	7.1 J
2	2-051A	0	5780	260	0.21	1.5	3.4 J	13.7 J	3690	9.6 J
	2-052B	2.5	15800	95.4	**0.81**	4.5	12	12.7 J	11700	10.4 J
	2-053C	5	15100	68.2	0.69	3.5	10.6	10.4 J	10700	7.6 J
(QAD)	2-751C	5	16400	129	**0.77**	5	13.2	6.2	11900	6.7
(QCD)	2-851C	5	12300	84.6	0.63	3.1	8.9	11 J	9560	7.6 J
	2-054D	10	8470	**1140**	0.58	1.6	3 J	7.4 J	4540	7.2 J
3	3-051A	0	8180	233	0.46	3.3	11.8	18 J	8550	36.8 J
	3-052B	2.5	7720	133	0.28	1.9	4.9 J	8.3 J	4890	5.6 J
	3-053C	5	15700	U 68.4	0.72	4	11.3	11.5 J	11700	7.3 J
	3-054D	10	11000	45.8	0.51	2.6	8.6 J	8.4 J	7660	5.2 J
Background (95% UCL) (1)			10540.00	642.00	0.73	4.5	12.50	13.00	1970.00	25.80

Notes:

Duplicate samples (QAD) or (QCD) samples are presented only if they are different from the original sample and not rejected.

U indicates that the compound was analyzed for, but not detected at or above the standard limit.
J indicates an estimated value.
UJ indicates the compound was analyzed for but not detected. The sample quantification limit or reported detection limit is an estimated quantity.
* R indicates that the data was rejected because of quality control measures

Boldface indicates a detection above the 95% UCL background level

Only data for metals detected above background is presented

(1) Background data is described in Section 17.0.

Table 15-4 (continued)
Concentration (mg/kg) of TAL Metals
SWMU No. 83 - SUMP

Boring Number	Sample Number (CAN083-SUM)	Sample Depth (Feet)	Manganese		Mercury		Nickel	Potassium		Silver		Zinc	
1	1-051A	0	105	J	0.01	U	8.6	1050		1.1	UJ	*	R
	1-052B	2.5	**239**	U	0.01	U	8.9	1210	J	**3.4**	J	*	R
	1-053C	5	111	J	0.01	U	**10.3**	2370	J	0.86	UJ	*	R
	1-054D	10	56.2	J	0.02	U	6	1210	J	0.95	UJ	**22.5**	J
2	2-051A	0	93.6	J	0.01	U	6.6	1030		0.84	UJ	13.9	J
	2-052B	2.5	**175**	J	0.02	U	**11.1**	2370		0.86	UJ	*	R
	2-053C	5	111	J	0.02	U	**9.8**	**2810**		0.85	UJ	**82.1**	J
(QAD)	2-751C	5	131	J	**0.15**		**11.4**	**2860**		0.41	U	**31.6**	
(QCD)	2-851C	5	106	J	0.01	U	**10.4**	2190		0.92	UJ	30.1	J
	2-054D	10	63.2	J	0.02	U	5.6	1320		0.93	UJ	*	R
3	3-051A	0	**271**	J	0.02	U	7.6	1500		0.92	UJ	**231**	J
	3-052B	2.5	50	J	0.02	U	6.1	1320		0.91	UJ	*	R
	3-053C	5	149	J	0.02	U	**10.4**	2320		0.87	UJ	**36.5**	J
	3-054D	10	99.9		0.1	U	6.9	1850		0.91	UJ	**22.8**	
Background (95% UCL) (1)			164		0.13		9.00	2572.00		2.20		21.90	

Notes:

Duplicate samples (QAD) or (QCD) samples are presented only if they are different from the original sample and not rejected.

U indicates that the compound was analyzed for, but not detected at or above the standard limit.
J indicates an estimated value.
UJ indicates the compound was analyzed for but not detected. The sample quantification limit or reported detection limit is an estimated quantity.
* R indicates that the data was rejected because of quality control measures

Boldface indicates a detection above the 95% UCL background level

Only data for metals detected above background is presented

(1) Background data is described in Section 17.0.

At 10 feet (CAN083-SUM1-054D), barium was detected at 2170 mg/kg and zinc was detected at 22.5 mg/kg. The value for zinc is an estimate since matrix spike recovery was not within control limits. Iron was detected at 4180 mg/kg. The background value for barium is 642 mg/kg, for zinc 21.9 mg/kg, and for iron 1970 mg/kg..

15.4.3.2 Borehole 2

In the surface sample (CAN083-SUM2-051A), copper was detected at 13.7 mg/kg. This value is an estimate due to contamination from the field blank or equipment rinsate. Iron was detected at 36980 mg/kg. Background for copper is 13.0 mg/kg.

Several TAL metals were detected above background in the sample collected at 2.5 feet (CAN083-SUM2-052B). These include: aluminum at 15,800 mg/kg, beryllium at 0.81 mg/kg, iron at 11,700 mg/kg, mangenese at 175 mg/kg and nickel at 11.1 mg/kg. The manganese value is an estimate since the matrix spike recovery was not within control limits. Background for these metals is 10,540 mg/kg for aluminum, 0.73 mg/kg for beryllium, 8,720 mg/kg for iron, 164 mg/kg for manganese and 9.0 mg/kg for nickel.

At 5 feet (CAN083-SUM2-053C), aluminum was detected at 15,100 mg/kg. Iron was detected at 9.8 mg/kg. Nickel was detected at 10,700 mg/kg. Potassium was detected at 2,810 mg/kg and zinc was detected at 82.1 mg/kg. The zinc value is an estimate since matrix spike recovery was not within control limits. The QA/QC duplicate samples were collected at this depth. The QC duplicate (CAN083-SUM2-851C), which was analyzed at the same laboratory as the normal sample, contained nickel at 10.4 mg/kg, iron at 9,560 mg/kg, and aluminu8m at 12,300 mg/kg. The QA duplicate, which was analyzed at a different laboratory than the normal sample, contained beryllium at 0.77 mg/kg, chromium at 13.2 mg/kg, cobalt at 5.0 mg/kg, mercury at 0.15 mg/kg, nickel at 11.4 mg/kg, iron at 11,900 mg/kg, and aluminum at 16,400 mg/kg.

At 10 feet (CAN083-SUM2-054D), barium was detected 1140 mg/kg and iron was detected at 4,540 mg/kg.

15.4.3.3 Borehole 3

In the surface sample (CAN083-SUM3-051A), iron was detected at 8,550 mg/kg, and copper was detected at 18.0 mg/kg. The copper value is an estimate due to contamination from the field blank or the equipment rinsate. Lead was detected at 36.8 mg/kg. Manganese was detected at 271 mg/kg and zinc was detected at 231 mg/kg. the lead, manganese, and zinc values are estimates since matrix spike recovery was not within control limits.

At 2.5 feet, only iron was detected at 4,890 mg/kg.

At 5 feet (CAN083-SUM3-053C), iron was detected at 11,700 mg/kg. Nickel was detected at 10.4 mg/kg. Zinc was detected at 36.5 mg/kg. The zinc value is an estimate since matrix spike recovery was not within control limits.

At 10 feet (CAN083-SUM3-054D), aluminum was detected at 11,000 mg/kg, zinc was detected at 22.8 mg/kg, and iron was detected at 7,660 mg/kg.

15.4.4 Wet Chemistry

In all three boreholes, samples were analyzed for cyanide, at the surface, 2.5, 5, and 10 feet. No cyanide was detected in any of the samples.

15.4.5 Summary

Volatile organic analysis occurred only at 5 feet. None were detected. TRPH was detected at the surface in all three boreholes. Boreholes 1 and 2 contained TRPH down to 5 feet with the highest concentrations occurring at 2.5 feet. No TRPH was detected at 10 feet. Metals were detected at the surface and in the subsurface samples of all three boreholes. Subsurface samples in borehole 2 contained many different kinds of metals.

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16.0 EXPLOSIVE ORDNANCE DISPOSAL TRAINING AREA (SWMU NO.108/EOD)

16.1 SWMU Description

16.1.1 Setting

The Explosive Ordnance Disposal Training Area (EOD) is located on the southeast corner of the base directly west of the Fire Department Training Area. The detonations occur in the center of a graded circular area approximately 200 feet in circumference. The area is routinely graded to remove any debris from explosives as well as vegetation. The area is two to three feet below grade and slopes towards the center; the circumference is defined by a one foot high earthen berm. The EOD is surrounded by a clear zone with an approximate 1,000 foot diameter. Figure 16-1 shows the SWMU setting and the borehole locations.

16.1.2 History of Use

This unit has been active since the early 1970's. The range is limited to Class A explosives with a maximum weight of 2.5 pounds of plastique C-4, which contains RDX, wax and inert material. The blasting caps contain RDX and small amounts of mercury fulmonate. All explosive material is solid and vaporizes to gaseous material upon detonation. Actual disposal of explosives is performed at the Melrose site.

16.1.3 Past Investigations

No data from previous investigations are available.

16.1.4 Land Use and Demography

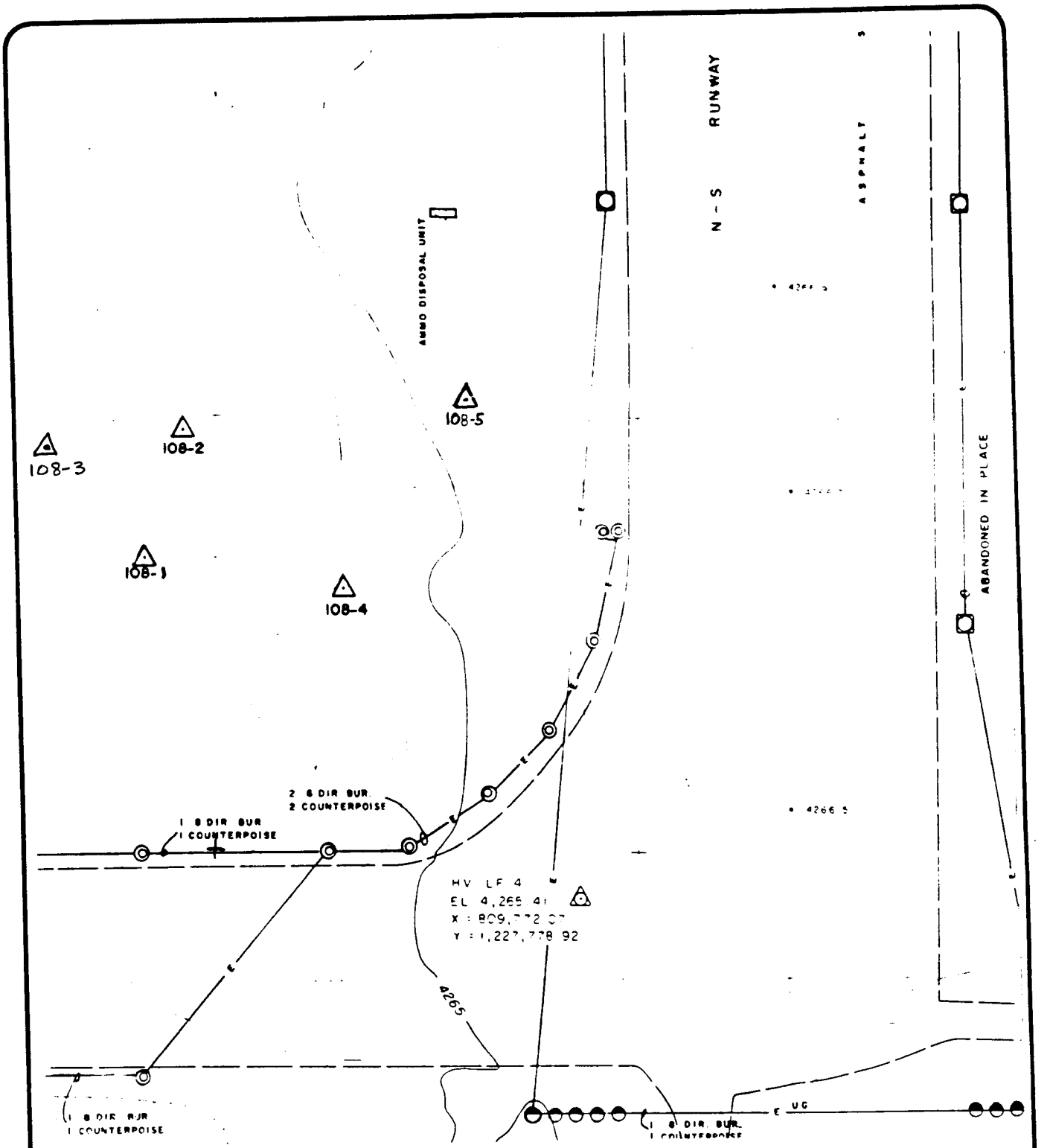
This SWMU is in an area which is not frequently used by base personnel except for detonation training and when the area is graded.

16.2 Field Investigation

Drilling and sampling activities at SWMU No. 108 began April 6, 1993 at 1530 hours. The activities, as outlined in the FSP (LRL, 1993), consisted of drilling 5 boreholes, collecting 10 surface samples, 30 subsurface samples, 8 QA/QC duplicate samples and 6 QA/QC water samples. Table 16-1 summarizes the field sampling program at SWMU No.108. Table 16-2 summarizes the various samples collected and analyses performed.

16.2.1 Sampling Objectives

Borehole locations, sampling depth, and parameters for analysis were selected, to the greatest extent possible, to determine if contamination in the detonation area exists. Boreholes 4 and 5 were moved from the original FSP in order to include data near the perimeter of the detonation area. Figure 16-1 shows the borehole locations.



Boring No.	Elevation (ft.)
1	4262.00
2	4262.02
3	4261.63
4	4262.08
5	4265.28

N

— Borehole

LRL Sciences, Inc.

SWMU #108
EOD

CANNON AFB, NEW MEXICO

Project:	Cannon AFB RFI
Contract No:	DACA47-93-C-009
Prepared by: LLH	Date: 10-25-93

Fig. 16-1

Table 16-1.
Summary of Drilling and Sampling
SWMU No. 108 - Explosive Ordnance Disposal Act. Area

Borehole Number	Sampling Depth (ft.-BGS)	Drilling/ Sampling Methods	Drillrig Used	Borehole Diameter (in.)	Ground Elevation	Date Grouted
1	0	NA/SSS	NA	NA	4262.00	4/07/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
2	0	NA/SSS	NA	NA	4262.02	4/07/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
3	0	NA/SSS	NA	NA	4261.63	4/07/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
4	0	NA/SSS	NA	NA	4262.08	4/7/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
5	0	NA/SSS	NA	NA	4265-28	4/7/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		

HSA = Hollow Stem Auger
HA = Hand Auger
SBC = Split Barrel Continuous Sampler
SS = Split Spoon
SSS = Stainless Steel Spoon

Table 16-2.
Summary of Sampling and Analyses
SWMU No. 108 - Explosive Ordnance Diposal Training Area

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
1	0	CAN108-EOD1-021A	N	SOIL	1455	PM	6010\7000S+
		CAN108-EOD1-061A	N	SOIL	1455	Reactives	9010\9030
	2.5	CAN108-EOD1-022B	N	SOIL	1540	PM	6010\7000S
		CAN108-EOD1-062B	N	SOIL	1540	Reactives	9010\9030
		CAN108-EOD1-821B	QCD	SOIL	1540	PM	6010\7000S
		CAN108-EOD1-861B	QCD	SOIL	1540	Reactives	9010\9030
		CAN108-EOD1-721B	QAD	SOIL	1540	PM	6010\7000S
		CAN108-EOD1-761B	QAD	SOIL	1540	Reactives	9010\9030
	5.0	CAN108-EOD1-023C	N	SOIL	1545	PM	6010\7000S
		CAN108-EOD1-063C	N	SOIL	1545	Reactives	9010\9030
	10.0	CAN108-EOD1-024D	N	SOIL	1550	PM	6010\7000S
		CAN108-EOD1-064D	N	SOIL	1550	Reactives	9010\9030
2	0	CAN108-EOD2-021A	N	SOIL	1615	PM	6010\7000S
		CAN108-EOD2-061A	N	SOIL	1615	Reactives	9010\9030
	2.5	CAN108-EOD2-022B	N	SOIL	1630	PM	6010\7000S
		CAN108-EOD2-062B	N	SOIL	1630	Reactives	9010\9030
	5.0	CAN108-EOD2-023C	N	SOIL	1640	PM	6010\7000S
		CAN108-EOD2-063C	N	SOIL	1640	Reactives	9010\9030
	10.0	CAN108-EOD2-024D	N	SOIL	1645	PM	6010\7000S
		CAN108-EOD2-064D	N	SOIL	1645	Reactives	9010\9030

Table 16-2. (Continued)
Summary of Sampling and Analyses
SWMU No. 108 - Explosive Ordnance Diposal Training Area

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
3	0	CAN108-EOD3-021A	N	SOIL	1700	PM	6010\7000S
		CAN108-EOD3-061A	N	SOIL	1700	Reactives	9010\9030
	2.5	CAN108-EOD3-022B	N	SOIL	1715	PM	6010\7000S
		CAN108-EOD3-062B	N	SOIL	1715	Reactives	9010\9030
	5.0	CAN108-EOD3-023C	N	SOIL	1720	PM	6010\7000S
		CAN108-EOD3-063C	N	SOIL	1720	Reactives	9010\9030
	10.0	CAN108-EOD3-024D	N	SOIL	1720	PM	6010\7000S
		CAN108-EOD3-064D	N	SOIL	1720	Reactives	9010\9030
4	0	CAN108-EOD4-021A	N	SOIL	1745	PM	6010/7000S
		CAN108-EOD4-061A	N	SOIL	1745	Reactives	9010/9030
	2.5	CAN108-EOD4-022B	N	SOIL	1805	PM	6010\7000S
		CAN108-EOD4-062B	N	SOIL	1805	Reactives	9010\9030
		CAN108-EOD4-821B	QCD	SOIL	1805	PM	6010\7000S
		CAN108-EOD4-861B	QCD	SOIL	1805	Reactives	9010\9030
		CAN108-EOD4-721B	QAD	SOIL	1805	PM	6010\7000S
		CAN108-EOD4-761B	QAD	SOIL	1805	Reactives	9010\7000S
	5.0	CAN108-EOD4-023C	N	SOIL	1810	PM	6010/7000S
		CAN108-EOD4-063C	N	SOIL	1810	Reactives	9010/7000S
	10.0	CAN108-EOD4-024D	N	SOIL	1820	PM	6010/7000S
		CAN108-EOD4-064D	N	SOIL	1820	Reactives	9010/7000S

Table 16-2. (Concluded)
Summary of Sampling and Analyses
SWMU No. 108 - Explosive Ordnance Diposal Training Area

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
5	0	CAN108-EOD4-021A	N	SOIL	1835	PM	6010/7000S
		CAN108-EOD5-061A	N	SOIL	1035	Reactives	9010/7000S
	2.5	CAN108-EOD5-022B	N	SOIL	1850	PM	6010/7000S
		CAN108-EOD5-062B	N	SOIL	1850	Reactives	9010/7000S
	5.0	CAN108-EOD5-023C	N	SOIL	1850	PM	6010/7000S
		CAN108-EOD5-063C	N	SOIL	1850	Reactives	9010-7000S
	10.0	CAN108-EOD5-024D	N	SOIL	1900	PM	6010/7040
		CAN108-EOD5-064D	N	SOIL	1900	reactives	9010/7000S
		CAN108-EOD0-321Z	QC	WATER	1915	PM	6010/7000S
		CAN108-EOD0-331Z	QC	WATER	1915	TCL VOC	8240
		CAN108-EOD0-221Z	QC	WATER	1930	PM	6010/7000S
		CAN108-EOD0-231Z	QC	WATER	1930	TCL VOC	8240
		CAN108-EOD0-621Z	QC	WATER	1920	PM	6010/7000S
		CAN108-EOD0-631Z	QC	WATER	1920	TCL VOC	8240

ft-BGS = feet below ground surface
N = Normal soil sample
PM = Priority metals = 8 TCLP metals + Ni
TCL VOC = Target Compound List Volatile Organic Compound
\+ = Metals analyzed using the 7000 Series include: mercury, selenium, and arsenic.

QAD = Duplicate soil sample (analyzed at different laboratory from normal samples).
QCD = Duplicate soil sample analyzed at same laboratory as normal samples.
QC = Quality control water sample (ambient blank, trip blank, etc.)

16.2.2 Surface and Subsurface Soil Investigation

Five boreholes were drilled at this SWMU. Borehole 1 was drilled to the southwest of center. Borehole 2 was drilled very close to the center of the detonation area. Borehole 3 was drilled to the northwest of center. Borehole 4 was drilled to the southeast of center and closer to the perimeter. Borehole 5 was drilled to the northeast of center adjacent to the perimeter. Drilling was advanced to depth of 10 feet. Samples were collected at the surface, 2.5, 5 and 10 feet in depth. Surface samples were collected with a stainless steel trowel and subsurface samples were collected with a split barrel continuous sampler. Samples were collected at discrete depths and locations. No composite samples were taken. Samples were analyzed for priority metals and wet chemistry (cyanide, reactivity, total solids, and sulfide). Duplicates, rinsate blanks, ambient blanks and decontamination water samples were also submitted to the laboratory for this SWMU.

16.3 Physical Characteristics

This section provides a discussion of the surface water drainage, groundwater, soils, and geology at the EOD based on a review of information from previous investigations at Cannon AFB and from the lithologic descriptions from the split barrel continuous sampler.

16.3.1 Surface Water Drainage

Surface water drainage in the vicinity of SWMU No.108 would remain in the detonation area due to the depth below grade and the earthen berm that surrounds the area.

16.3.2 Groundwater

Depth to groundwater at Cannon AFB is approximately 250 feet or greater. Groundwater recharge rates for the High Plains Region where Cannon AFB is located are typically low. Localized recharge rates for Curry County range from 0.75 - 12.22 mm/yr (Stone, 1985). EPA, 1987 DRASTIC reports recharge rates of 1 in/yr. Section 1.0 of this report includes a discussion of groundwater hydrology for the High Plains and Cannon AFB.

16.3.3 Soils and Geology

The near surface (upper ten feet) stratigraphy in the area surrounding the explosive ordinance activity area consist of Tertiary Miocene to Pliocene fluvial deposits of the Ogallala Formation. The soils have been described as a fine sandy loam (Ab) of the Amarillo soil group (USDA, 1993). Interpretations and correlation on the fluvial deposits for this area are based on split spoon samples collected during the drilling process. The soils consist of very fine to fine-grained, moderate to well sorted, submature to mature (textural), unconsolidated, calcareous, reddish brown, clays, silts, and sands. Thin to moderately thin banded layers and lenses of caliche material were interbedded throughout much of the samples collected. The sands were

comprised of angular to subangular grains with varying amounts of silts, clays, and calcium carbonate (caliche) material. This description of lithology (Figure 16-2) is similiar to the description of soils given by the USDA Soil Survey, 1993. The thickness of this particular unit remains unknown, due to the fact that boring levels did not exceed ten feet. The total thickness of the Ogallala Formation beneath the explosive ordinance activity area is not presently known, but regional information based on Curry County reports have suggested thicknesses of approximately 320-400 feet. No groundwater was encountered while drilling at these five borehole locations. The minimum depth of the High Plains aquifer is reported to be greater than 250 feet below ground surface.

16.4 Nature and Extent of Contamination

16.4.1 Volatile Organic Compounds

A series of HNU meter readings were taken in the well head and in the breathing zone for each borehole for worker safety purposes. No positive reading were obtained.

16.4.2 Priority Metals

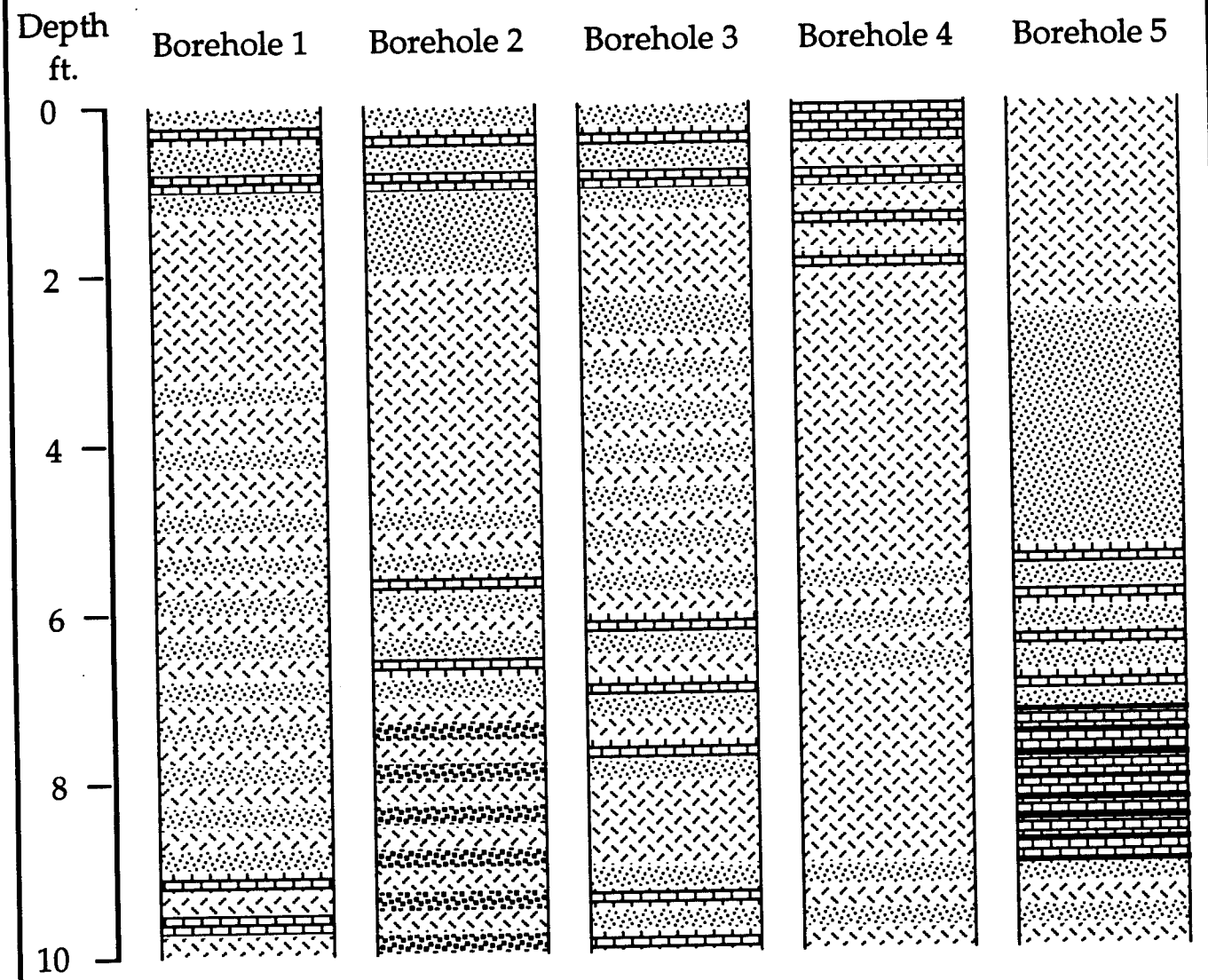
Total metals concentrations, using the RCRA SW-846 test methods for the analysis of metals in soils, were determined for the eight TCLP metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) plus nickel. These are the priority metals. Samples were collected for priority metals analysis at the surface, 2.5, 5, and 10 feet.

In the following presentation of metals results, only metals concentrations in excess of background concentrations are presented. No background data was collected for this investigation, therefore, background concentrations were taken from Concentrations of Selected Naturally Occurring Chemical Constituents in Soil and Groundwater at Cannon Air Force Base Clovis, New Mexico, March 1993 prepared by Woodward-Clyde. For a discussion of Woodward-Clydes selection of background values, see Section 1.7.

16.4.2.1 Borehole 1

In the surface sample (CAN108-EOD1-021A), nickel was detected at 11.4 mg/kg (Table 16-3). This value is an estimate since matrix spike recovery was not with control limits. Background for nickel is 9.0 mg/kg.

No priority metals were detected above background at 2.5, 5 or 10 feet. The QA/QC duplicate samples were collected at 2.5 feet. The QC sample, which was analyzed at the same laboratory as the normal sample, contained no priority metals above background. The QA sample, which was analyzed at a different laboratory from the normal sample, contained no priority metals above background.



LEGEND

	Asphalt		Clay
	Gravel		Caliche
	Sand		Banded Clay

LRL Sciences, Inc.

SWMU #108
STRATIGRAPHIC COLUMN
CANNON AFB, NEW MEXICO

Project: Cannon AFB RFI	
Contract No: DACA47-93-C-009	
Prepared by: KCH	Date: 10-25-93

Fig. 16-2

Table 16-3
Concentration (mg/kg) of Priority Metals
SWMU No. 108 - EOD SITE

Boring Number	Sample Number (CAN108-EOD)	Sample Depth (Feet)	Chromium		Nickel	
1	1-021A	0	9.9	J	11.4	J
	1-022B	2.5	4.3	UJ	5.9	J
(QAD)	1-721B	2.5	5		4.8	
(QCD)	1-821B	2.5	4.4	UJ	5.4	J
	1-023D	5	5.9	UJ	7.2	J
	1-024D	10	4.5	UJ	5.6	J
2	2-021A	0	10.7	J	9.7	
	2-022B	2.5	4.1	UJ	4.5	J
	2-023C	5	2.8	UJ	5	J
	2-024D	10	3.6	UJ	5.2	J
3	3-021A	0	6.1	UJ	7.3	J
	3-022B	2.5	4.7	UJ	4.8	J
	3-023C	5	6.6	UJ	7.9	J
	3-024D	10	2.6	UJ	4.2	J
4	4-021A	0	7.5	J	7.7	J
	4-022B	2.5	8	J	7	J
(QAD)	4-721B	2.5	8.3		6.4	
(QCD)	4-821B	2.5	9.1	J	9.2	J
	4-023C	5	5	J	6.3	J
	4-024D	10	5.1	J	8.5	J
5	5-021A	0	9.7	J	9.2	J
	5-022B	2.5	6.5	UJ	6.6	J
	5-023C	5	8.5	J	8.1	J
	5-024D	10	4	UJ	5	J
Background (95% UCL) (1)			12.50		9.00	

Notes:

Duplicate samples (QAD) or (QCD) samples are presented only if they are different from the original sample and not rejected.

U indicates that the compound was analyzed for, but not detected at or above the standard limit.
J indicates an estimated value.
UJ indicates the compound was analyzed for but not detected. The sample quantification limit or reported detection limit is an estimated quantity.
* R indicates that the data was rejected because of quality control measures

Boldface indicates a detection above the 95% UCL background level

Only data for metals detected above background is presented

(1) Background data is described in Section 17.0.

16.4.2.2 Borehole 2

In the surface sample (CAN108-EOD2-021A), nickel was detected at 9.7 mg/kg.

No priority metals were detected above background at 2.5, 5 or 10 feet.

16.4.2.3 Borehole 3

No priority metals were detected above background in the surface, at 2.5, 5 or 10 feet.

16.4.2.4 Borehole 4

No priority metals were detected above background in the surface sample, or at 2.5, 5 or 10 feet. The QA/QC duplicate samples were collected at 2.5 feet. The QC duplicate (CAN108-EOD4-821B), which was analyzed at the same lab as the normal sample, contained nickel at 9.2 mg/kg. This value is an estimate since matrix spike recovery was not within QC limits. Background for nickel is 9.0 mg/kg. The QA duplicate, analyzed at a different lab than the normal sample, contained no priority metals above background.

16.4.2.5 Borehole 5

In the surface sample (CAN108-EOD5-021A), nickel was detected at 9.2 mg/kg. This value is an estimate since the matrix spike recovery was not within control limits.

No priority metals were detected above background at 2.5, 5 or 10 feet.

16.4.3 Wet Chemistry

For this SWMU, wet chemistry data (cyanide, reactivity, total solids and sulfides) were collected at the surface, 2.5, 5, and 10 feet. The cyanide data was rejected since the reported %Rs for the matrix spike analysis were less than 30%. The reactivity data was rejected since the test methods employed, analyzed for total cyanide and sulfide rather than reactive cyanide and sulfide. No total sulfides were detected in any of the samples.

16.4.4 Summary

Nickel was detected in the surface of 3 out of 5 boreholes. No other priority metals were detected above background at this SWMU. No sulfides were detected in any of the samples.

17.0 QUALITY ASSURANCE/QUALITY CONTROL OF DATA

17.1 Introduction

This section summarizes quality assurance procedures related to field and laboratory data and the results of quality control samples taken during the RFI at 15 SWMUs on Cannon AFB near Clovis, New Mexico. A copy of the analytical results is contained in Appendix A.

Details of data quality objectives for the overall project are discussed in Volume I of the QAP for the RFI(LRL, 1993). The QAP provides the documentation and procedures of the RFI quality assurance program. The SOPs in the RFI field sampling plan are from the Cannon RCRA Facility Investigation Work Plan (Cannon AFB 1991).

Variances from the quality assurance objectives result in the implementation of appropriate corrective measures and an assessment of the impact on the usability of the data in the decision-making process.

As used in this section, quality control(QC) refers to activities which provide methods for checking, verifying, or quantifying the data against established standards.

17.2 Specific Type of QA/QC Activities

Specific QA activities required by the QAP include the following:

- Adherence to sampling and reporting procedures outlined in the SOPs for the RFI Work Plan (LRL, 1993)
- Audits of field procedures, including a minimum of one systems audit on field performance
- Collection and analysis of QC samples

17.2.1 QC Samples

Field duplicates, ambient blanks, rinsate blanks, decontamination water blanks and trip blanks were collected and submitted to the analytical laboratory to provide a means of assessing the quality of the data resulting from the field sampling program. Field duplicate samples were analyzed to check for sampling and laboratory reproducibility and to evaluate whether analytical results were representative of the sample analyzed. Trip blank samples were analyzed to check for procedural contamination, cross-contamination, and laboratory contamination during shipment and storage of aqueous samples. Ambient blanks were used to evaluate contamination as a result of airborne chemicals. Decontamination water blanks were utilized to evaluate contamination that might be introduced during decontamination activities and to evaluate contaminants contained in the water, used for ambient and rinsate blanks. The rinsate blanks were used to evaluate contamination in the laboratory supplied water used for rinsing the equipment. Decontamination procedures were carried out according to COE directions.

17.3 Results of QAP-Required Activities

17.3.1 Field Audits

Field audits were conducted during the 2-day period of April 13-14, 1993. Field audits were conducted to evaluate conformance of field practice to the SOPs. A SWMU site QAP report (Appendix C) was completed for each SWMU. The following SOPs were audited:

Audit Date: April 13, 1993 (SWMU 39)

- SOP No. 1.3, Sample Handling, Documentation and analysis
- SOP No. 4.1, Equipment Decontamination
- SOP Nos. 4.1, 5.1, and 5.2, Subsurface Drilling and Sampling
- SOP No. 5.1, Lithologic Description of Subsurface Samples

Audit Date: April 14, 1993 (SWMU 48A & B)

- SOP No. 1.3, Sample Handling, Documentation and analysis
- SOP No. 4.1, Equipment Decontamination
- SOP Nos. 4.1, 5.1, and 5.2, Subsurface Drilling and Sampling
- SOP No. 5.1, Lithologic Description of Subsurface Samples

Field audits showed compliance with the SOPs and the LRL contract.

17.3.2 Laboratory Audits

The COE laboratory manager was responsible for implementation of the laboratory QAP.

17.4 Data Validation

The analytical data generated by the laboratory were reviewed for accuracy, precision, completeness, representativeness, and comparability. The data validation process for this project consisted of data generation, reduction, and two levels of review through the data validation contractor.

At least 10% of the validated data packages received a second level of validation or review by a designee of LRL Sciences QA/QC officer whose function is to provide an independent review of the package. Laboratory results were reviewed and data qualified, if required.

17.4.1 Full Data Validation

17.4.1.1 Volatiles

17.4.1.1.1 *Completeness of Data.* 94.7 percent of the data was acceptable (percent not with an 'R' qualification compared to total analyzed by the lab).

17.4.1.1.2 *Calibrations*. 5,753 out of 6,204 results had the percent difference between the response factors from the initial or continuing calibration inside the QA objective. Analytes commonly found to be outside the QA limit included acetone, bromoform, 2-butanone, 2-hexanone, and 4-methyl-2-pentanone.

17.4.1.1.3 *Internal Standard Performance*. Generally, the internal standard areas and retention times for the sample were within the QC limits. 6016 of 6,204 results had internal standards inside the QC limits.

17.4.1.1.4 *Tentatively Identified Compounds (TIC)*. In 126 of the 193 cases, the TIC identifications were supported with mass spectral evidence meeting validation criteria.

17.4.1.1.5 *Target Compound Identification*. In most cases target compound indentification was satisfactory. But in some cases where acetone was reported, the mass spectrum was that of a poly(dimethylsiloxane) derivative. The sample may have shown acetone but, with the presence of the siloxane, it was not possible to unambiguously identify acetone. In other cases the acetone was clearly present, but did contain some admixture of siloxane so that quantitation was not accurate. The siloxane appears to be a hexamethyl dihydro trisiloxane or octamethyl trisiloxane. These compounds are quite volatile in spite of their high molecular weight; this is a result of low intermolecular attraction common in low polarizability compounds. As a consequence, they may elute with materials of considerably lower molecular weight. Analyses showing these features were qualified 'R' for acetone in the data validation report.

17.4.1.1.6 *Quantification and Reported Detection Limits*. In the 5,247 of 6,204 results, quantification and detection limits were properly calculated. Evaluation of the effect of raised detection limits on the usability of the data is provided within the data interpretation sections.

17.4.1.1.7 *System Performance*. System performance consists of a complete evaluation of instrument-performance QC checks (i.e., tuning, calibration, chromatographic performance). A review of these indicators shows the quality of all of this data to be satisfactory.

17.4.1.1.8 *Holding Times*. No samples were qualified due to exceeding holding times.

17.4.1.2 <u>Inorganics</u>

17.4.1.2.1 *Completeness of Data*. 97.1 percent of the data was acceptable (percent not with a 'R' qualification compared to total analyzed by the lab).

17.4.1.2.2 *Calibration*. 24 of the 883 results reviewed for GFAA had initial calibration correlation coefficients for selenium, arsenic, and lead below 0.995. These samples were qualified as estimated.

17.4.1.2.3 *Furnace Atomic absorption*. 131 of 883 results reviewed had post digestion spike recoveries outside the 85 to 115 percent control limits. These samples qualified as estimated. Common missed analytes were selenium, thallium and arsenic.

17.4.1.2.4 *ICP Serial Dilution.* 2,022 of 2,082 results reviewed had less than the 10 percent difference between original analytical result and that from the diluted sample. The samples that exceeded the 10 percent limit were qualified as estimated. Analytes that commonly exceeded the limit were antimony, cobalt, and potassium.

17.4.1.3 Additional Analyses

Over ten percent of the samples analyzed for the following analytes also underwent full validation as described in section 7.0 of the QAP (LRL, 1993).

- Benzene, toluene, ethyl benzene, xylene (BTEX)
- Total Recoverable Petroleum Hydrocarbons (TRPH)
- Reactivity
- Sulfide
- Cyanide

17.4.2 Quality Control Review

For this project, quality control review (QCR) has been defined by LRL Sciences as the evaluation of the analytical data with respect to the following:

- Holding times
- Method blanks
- Laboratory control samples
- Laboratory duplicate sample
- MS/MSD
- Surrogate compound percent recoveries
- Field duplicate results
- Overall assessment of data for a case
- Completeness of sample delivery package

In addition, if the laboratory narrative indicated a problem, the effect on the quality of the associated data was evaluated and the results qualified accordingly. The QC review of the data followed procedures described in section 7.0 of the QAP (LRL, 1993).

17.4.2.1 Method Blanks

Validation of method blank contamination followed the protocols specified in the EPA National Functional Guidelines (NFG, 1991). Within these protocols, method blanks are associated with specific field samples, and only those samples associated with a given method blank were qualified because of blank contamination. 388 results for metals and 13 results for VOA had method blank contamination. Common contaminants for metals include cadmium and chromium. Common contaminants for VOA include acetone and methylene chloride.

DRAFT

17.4.3 Summary

As summarized above and discussed in detail in the full validation reports in Volumes 3 and 4, conformance to accuracy, precision, and representativeness of an analytical value to the samples analyzed were evaluated for all sample results, and qualification or rejection of sample data were performed in accordance with specified guidelines and criteria (NFG, 1991). The qualified data qualified, presented in this report was found to meet the quality assurance objectives for this project as specified in the validation and quality control review protocols.

Comparability expresses the confidence with which one data set can be compared to another. Data are comparable when considering collection techniques and measurement procedures; method and reporting are equivalent for samples within sample set. Throughout this investigation, SOPs for the field activities were implemented and EPA-approved standards methods were used for analysis and reporting. Consequently, within each data set results are comparable to one another as well as to other data sets for this investigation.

Completeness was 95.0 percent, calculated as the ratio of acceptable results to the total number of analytical results requested on samples submitted for analysis.

The full validation of over 10 percent of all sample data is intended to be used as a guide to general laboratory performance on the site sample analyses and to identify problems which may not have been observed in the quality control review of the rest of the data. As summarized in section 18.4.2.1, several analytes were found to occur commonly in a significant number of laboratory blanks. As such, the presence of low levels of acetone and methylene chloride in environmental samples is probably a result of laboratory contamination.

In addition, the full validation reports indicate that the laboratory commonly did not meet quality assurance objectives for calibration for the following analytes: acetone, 2-butanone, 2-hexanone, bromoform, and 4-methyl-2-pentanone. It is possible that the calibration problems for many of these analytes is related to variable amounts of laboratory contamination during calibration. Because the calibration problems for these analytes occurred with some regularity, analytical values for these analytes in all environmental samples should be considered of lower reliability than the other unqualified analytical results.

For the SW-846 metal analyses, the full validation indicated sufficient difficulties in the GFAA analyses for selenium, thallium and arsenic so that the analytical values for these analytes in samples should also be considered of lower reliability than other, unqualified analytical results.

18.0 SUMMARY OF RISK ASSESSMENT

18.1 Summary of the Human Health Risk Assessment

A human health risk assessment (HRA) was performed using the site investigation data obtained for 15 Solid Waste Management Units (SWMUs) at Cannon Air Force Base (AFB). The objective of the HRA is to assess the carcinogenic risk and noncarcinogenic hazard posed by contaminated soil at the various SWMUs to potential human receptors. The information from the HRA can then be used to assist in determining if there should be further investigation, remedial action, or no further action for each of the SWMUs.

The complete description of the HRA conducted, including all assumptions made, calculations performed, and details of results is presented in Section 19.0 in Volume 2 of this report. This section presents a summary of the general approach used and summaries of results for each Risk Assessment Area (RAA).

18.1.1 Overview of Approach

The HRA was conducted using the standard principles and approaches identified in "Risk Assessment Guidance for Superfund: Volume I: Human Health Evaluation Manual, Part A" (RAGS), (EPA, 1989a). RAGS, which is the Superfund guidance document for human health risk assessment, was used instead of RFI guidance for human health risk assessment due to its more comprehensive nature. Assumptions made throughout this risk assessment were generally conservative, and therefore tend to overestimate the actual risk.

First the results from the sampling and analysis were evaluated by identifying Chemicals of Concern (COCs), grouping the SWMUs into RAAs, and summarizing soil characterization results (data evaluation). For each RAA identified, a risk assessment was then performed by identifying the potential receptors and calculating their chronic daily intake of the COCs by all pathways (exposure assessment), and assessing the toxicity of all of the COCs (toxicity assessment). The chronic daily intake results were then combined with the toxicity assessment results to estimate a cancer risk and noncancer hazard index for each receptor based on reasonable maximum exposures (risk characterization). Each of these steps of the HRA is discussed in more detail below.

18.1.1.1 Data Evaluation

The results from sample analysis were first validated using the United States Environmental Protection Agency (EPA) Laboratory Data Validation Functional Guidelines (EPA, 1988b, EPA, 1991g) in order to determine the useability of the data. The data were reviewed with respect to the overall quality of the data, the quantitation limits achieved in the analysis, and the laboratory quality assurance/quality control (QA/QC) practices, including precision, accuracy, representativeness, completeness, and comparability. The data were either accepted, rejected, or accepted with qualifications. All rejected data were eliminated from further consideration.

The COCs for each SWMU were then identified by eliminating chemicals that were not detected in any environmental sample, eliminating chemicals that were conclusively identified in data validation as laboratory contaminants, eliminating metals in which the maximum detected concentration was less than its background soil concentration at Cannon AFB, and eliminating chemicals, except lead, for which there are no EPA-verified toxicity data. The metals excluded due to the lack of EPA-verified toxicity data include aluminum, calcium, cobalt, copper, iron, magnesium, and potassium. The remaining chemicals constitute the list of COCs. The composite list of COCs for the 15 SWMUs includes the following: arsenic, barium, beryllium, chromium, lead, manganese, nickel, silver, vanadium, zinc, acetone, ethylbenzene, methylene chloride, tetrachloroethylene, 1,1,1-trichloroethane, toluene, and xylene.

For the HRA, the SWMUs were divided into Risk Assessment Areas (RAAs), and the subsequent calculations and risk analysis were performed for each RAA. A Risk Assessment Area (RAA) is a group of SWMUs that are geographically close and have similar chemical release sources. Grouping the SWMUs into RAAs allows the identification of chemicals and pathways that result in significant contributions to risk, and the assessment of whether potential human health impacts are related to a particular RAA or contamination source. The physical setting and soil characterization data from each RAA are used in the fate and transport modeling and exposure assessment portions of this HRA. SWMUs were grouped using the following criteria:

- Physical setting: This criterion considers the physical characteristics such as the site-specific geology, hydrogeology, hydrology, and meteorology. SWMUs in close proximity share these characteristics, and are more likely to have the same risk impacts than those farther away.

- Function: SWMUs that serve similar functions at Cannon AFB are more likely to have similar chemical release sources.

- Chemical release sources: SWMUs with common or similar chemical release sources are more likely to have the same COCs.

The SWMUs were grouped into 4 RAAs as follows:

RAA #1	SWMUs #1, 3, 5, 7, 8, 9, 11, 16, 32A, 33B, 38, and 39
RAA #2	SWMU #48A and B
RAA #3	SWMU #83
RAA #4	SWMU #108

The first step in quantifying the potential human health risk posed by the RAAs is to calculate the exposure point concentrations for each medium sampled. For this investigation, only soil samples were collected.

An HRA is based on an estimate of the reasonable maximum exposure (RME) expected to occur under current and future land use conditions (EPA, 1989d). The RME is defined as the highest exposure that can reasonably be expected to occur at a site. The EPA recommends that the 95% upper confidence limit (UCL) be used as the representative RME concentration for risk assessments (EPA, 1989d; EPA, 1992).

For the finite number of soil sample results, which were assumed to be distributed normally, and using a depth interval of 10 feet below ground surface, the 95% UCL for each COC in each RAA was calculated.

A set of criteria was established to determine the numerical values to be used for qualified data:

Data Validation Qualifier	Example of Result	Numerical Value Used in 95 % UCL Calculations
J	1.5 J	1.5
U	1.5 U	If the reported detection limit (RDL) (e.g., 1.5) is greater than the maximum detected concentration, exclude from calculations. Otherwise, use half the RDL (e.g., 1.5/2 = 0.75) in calculations.
UJ	1.5 UJ	Same as "U" qualified data.

The analytical results used and the corresponding 95% UCL calculations for all COCs for each RAA are presented in Appendix F. All COC data for a particular RAA were considered, which thus in some instances included COC data from SWMUs without any valid detections. Such an inclusion resulted in 95% UCLs that were representative of an entire RAA.

Although the number of samples taken was constant within a chemical group (i.e., BTEX, TCL VOCs, and metals) for a particular RAA, the number of results, or the total number of data points used in calculating the 95% UCL, varied with the COC. The number of results, depended on the amount and type of qualified data for a particular COC. For instance, most of the sample data for 1,1,1-trichloroethane (TCA) and methylene chloride in RAA #1 were nondetects with RDLs greater than the maximum detected concentration. Therefore, these nondetects were not included in the calculations of 95% UCLs. Consequently, the number of results is low (e.g., only two results for methylene chloride in RAA #1). The low number of results provides an insufficient data set for calculating a meaningful 95% UCL (EPA, 1992). In these cases, the maximum detected COC concentrations were selected in order to conservatively represent the RME values.

For some COCs, 90% or more of the sample data were nondetects with RDLs less than the maximum detected concentration. These COCs included: toluene, ethylbenzene, xylenes, acetone, tetrachloroethene, methylene chloride, and silver. The nondetects for these COCs were

included in the calculations of 95% UCLs. However, the high percentage of non-detects compared with the total number of results precludes a clear representation of the RME values by the calculated 95% UCLs.

18.1.1.2 Exposure Assessment

The objective of the exposure assessment is to estimate, for each COC, the extent of exposure to an individual (herein referred to as a receptor) based on onsite soil concentrations and fate and transport modeling results. Exposure is expressed as a chronic daily intake (or dose) for each exposure pathway of concern and each receptor of concern. Results of the exposure assessment are then combined with toxicity data for each COC to determine the probability of an exposed receptor developing cancer and noncancer adverse health effects.

An exposure pathway describes the course a COC takes from the source to the receptor. Only complete exposure pathways need to be assessed in an HRA (EPA, 1989d). A complete exposure pathway consists of the following four elements:

- A source and mechanism of chemical release;
- A retention or transport medium;
- A point of potential human contact with the contaminated medium (referred to as the exposure point or receptor); and,
- An exposure route (e.g., ingestion) at the contact point.

Before identifying complete exposure pathways, the 15 SWMUs investigated at Cannon AFB were characterized with respect to current and future land use. The current and future land use of the RAAs is industrial. As a military installation, the use of Cannon AFB is highly specialized and there is low probability that the RAAs will support residential use in the future. The nearest sensitive receptors, or those more sensitive to chemical exposures, are children living in the residential area located in the corner of the base northwest of the NE-SW runway, approximately one-half mile from the nearest RAA, RAA #1.

Based on the current and anticipated future land use of the RAAs, two exposure scenarios were defined. The first exposure scenario is that of "baseline" conditions, which incorporate the following assumptions:

- The land use of the RAAs will not change. The RAAs will remain industrial, and will never support residential use;
- The site characterization data available are representative of site conditions in the future; and,
- Short-term activities such as construction will not occur. No further remedial action will be implemented to reduce the exposure to COCs.

Since the RAAs have an industrial/commercial setting, it is anticipated that some level of construction might occur at the RAAs in the future. Therefore, the second exposure scenario is that of "construction" conditions, which incorporate the following assumptions:

- Trenching activities will take place at each RAA;
- One utility trench will be constructed along the length of each RAA. The trench will be straight, four feet wide, and 10 feet deep;
- Construction activities will occur over a 30-day period; days will be 8-hour days, for a total exposure duration for the construction scenario of 240 hours; and,
- Onsite construction workers will be potentially exposed as a result of construction activities, and mitigation measures (i.e., dust control, personal protective equipment) will not exist;
- The site characterization data available are representative of site conditions during construction activities.

For an exposure pathway to be considered complete, it must be possible for a COC to be transported from the source by an environmental transport medium to an exposure point. Three transport mechanisms were qualitatively evaluated to assess the viability of transport to receptors: air transport, vadose or unsaturated zone transport, and surface water transport. Of these, only air transport was determined to be a complete transport pathway. Air transport of COCs occurs via either vapor phase or airborne particulate (dust) mechanisms. For the purposes of this HRA, vapor-phase transport was assumed to occur for volatile organic COCs, while particulate transport was assumed to occur for inorganic COCs. Although many of the RAAs are paved, both vapor-phase and particulate transport of COCs were conservatively assumed to be viable transport mechanisms. Modeling of both vapor-phase and particulate transport was performed to estimate the environmental concentrations of COCs in ambient air at each RAA and at offsite receptor locations.

Based on the fate and transport modeling and onsite RME concentrations in soil, exposure dose estimations were then made for each RAA for both the baseline scenario and the construction scenario for soil ingestion, dermal absorption, inhalation of vapors, and inhalation of airborne dusts for each scenario.

18.1.1.3 Toxicity Assessment

A toxicity assessment was performed to identify and summarize the toxicological properties of the potential chemicals of concern selected for the HRA. In addition, toxicity values were obtained for use in conjunction with the results of the exposure assessment in order to quantitatively and qualitatively assess the potential for adverse effects to occur to receptors associated with the site.

Two types of adverse effects, carcinogenic and noncarcinogenic, are generally taken into consideration to assess potential impacts to human health. Quantitative toxicological assessments for many chemicals, including both noncarcinogenic and carcinogenic responses, can be found in the Integrated Risk Information System (IRIS) database and in the Health Effects Assessment Summary Tables (HEAST) documents, produced by EPA (EPA, 1993a; EPA, 1993b).

Carcinogenic effects are characterized by the production of tumors resulting from cellular changes that lead to uncontrolled cellular proliferation. The EPA currently assumes that there is not a threshold effect for substances which cause cancer, and that there is a linear relationship between the exposure concentration and the probability that cancer will be produced due to exposure. Therefore, carcinogenic risk is defined as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen.

Dermal slope factors (SFs), which are used to assess dermal exposures to potential carcinogens, are usually not available directly from the EPA; therefore, when possible, dermal SFs have been derived for the purposes of this risk assessment. A dermal SF can be derived by dividing available oral slope factors by absorption factors derived from literature searches to obtain an estimated absorbed slope factor. From this estimated absorbed dermal slope factor, the carcinogenic risk from dermal exposure may be calculated.

Noncarcinogenic effects cover a wide range of toxicological responses ranging from effects on specific organs (e.g. the liver), to systemic effects (e.g. the central nervous system) to effects on reproduction and offspring (e.g., teratogenicity and mutagenicity). Based on scientific understanding of homeostatic and adaptive mechanisms, systemic or noncarcinogenic toxicity is assumed to have an identifiable threshold for both the individual and the population, which means that the organisms or receptors can tolerate a range of exposures without adverse effects. The benchmark value of this threshold is the reference dose or RfD, expressed in milligrams of chemical per kilogram of body weight of individual per day (mg/kg-day) (EPA, 1993b).

For the purposes of risk assessment, noncarcinogenic effects are assessed using chronic reference doses (RfDs) in milligram-chemical per kilogram-body weight of individual per day (mg/kg-day). A chronic RfD is an estimate (with uncertainty spanning as high as an order of magnitude) of a human daily intake that is likely to be without an appreciable risk of deleterious effects during a lifetime or a portion of a lifetime (greater than 7 years), including sensitive subpopulations (EPA, 1993a).

Usually, exposures that are less than the RfD (resulting in a hazard quotient or hazard index equal to or less than 1) are not likely to be associated with adverse health risks. As the frequency and level of exposures exceeding the RfD increases, the likelihood for adverse effects also increases. However, a clear distinction that could categorize all exposures below the RfD as "acceptable" (risk-free) and all exposures in excess of the RfD as "unacceptable" (causing adverse effects) cannot be made (EPA, 1993b).

RfDs are often available from the EPA for oral and inhalation routes of exposure. The appropriate type of RfD should be used to assess corresponding exposures. Often toxicity values for noncarcinogenic inhalation exposures are presented as reference concentrations, which are

levels of exposure (in mg/m^3) that are not expected to result in adverse effects. For the purposes of this risk assessment, reference concentrations (RfCs) identified for chemicals of concern have been converted into inhalation reference doses according to EPA guidance (EPA, 1989d).

Dermal exposures have been identified as potential routes of exposure for this study. In general, dermal RfDs are not available for risk assessment purposes, but they have been derived for some of the chemicals of concern in order to assess potential dermal exposures. The dermal RfDs have been derived by multiplying available oral RfDs by absorption factors identified in literature searches. The result is an assumed absorbed dose of contaminant, below which exposures are not expected to result in adverse effects, and above which potential hazards may exist.

18.1.1.4 Risk Characterization

The exposure dose estimations were compared with toxicity values for carcinogenic and noncarcinogenic effects to arrive at a risk characterization for each RAA. Because the development of carcinogenic and noncarcinogenic effects are assumed to be caused by different mechanisms of action, different methodologies are used to quantitate these effects.

The carcinogenic effects were determined by calculating the excess cancer risk for the SWMUs. Excess cancer risk refers to the incremental cancer risk above the normal background cancer risk that arises due to onsite COCs. The acceptable excess cancer risk range for regulatory purposes ranges between 10^{-4} and 10^{-6} (EPA, 1990a; EPA, 1991c). Depending on the nature and type of regulatory program under which work is being conducted, and on site-specific exposures and conditions, cleanup goals and/or treatment standards will be set towards one end or the other of the range. Risk management decisions made under RCRA programs generally are concerned with risk in the 10^{-4} range.

To assess the potential adverse noncarcinogenic effects resulting from exposure to COCs, the pathway-specific dose is compared with the appropriate reference dose, or "safe dose," to arrive at a ratio called the hazard index. Usually, if the hazard index is greater than one, meaning the exposure level exceeds the threshold reference dose, a potential for adverse noncarcinogenic health effects may exist. If the hazard index is equal to or less than one, exposures to the COCs are not expected to result in a systemic toxic response. As the frequency of exposures exceeding the reference dose increases and the size of the excess increases, the probability for adverse effects also increases. For regulatory purposes, a hazard index of one or less is considered to be an acceptable noncarcinogenic risk level (EPA, 1989a, 1990a, 1991c). If the pathway-specific or total exposure hazard index is greater than one, segregation of the hazard index, based on the type of effects or mechanisms, may have to be considered (EPA, 1989d).

For effects from lead exposure, the EPA has set 10 ug-lead/dl-blood as the target blood lead concentration using the Uptake/Biokinetic (UBK) Model. This model is used to calculate potential blood lead levels for children at residences who are subject to chronic exposure to lead. The UBK Model is not appropriate, however, to be used for short-term scenarios such as the construction scenario. Therefore, the short-term exposure of adult receptors to airborne particulates containing lead was compared to the Occupational Safety and health Administration

(OSHA) permissible exposure level (PEL) for lead of 5.0×10^{-2} milligrams per cubic meter (mg/m^3).

18.1.2 Summary of Results for Risk Assessment Area #1

RAA #1 is comprised of SWMUs #1, 3, 5, 7, 8, 9, 11, 16, 32A, 33B, 38, and 39. The COCs identified for this RAA are the following: toluene, xylenes, 1,1,1-trichloroethane (TCA), acetone, methylene chloride, tetrachloroethene, arsenic, barium, chromium, lead, nickel, and silver.

It was assumed that the current and future land use of this RAA is industrial. Two exposure scenarios and the associated potential receptors were identified; that of a baseline scenario, with the onsite worker, offsite residential, and offsite sensitive receptors, and a construction scenario, with the onsite construction worker, onsite general-duty worker, offsite residential, and offsite sensitive receptors. Air transport was determined to be the only complete transport pathway.

Exposure dose estimations were made for both the baseline scenario and associated receptors and the construction scenario and associated receptors, for soil ingestion, dermal absorption, and inhalation of vapors and airborne dusts. The toxicity of each of the identified COCs was assessed, and slope factors were derived for carcinogenic risks and reference doses were derived for noncarcinogenic risks.

The carcinogenic COCs identified for this RAA were methylene chloride, tetrachloroethene, arsenic, chromium, and nickel. A summary of the cancer risks for each of the receptors under the baseline and construction scenarios are presented below.

RAA #1 Cancer Risk from all Pathways for Baseline Scenario

Risk Assessment Area	Onsite Worker	Offsite Residential Worker	Offsite Sensitive Receptor
RAA #1	4×10^{-5}	1×10^{-6}	2×10^{-6}

RAA #1 Cancer Risk from all Pathways for Construction Scenario

Risk Assessment Area	Onsite Construction Worker	Onsite General-Duty Worker	Offsite Residential Receptor	Offsite Sensitive Receptor
RAA #1	1×10^{-7}	6×10^{-8}	1×10^{-9}	6×10^{-9}

The carcinogenic risk for each of the receptors evaluated under the baseline and construction scenarios were within the EPA's target risk range of 10^{-4} to 10^{-6}. Onsite workers under the

baseline scenario have the greatest estimated cancer risk among the receptors, at 4×10^{-5}. The greatest contribution to the cancer risk for onsite workers is derived from chromium exposure through the inhalation pathway (3×10^{-5}), followed by the dust inhalation (5×10^{-6}), soil ingestion (1×10^{-6}), and dermal absorption of arsenic (1×10^{-6}). The toxicity values for chromium assumed that the COC was present in its hexavalent (VI) form. However, if the chromium were present in its trivalent (III) form, the carcinogenic risk would not be quantifiable due to the lack of toxicity data for trivalent chromium.

Noncancer hazard indices were calculated for each of the COCs identified: toluene, xylenes, TCA, acetone, methylene chloride, tetrachloroethene, arsenic, barium, chromium, nickel, and silver. A summary of the hazard indices for each of the receptors are presented below.

RAA #1 Noncancer Hazard Index from all Pathways for Baseline Scenario

Risk Assessment Area	Onsite Worker	Offsite Residential Worker	Offsite Sensitive Receptor
RAA #1	6.1×10^{-1}	2.6×10^{-2}	9.5×10^{-2}

RAA #1 Noncancer Hazard Index from all Pathways for Construction Scenarios

Risk Assessment Area	Onsite Construction Worker	Onsite General-Duty Worker	Offsite Residential Receptor	Offsite Sensitive Receptor
RAA #1	4×10^{-2}	2.9×10^{-2}	4.9×10^{-4}	2.3×10^{-3}

The hazard index for each of the receptors under the baseline and construction scenarios evaluated did not exceed EPA's "level of concern" of unity (1.0) for noncarcinogenic effects.

The UBK Model was used to calculate potential blood lead levels for children at residences who are subject to chronic exposure to lead for the baseline scenario. Based on the site-specific conditions of RAA #1 baseline scenario, zero percent of the child receptors chronically exposed to these conditions would have blood lead concentrations above the concentration of concern of 10 μg/dl. Under the construction scenario, onsite and offsite airborne lead concentrations arising from the site-specific conditions at RAA #1 are at least two orders of magnitude below the OSHA PEL.

18.1.3 Summary of Results for Risk Assessment Area #2

RAA #2 is comprised of SWMU #48A and B. The COCs identified for this RAA are the following: toluene, ethylbenzene, xylenes, acetone, methylene chloride, barium, nickel, and vanadium.

It was assumed that the current and future land use of this RAA is industrial. Two exposure scenarios and the associated potential receptors were identified; that of a baseline scenario, with the onsite worker, offsite residential, and offsite sensitive receptors, and a construction scenario, with the onsite construction worker, onsite general-duty worker, offsite residential, and offsite sensitive receptors. Air transport was determined to be the only complete transport pathway.

Exposure dose estimations were made for both the baseline scenario and associated receptors and the construction scenario and associated receptors, for soil ingestion, dermal absorption, and inhalation of vapors and airborne dusts. The toxicity of each of the identified COCs was assessed, and slope factors were derived for carcinogenic risks and reference doses were derived for noncarcinogenic risks.

The carcinogenic COCs identified for this RAA were methylene chloride and nickel. The cancer risks for each of the receptors for the baseline and construction scenarios are presented below.

RAA #2 Cancer Risk from all Pathways for Baseline Scenario

Risk Assessment Area	Onsite Worker	Offsite Residential Worker	Offsite Sensitive Receptor
RAA #2	3×10^{-7}	2×10^{-11}	2×10^{-11}

RAA #2 Cancer Risk from all Pathways for Construction Scenario

Risk Assessment Area	Onsite Construction Worker	Onsite General-Duty Worker	Offsite Residential Receptor	Offsite Sensitive Receptor
RAA #2	7×10^{-8}	7×10^{-8}	2×10^{-11}	1×10^{-10}

The carcinogenic risk for each of the receptors evaluated were less than the EPA's target risk range of 10^{-4} to 10^{-6}.

Noncancer hazard indices were calculated for each of the COCs identified: toluene, ethylbenzene, xylenes, acetone, methylene chloride, barium, nickel, and vanadium. The hazard indices for each of the receptors for the baseline and construction scenarios are presented below.

RAA #2 Noncancer Hazard Index from all Pathways for Baseline Scenario

Risk Assessment Area	Onsite Worker	Offsite Residential Worker	Offsite Sensitive Receptor
RAA #2	9.4×10^{-2}	3.8×10^{-5}	1.8×10^{-4}

RAA #2 Noncancer Hazard Index from all Pathways for Construction Scenario

Risk Assessment Area	Onsite Construction Worker	Onsite General-Duty Worker	Offsite Residential Receptor	Offsite Sensitive Receptor
RAA #2	4×10^{0}	4×10^{0}	1.3×10^{-3}	5.9×10^{-3}

The hazard index for two of the receptors evaluated exceeded EPA's "level of concern" of unity (1.0) for noncarcinogenic effects. Specifically, onsite construction workers and general duty workers have an estimated hazard index of 4.0. The greatest contribution to the hazard index for these two receptors was derived from the dust inhalation of barium (4.0). Offsite resident receptors have a hazard index of 1.3×10^{-3}, while offsite sensitive receptors have a hazard index of 5.9×10^{-3}.

Exceeding an HI of unity simply means that the potential for adverse noncarcinogenic health effects may exist. It does not mean that such effects do exist. Also, hazard indices are not statistical probabilities, and the level of concern does not increase linearly as the RfD is approached or exceeded (see Section 19.5.2).

Since the total hazard index for onsite construction workers and general duty workers was greater than one, the results giving rise to the exceedance should be more closely examined, and the type of noncancer health effects and their mechanisms of action should be considered. In this case, exposure to barium through the inhalation pathway caused the HI of unity to be exceeded. Recall, as was discussed in Section 19.2.2, that the prevalence with which barium was identified as a COC suggested that the background concentration of barium used (Table 19-1) may not have been representative of the SWMUs investigated as part of this effort. Thus, the calculated hazard index could be due, either all or in part, to background barium concentrations. It was beyond the scope of this RFI to determine the background metal concentrations at the 15 SWMUs.

Also, it must be emphasized that it was assumed that no mitigation measures would be performed during construction to minimize exposure. Thus, no dust suppression measures were assumed to occur; such measures, if effectively instituted, would eliminate the exposure pathway for all receptors other than construction workers. Similarly, personal protective equipment (PPE) was not assumed to be used by the construction workers; use of PPE would reduce, if not

eliminate, their exposure. As a result, the cancer risks and noncancer hazard indices estimated represent the worst-case excess cancer risk and noncancer hazard expected to occur during a hypothetical construction scenario.

18.1.4 Summary of Results for Risk Assessment Area #3

RAA #3 is comprised of SWMU #83. The COCs identified for this RAA are the following: barium, beryllium, lead, manganese, nickel, silver,and zinc.

It was assumed that the current and future land use of this RAA is industrial. Two exposure scenarios and the associated potential receptors were identified; that of a baseline scenario, with the onsite worker, offsite residential, and offsite sensitive receptors, and a construction scenario, with the onsite construction worker, onsite general-duty worker, offsite residential, and offiste sensitive receptors. Air transport was determined to be the only complete transport pathway.

Exposure dose estimations were made for both the baseline scenario and associated receptors and the construction scenario and associated receptors, for soil ingestion, dermal absorption, and inhalation of vapors and airborne dusts. The toxicity of each of the identified COCs was assessed, and slope factors were derived for carcinogenic risks and reference doses were derived for noncarcinogenic risks.

The carcinogenic COCs identified for this RAA were beryllium and nickel. The cancer risks for each of the receptors for the baseline and construction scenarios are presented below.

RAA #3 Cancer Risk from all Pathways for Baseline Scenario

Risk Assessment Area	Onsite Worker	Offsite Residential Worker	Offsite Sensitive Receptor
RAA #3	9×10^{-7}	6×10^{-10}	9×10^{-1}

RAA #3 Cancer Risk from all Pathways for Construction Scenario

Risk Assessment Area	Onsite Construction Worker	Onsite General-Duty Worker	Offsite Residential Receptor	Offsite Sensitive Receptor
RAA #3	2×10^{-7}	2×10^{-7}	1×10^{-10}	4×10^{-10}

The carcinogenic risk for each of the receptors evaluated were less than the EPA's target risk range of 10^{-4} to 10^{-6}.

Noncancer hazard indices were calculated for each of the COCs identified: barium, beryllium, manganese, nickel, silver, and zinc. Noncancer hazard indices were calculated for each of the COCs identified: toluene, ethylbenzene, xylenes, acetone, methylene chloride, barium, nickel, and vanadium. The hazard indices for each of the receptors for the baseline and construction scenarios are presented below.

RAA #3 Noncancer Hazard Index from all Pathways for Baseline Scenario

Risk Assessment Area	Onsite Worker	Offsite Residential Worker	Offsite Sensitive Receptor
RAA #3	2.3×10^{-1}	1.3×10^{-4}	6.3×10^{-4}

RAA #3 Noncancer Hazard Index from all Pathways for Construction Scenario

Risk Assessment Area	Onsite Construction Worker	Onsite General-Duty Worker	Offsite Residential Receptor	Offsite Sensitive Receptor
RAA #3	5.8×10^{0}	5.8×10^{0}	2.7×10^{-3}	1.3×10^{-2}

The total hazard index for each of the receptors evaluated for the baseline scenario did not exceed EPA's "level of concern" of unity (1.0) for noncarcinogenic effects.

The hazard index for two of the receptors evaluated exceeded EPA's "level of concern" of unity (1.0) for noncarcinogenic effects. Specifically, onsite construction workers and general duty workers have an estimated hazard index of 5.8. The greatest contribution to the hazard index for both types of onsite workers is derived from barium (4.6) and manganese (1.2) exposure through the inhalation pathway. Offsite resident receptors have a hazard index of 2.7×10^{-3}, while offsite sensitive receptors have a hazard index of 1.3×10^{-2}.

Exceeding an HI of unity simply means that the potential for adverse noncarcinogenic health effects may exist. It does not mean that such effects do exist. Also, hazard indices are not statistical probabilities, and the level of concern does not increase linearly as the RfD is approached or exceeded.

Since the total hazard index for onsite construction workers and general duty workers was greater than one, the results giving rise to the exceedance should be more closely examined, and the type of noncancer health effects and their mechanisms of action should be considered. In this case, exposure to barium through the inhalation pathway caused the HI of unity to be exceeded. The prevalence with which barium was identified as a COC suggested that the background concentration of barium used may not have been representative of the SWMUs investigated as part of this effort. Thus, the calculated hazard index could be due, either all or

in part, to background barium concentrations. The HI contribution of manganese through the inhalation pathway just exceeds the HI of unity and also may be due, either all or in part, to background concentrations. It was beyond the scope of this RFI to determine the background metal concentrations at the 15 SWMUs.

Also, it must be emphasized that it was assumed that no mitigation measures would be performed during construction to minimize exposure. Thus, no dust suppression measures were assumed to occur; such measures, if effectively instituted, would eliminate the exposure pathway for all receptors other than construction workers. Similarly, personal protective equipment (PPE) was not assumed to be used by the construction workers; use of PPE would reduce, if not eliminate, their exposure. As a result, the cancer risks and noncancer hazard indices estimated represent the worst-case excess cancer risk and noncancer hazard expected to occur during a hypothetical construction scenario.

The UBK Model was used to calculate potential blood lead levels for children at residences who are subject to chronic exposure to lead for the baseline scenario. Based on the site-specific conditions of RAA #3 baseline scenario, zero percent of the child receptors chronically exposed to these conditions would have blood lead concentrations above the concentration of concern of 10 μg/dl. Under the construction scenario, onsite and offsite airborne lead concentrations arising from the site-specific conditions at RAA #3 are at least two orders of magnitude below the OSHA PEL.

18.1.5 Summary of Results for Risk Assessment Area #4

RAA #4 is comprised of SWMU #108. The only COC identified for this RAA is nickel.

It was assumed that the current and future land use of this RAA is industrial. Two exposure scenarios and the associated potential receptors were identified; that of a baseline scenario, with the onsite worker, offsite residential, and offsite sensitive receptors, and a construction scenario, with the onsite construction worker, onsite general-duty worker, offsite residential, and offsite sensitive receptors. Air transport was determined to be the only complete transport pathway.

Exposure dose estimations were made for both the baseline scenario and associated receptors and the construction scenario and associated receptors, for soil ingestion, dermal absorption, and inhalation of vapors and airborne dusts. The toxicity of each of the identified COCs was assessed, and slope factors were derived for carcinogenic risks and reference doses were derived for noncarcinogenic risks.

The only carcinogenic COC identified for this RAA was nickel. The cancer risk for each of the receptors for the baseline and construction scenarios are presented below.

RAA #4 Cancer Risk from all Pathways for Baseline Scenario

Risk Assessment Area	Onsite Worker	Offsite Residential Worker	Offsite Sensitive Receptor
RAA #4	2×10^{-7}	2×10^{-11}	2×10^{-11}

RAA #4 Cancer Risk from all Pathways for Construction Scenario

Risk Assessment Area	Onsite Construction Worker	Onsite General-Duty Worker	Offsite Residential Receptor	Offsite Sensitive Receptor
RAA #4	3×10^{-8}	3×10^{-8}	2×10^{-12}	1×10^{-11}

The carcinogenic risk for each of the receptors evaluated were less than the EPA's target risk range of 10^{-4} to 10^{-6}.

Noncancer hazard indices were calculated for nickel. The hazard indices for each of the receptors for the baseline and construction scenarios are presented below.

RAA #4 Noncancer Hazard Index from all Pathways for Baseline Scenario

Risk Assessment Area	Onsite Worker	Offsite Residential Worker	Offsite Sensitive Receptor
RAA #4	3.2×10^{-4}	2.6×10^{-8}	1.9×10^{-7}

RAA #4 Noncancer Hazard Index from all Pathways for Construction Scenario

Risk Assessment Area	Onsite Construction Worker	Onsite General-Duty Worker	Offsite Residential Receptor	Offsite Sensitive Receptor
RAA #4	2.3×10^{-4}	3.8×10^{-5}	4.1×10^{-10}	3.0×10^{-9}

The total hazard index for each of the receptors evaluated for the baseline and construction scenarios did not exceed EPA's "level of concern" of unity (1.0) for noncarcinogenic effects.

18.2 Ecological Risk Assessment

An ecological risk assessment (ERA) was conducted using the site investigation data obtained for 15 SWMUs at Cannon AFB. The objectives of the ERA were to evaluate the potential for adverse effects to the environment posed by contaminated soil to the environment. From the information gathered, a recommendation can be made for no further action or for further study.

The ERA was performed using the guidelines presented in the "Risk Assessment Guidance for Superfund: Volume II Environmental Evaluation Manual" (EPA, 1989d). Assumptions made throughout the ERA were generally conservative, and therefore tend to overestimate the actual risk. The complete description of the ERA conducted, including all assumptions made, calculations performed, and details of results, is presented in Section 20.0, contained in Volume 2 of this report. This section presents a summary of the general approach used and summaries of results.

The approach employed is similar to that used for the HRA. First, COCs were selected and exposure point concentrations for soils were derived based on criteria determined in the HRA (data evaluation). Next, potential ecological receptor(s) and pathway(s) of exposure were identified, and exposure concentrations for all complete pathway(s) were calculated (exposure assessment). A toxicity assessment based on the ecological receptor(s) was then conducted. Finally, a risk characterization was performed by comparing the results of the exposure assessment with the toxicity assessment.

The data evaluation for the ERA followed the same process as that for the HRA, summarized earlier in this chapter. In the exposure assessment, the type and magnitude of exposures to the environment from the identified COCs are identified, and where feasible, quantified. Because of the complexity of the ecological habitats and the scarcity of reliable toxicity and transport data, the exposure assessment for the ERA must necessarily limit the quantification of exposures to one or a few scenarios. In some cases, the data can only be analyzed qualitatively. The scenario(s) selected for quantification are those that are generally considered to be the most conservative, that is, the pathways and routes of exposure that are most likely to be followed, and the receptor(s) most sensitive or most likely to be impacted by contamination.

It is not feasible to evaluate, even qualitatively, the effects of contaminants on all of the species in an entire ecosystem. Instead, as is described in RAGS, Volume II (EPA, 1989d), ecologists will often use professional judgement to select an "indicator species" that is thought to be representative of the success of other species that could be impacted in a given habitat. The indicator species, also called the ecological receptor, is selected based on one or more of the following attributes: 1) the species' susceptibility to contaminants or other environmental changes; 2) the importance of the species to the entire habitat, e.g., whether the species occurs frequently in the area or is a central part of the food chain; 3) whether the species is likely to be exposed to the identified contaminants; and 4) the availability of toxicity data on the species.

Of the potential terrestrial receptors, the deer mouse was considered to be the most appropriate receptor for evaluating these SWMUs for several reasons. First, even if the SWMUs are uncovered in the future, all of the SWMUs, with the exception of SWMU 108, will nevertheless

be surrounded by buildings and industrial areas and will remain near the flight line. The habitat of the SWMUs would only be conducive to invertebrates, insects, small mammals such as the deer mouse, and possible raptors. Second, there is a large data base of toxicity studies on laboratory mice because of their widespread use for human health assessment. Comparing toxicity data for laboratory mice to wild deer mice has a lower uncertainty than comparing the same toxicity data to a less closely related species such as the plains pocket gopher, invertebrates, or insects. Third, although there will not likely be high raptor activity around the SWMUs due to their location, the deer mouse does serve as prey for raptors in the area.

For the ERA, the only complete pathway of exposure identified was onsite soil ingestion, therefore no fate and transport modeling was performed. Because of the lack of toxicity data for dermal and inhalation routes of exposure, direct ingestion of soil by the deer mouse is the main route of exposure considered in this ERA. Calculations were performed to estimate the daily ingestion dose of each COC by the deer mouse.

The toxicity values used to evaluate the potential for adverse effects to the deer mouse were based on laboratory studies of mice or rats orally exposed to the COCs. From these studies, No-Observed-Adverse-Effects-Levels (NOAELs) in mg-COC/kg-mouse weight were identified, representing levels of exposure above which there may be adverse effects to the indicator species. An uncertainty factor for extrapolation from laboratory mice and rat studies to wild deer mice of 10 was incorporated into the values used to assess potential hazards.

There were no available studies that calculated a NOAEL for barium or that have been able to demonstrate conclusive signs of barium toxicity. There were studies that detected no effects at various exposure levels. One of these values, 100 ppm in drinking water, divided by an uncertainty factor of 10, was used as a surrogate NOAEL. Although the NOAEL could in fact be much higher, the use of this value allows quantification of risk based on a known safe level of barium. No information regarding the potential effects of 1,1,1-trichloroethane on animals has been identified for this study, therefore no further quantitative evaluation of the ecological effects is possible for this COC.

There is no specified formal method for quantitatively characterizing the risk to the environment. The risk to the environment was therefore characterized by following a similar process for noncarcinogens as that outlined for the HRA described in RAGS, Volume I (EPA, 1989a). In the HRA, a Hazard Quotient (HQ) was determined for the noncarcinogenic risk for each COC from all of the complete pathways of exposure for that RAA (e.g., onsite inhalation, offsite inhalation, etc.). This HQ was determined by dividing the estimated pathway-specific daily intake of the COC by the reference dose for that COC.

The characterization of risk to the environment was conducted in an analogous fashion. An HQ was determined for the risk from each COC, for the RAA with the highest RME for that COC. For the ERA, there was only one complete pathway considered. The HQ was determined by dividing the estimated daily intake of the COC by the ecological receptor, by the selected toxicity value for the ecological receptor.

The HQ is used to assess the potential hazards posed to indicator species by comparing the daily dose values with the toxicity values. If the daily dose values are less than the toxicity values, meaning that the HQ is less than one, then it is expected that the deer mice will not suffer harmful effects. If the daily dose value exceeds the toxicity value, meaning that the HQ is more than one, then the potential exists that the deer mouse could be exposed to higher levels of the COC than it can tolerate without harmful effects. It is assumed that the risks for adverse effects posed to the deer mouse is indicative to the risks for adverse effects posed to the ecosystem at Cannon AFB in general.

The values for the HQ for each COC were calculated and are all below one. The HQ for each COC represents the highest possible HQ for that COC for any of the RAAs, since the calculations are based on the highest RME value at any of the RAAs.

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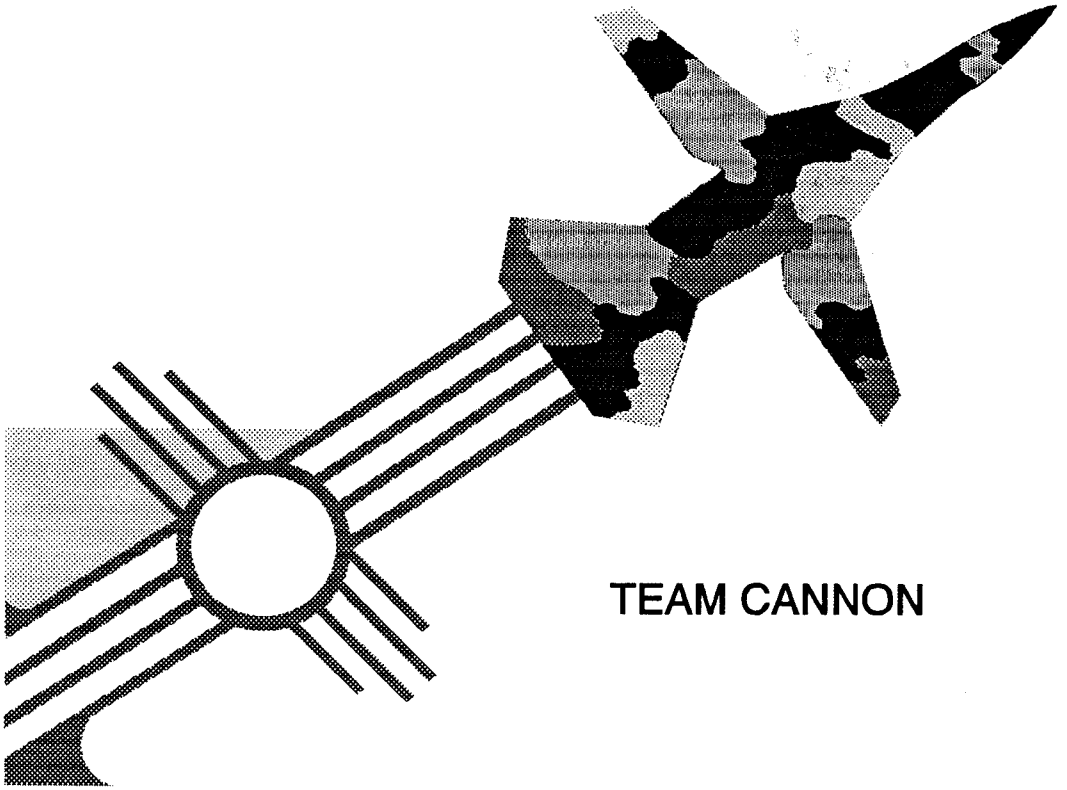
APP II
PHASE
SWMU: 1, 3, 5, 7, 8, 9, 11, 16, 32a, 33b
38, 39, 48a, 48b, 83, 108

27th FIGHTER WING



APPENDIX II
RCRA FACILITY INVESTIGATION

RFI REPORT
VOLUME 1

Project No. CZQZ 909012

CANNON AFB, NEW MEXICO

LRL sciences inc.

UNITED STATES ARMY
CORPS OF ENGINEERS
ALBUQUERQUE DISTRICT

OGDEN ENVIRONMENTAL AND ENERGY SERVICES

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ACRONYMS AND ABBREVIATIONS

AA	Atomic Absorption
AB	Analytical Batch
AFB	Air Force Base
BFB	Bromofluorobenzene - volatile instrument performance check compound.
CCB	Continuing Calibration Blank
CCV	Continuing Calibration Verification
CRDL	Contract Required Detection Limit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
COC	Contaminant of Concern
COE	U.S. Army Corps of Engineers
CRQL	Contract Required Quantitation Limit
CCV	Continuing Calibration Verification
CRA	AA Standard at the CRDL or IDL, whichever is greater.
CUZ	Compatible Use Zone
CVAA	Cold Vapor Atomic Absorption
%D	Percent Difference
DMP	Data Management Plan
EPA	U.S. Environmental Protection Agency
ER	Equipment Rinsate
ERA	Ecological risk Assessment
FB	Field Blank

ACRONYMS AND ABBREVIATIONS (Continued)

FSP	Field Sampling Plan
GC/EC	Gas Chromatography/Electron Capture Detector
GC/MS	Gas Chromatography/Mass Spectrometry
GFAA	Graphite Furnace Atomic Absorption
HRA	Health Risk Assessment
HSP	Health and Safety Plan
ICP	Inductively Coupled Plasma
ICS	Interference Check Sample
ICV	Initial Calibration Verification
IDL	Instrument Detection Limit
IS	Internal Standards - Compounds added to every VOA and BNA standard, blank, matrix spike duplicate, and sample extract at a known concentration, prior to instrumental analysis. Internal standards are used as the basis for quantitation of the target compounds.
LCS	Laboratory Control Sample
mg/kg	milligrams per killogram
MSA	Method of Standard Addition
MSL	Mean Sea Level
MS/MSD	Matrix Spike/Matrix Spike Duplicate
m/z	The ratio of mass (m) to charge (z) of ions measured by GC/MS.
OWS	Oil/Water Separator
PCB	Polychlorinated biphenyl (Arochlor is a trademark)
PE	Performance Evaluation
PID	Photoionization Detector

ACRONYMS AND ABBREVIATIONS (Continued)

PPE	Personal Protective Equipment
QA	Quality Assurance - Total program for assuring the reliability of data.
QAP	Quality Assurance Plan
QC	Quality Control - Routine application of procedures for controlling the monitoring process
%R	Percent Recovery
RAA	Risk Assessment Area
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RF	Response Factor
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
RPD	Relative Percent Difference (between matrix spike and matrix spike duplicate)
RRF	Relative Response Factor
$\overline{RRF}$	Average Relative Response Factor
RRT	Relative Retention Time (with retention to internal standard)
RSD	Relative Standard Deviation
RT	Retention Time
RW	Rinse Water
SDEV	Standard Deviation

ACRONYMS AND ABBREVIATIONS (Continued)

SDG	Sample Delivery Group - Defined by one of the following, whichever occurs first: • Case of field samples • Each 20 field samples within a case • Each 14-day calendar period during which field samples in a Case are received beginning with receipt of the first sample in the SDG. (For VOA contracts, the calendar period is 7-day.)
SMC	System Monitoring Compound - formerly surrogates for volatile analysis.
SMO	Sample Management Office
SOP	Standard Operating Procedure
SOW	Statement of Work
SV	Senivolatile analysis - Method based on analysis by GC/MS for BNA organic compounds.
SWDL	Southwest Division Laboratory
SWMU	Solid Waste Management Unit
TAC	Tactical Air Command
TCL	Target Compound List
TIC	Tentatively Identified Compound - A compound tentatively identified from search of the NIST mass spectral library that is not on the TCL.
TPH	Total Petroleum Hydrocarbons
TRPH	Total Recoverable Petroleum Hydrocarbons
μg/kg	micrograms per kilogram
VOA	Volatile Organic Analysis - Method based on the purge and trap technique for organic compound analysis.
VOC	Volatile Organic Compound
VTSR	Validated Time of Sample Receipt - Time of sample receipt at the laboratory as recorded on the shipper's delivery receipt and Sample Traffic Report.

DATA QUALIFIER DEFINITIONS

The following definitions provide brief explanations of the national qualifiers assigned to results in the date review process. If the Regions choose to use additional qualifiers, a complete explanation of the qualifiers should accompany the data review.

U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

J - The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

N - The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".

NJ - The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.

UJ - The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

R - The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

QUALIFICATION CODE REFERENCE TABLE

QUALIFIER	ORGANICS	INORGANICS
H	Holding times were exceeded.	Holding times were exceeded.
S	Surrogate recovery was outside QC limits.	The sequence or number of standards used for the calibration was incorrect.
C	Calibration %RSD or %D were noncompliant.	Correlation coefficient is <0.995.
R	Calibration RRF was <0.05.	%R for calibration is not within control limits.
B	Presumed contamination from preparation (method) blank.	Presumed contamination from preparation (method) or calibration blank.
L	Not applicable.	Laboratory Control Sample %R were not within control limits.
Q	MS/MSD recovery was poor or RPH high.	MS recovery was poor.
E	Not applicable.	Duplicates showed poor agreement.
I	Internal standard performance was unsatisfactory.	ICP ICS results were unsatisfactory.
A	Not applicable.	ICP Serial Dilution %D were not within control limits.
M	Tuning (BFB) was noncompliant.	Not applicable.
T	Presumed contamination from trip blank.	No applicable.
+	False positive - reported compound was not present.	Not applicable.
-	False negative - compound was present but not reported.	Not applicable.
F	Presumed contamination from FB or ER.	Presumed contamination from FB or ER.

QUALIFICATION CODE REFERENCE TABLE (Concluded)

QUALIFIER	ORGANICS	INORGANICS
$	Reported result or other information incorrect.	Reported result or other information was incorrect.
?	TIC identity or reported retention time has been changed.	No applicable.
D	The analysis with this flag should not be used because another more technically sound analysis is available.	The analysis with this flag should not be used because another more technically sound analysis is available.
P	Instrument performance for pesticides was poor.	Post Digestion Spike recovery was not within control limits.
*#	Unusual problems found with the data that have been described in Section 2, "Data Validation Findings." The number following the asterisk (*) will indicate the subsection where a description of the problem can be found.	Unusual problems found with the data that have been described in Section 2, "Data Validation Findings." The number following the asterisk (*) will indicate the subsection where a description of the problem can be found.

Definitions Of Acronyms Used

QC	Quality Control
%RSD	Percent Relative Standard Deviation
RRF	Relative Response Factor
%R	Percent Recovery
MS/MSD	Matrix Spike/Matrix Spike Duplicate
RPD	Relative Percent Difference
ICP ICS	Inductively Coupled Plasma Interference Check Sample
BFB	Bromofluorobenzine
FB	Field Blank
ER	Equipment Rinsate
TIC	Tentatively Identified Compound

EXECUTIVE SUMMARY

A Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) was conducted to evaluate the nature and extent of potential contamination from 15 solid waste management units (SWMUs) at Cannon Air Force Base, New Mexico. The following requirements taken from the RCRA Facility Investigation (RFI) Data Management Plan, Cannon AFB, New Mexico, June 1991, presents a description of the regulatory framework under which this project was conducted.

The Hazardous and Solid Waste Amendments (HSWA) to the RCRA were enacted into law on November 8, 1984. One of the major provisions (Section 3004(u)) of these amendments requires corrective action for releases of hazardous waste or constituents from solid waste management units (SWMUs) at hazardous waste treatment, storage, or disposal facilities. Under this provision, any facility applying for a RCRA hazardous waste management facility permit will be subject to a RCRA Facility Assessment (RFA). The RFA is conducted by the regulatory agency and is designed to identify SWMUs which are, or are suspected to be, the source of a release to the environment. If any such units are identified, the owner or operator of the facility will be directed to perform a RCRA Facility Investigation (RFI) to obtain information on the nature and extent of the release so that the need for interim corrective measures or a Corrective Measures Study can be determined. Information collected during the RFI can also be used by the owner or operator to aid in formulating and implementing appropriate corrective measures. Such corrective measures may range from stopping the release through the application of a source control technique to a full-scale cleanup of the affected area. In cases where releases are sufficiently characterized, the regulatory agency may require the owner or operator to collect specific information needed to implement corrective measures during the RFI.

The RFI Work Plan consists of six documents prepared concurrently:

- Data Collection Quality Assurance Plan
- Data Management Plan
- Health and Safety Plan
- Community Relations Plan
- Field Sampling Plan
- Project Management Plan

A Risk Assessment was also performed as part of this RFI project.

LRL Sciences, Inc. (LRL), was contracted by the U.S. Army Corps of Engineers (COE), Albuquerque District, to perform the RFI. The project was performed in accordance with the RCRA Facility Investigation Work Plan (1990) prepared by Lee Wan and Associates and the General Plans for Cannon AFB RFIs (1991) prepared by the Environment Management Branch, Civil Engineering Squadron, Cannon AFB, NM. The RCRA Facility Investigation Work Plan was approved by EPA (Davis, 1992). LRL supplements to the Work Plan included the Field Sampling Plan, the Safety and Health Plan, and the Quality Assurance Plan. These plans were approved by the COE and Cannon AFB. These supplemental plans were necessary to perform specific requirements and tasks in the COE Scope of Services.

The RFI field activities were conducted during April 1993. The field activities included auger drilling and sampling of surface and subsurface soils in the vicinity of each SWMU.

The following is a list of the SWMUs investigated during this RFI. The work was done under Air Force Project No. CZQZ 909012 and COE Contract No. DACA47-93-C-0009.

SWMU	Unit	Building
1	Oil/Water Separator	119
3	Oil/Water Separator	108 (old 125)
5	Oil/Water Separator	126 (old 121)
7	Oil/Water Separator	129
8	Oil/Water Separator	165
9	Aircraft Washrack Drain System	165
11	Oil/Water Separator	170
16	Oil/Water Separator	680
32A	Oil/Water Separator	186-1
33B	Oil/Water Separator	186-2
38	Oil/Water Separator	194
39	Oil/Water Separator	195
48A	Underground Waste Oil Tank (IRP Site)	
48B	Above Ground Overflow Capacity Tank (IRP Site)	
83	Sump (IRP Site)	
108	Explosive Ordnance Disposal Activities Area	

These SWMUs were identified during a RCRA Facility Assessment conducted by the U.S. EPA in 1987.

Environmental samples were analyzed by the primary and QC laboratory, NDRC Laboratories, Inc., located in Richardson, Texas, and the two QA laboratories Eureka Laboratories, located in Sacramento, California, and Aquatec Laboratories, located in Colchester, Vermont. These laboratories were under contract with the Army Corps of Engineers Southwest Division Laboratory, located in Dallas, Texas.

RCRA SW-846 protocol was followed for soil analysis. The analytical parameter list included:

- Target Compound List Volatile Organic Compounds (TCL VOC)
- BTEX (Benzene, Toluene, Ethyl Benzene, Xylene)
- Priority Metals (TCLP List and Nickel)
- Target Analyte List (TAL) Metals
- Total Recoverable Petroleum Hydrocarbons (TRPH)
- Cyanide
- Reactives
- Sulfides

Not all of the parameters listed above were analyzed at every SWMU.

Laboratory analytical data was validated by LRL Sciences, Inc., and Ogden Environmental according to the USEPA CLP National Functional Guidelines for data validation. Validated data was then used to present the nature and extent of potential contamination and to develop a risk assessment.

Following is a summary of the nature and extent of contamination for each SWMU.

SWMU No. 1 - Oil/Water Separator No. 119

Toluene and chromium were the only analytes detected (or detected above background) in the surface samples of all three boreholes. The highest concentration of toluene found in the surface was 36 μg/kg. The highest concentration of chromium detected at the surface was 34.6 mg/kg. Borehole 2 contained the most subsurface analytes including acetone at 24 μg/kg, mercury at 0.15 mg/kg, and nickel at 9.2 mg/kg. Borehole 3 contained only nickel in the subsurface at 9.6 mg/kg.

SWMU No. 3 - Oil/Water Separator No. 108

In borehole 1, both organics and metals were detected at the surface and at depth. Toluene and acetone were both detected at 8 μg/kg, which is below the contract required quantitation limit (CRQL). Chromium was detected at 17.8 mg/kg. The QA duplicate contained nickel at 10.3 mg/kg and mercury at 0.15 mg/kg. In boreholes 2 and 3, no organics were detected. Metals detected included nickel at 9.6 mg/kg, barium at 816 mg/kg, and chromium at 16.4 mg/kg.

SWMU No. 5 - Oil/Water Separator No. 121

No analytes were detected (or detected above background) in any of the surface samples for the three boreholes. Nickel was detected in all the boreholes at 2.5 feet with the highest concentration at 12.7 mg/kg. Boreholes 2 and 3 contained two or more of the following compounds at 10 feet: acetone (16 μg/kg), nickel (10.1 mg/kg), and barium (749 mg/kg) or mercury (0.2 mg/kg).

SWMU No. 7 - Oil/Water Separator No. 129

Chromium was the only metal detected at the surface of all three boreholes with the highest concentration of 38.7 mg/kg. Arsenic (31.8 mg/kg), toluene (20 μg/kg), and several other organic compounds detected below the CRQL were also found at the surface. At 5 feet, borehole 1 contained mercury (0.2 mg/kg), borehole 2 contained nickel at 98 mg/kg, and borehole 3 contained acetone at 24 μg/kg.

SWMU No. 8 - Oil/Water Separator No. 165

No analytes were detected (or detected above background) in the surface samples in any of the boreholes. All three boreholes contained subsurface metals including nickel (31.6 mg/kg), chromium (13.2 mg/kg), and barium (812 mg/kg). Only borehole 3 contained subsurface BTEX (xylenes at 2.4 μg/kg).

SWMU No. 9 - Aircraft Washrack Drain

Several organics and metals occur in one or more of the surface samples of all four boreholes. These include : acetone at 250 μg/kg, tetrachloroethane at 14 μg/kg, toluene and xylene below the CRQL of 58 mg/kg, chromium at 26.9 mg/kg, nickel at 10.5 mg/kg, and barium at 840 mg/kg. In the subsurface samples, barium was detected at 1380 mg/kg, chromium at 31.1 mg/kg and acetone at 16.0 μg/kg.

SWMU No. 11 - Oil/Water Separator No. 170

The only target analyte organics detected at the surface were methylene chloride, detected below the CRQL of 11 μg/kg, and toluene at 13 μg/kg. No metals were detected above background at the surface. Nickel occurred at 2.5 feet in all three boreholes with the highest concentration at 10.6 mg/kg. Mercury (0.26 mg/kg) and methylene chloride ($<$ CRQL of 10 μg/kg) occurred at 10 feet.

SWMU No. 16 - Oil/Water Separator No. 680

No organic compounds were detected in any of the boreholes. Nickel was detected at 5 feet in all three boreholes with the highest concentration at 9.6 mg/kg. Lead at 41.3 mg/kg and mercury at 0.24 mg/kg were detected in borehole 3 at the surface and at 2.5 feet, respectively.

SWMU No. 32A - Oil/Water Separator No. 186, #1-East

The only analyte detected at the surface was xylene at 34.0 μg/kg in borehole 2. Nickel (10.3 mg/kg) and mercury (0.27 mg/kg) were detected in the subsurface of borehole 1. Barium (1480 mg/kg) was detected at 10 feet in Borehole 3.

SWMU No. 33B

Acetone was detected in the surface sample of all three boreholes and at 10 feet in boreholes 1 and 3. The highest concentration detected was 15 μg/kg. Borehole 3 contained the most metals with chromium (41.3 mg/kg) and nickel (9.4 mg/kg) at the surface and arsenic (32.4 mg/kg) at 2.5 feet and barium (654 mg/kg) at 10 feet.

SWMU No. 38 - Oil/Water Separator No. 194

From the surface to 2.5 feet, several organic compounds were detected in one or more boreholes: acetone at 17.0 μg/kg, 1,1,1-trichloroethane (<CRQL of 10 μg/kg), and toluene (<CRQL or 10 μg/kg). Borehole 1 contained nickel (10.6 mg/kg) and chromium (13.9 mg/kg) at 2.5 feet. All three boreholes contained nickel (11.0 mg/kg) at 5 feet.

SWMU No. 39 - Oil/Water Separator No. 195

At the surface and at 5 feet, toluene was detected at 12.0 μg/kg and acetone was detected at 38.0 μg/kg. In boreholes 2 and 3, nickel (9.7 mg/kg) occurred at 2.5 feet. All three boreholes contained metals at 5 feet, including: nickel (11.8 mg/kg), lead (52.0 mg/kg), and chromium (14.9 mg/kg). Borehole 3 contained barium (2200 mg/kg) at 10 feet.

SWMU No. 48A and 48B - Above Ground and Underground Storage Tanks

At the surface, only borehole 5 contained target analyte organics including acetone (110 μg/kg), xylene (75 μg/kg), and methylene chloride (150 μg/kg). Subsurface organic detections included: methylene chloride at 37 μg/kg and acetone at 39 μg/kg. Metals detected in the surface and subsurface samples include: barium (1760 mg/kg), nickel (12.9 mg/kg), beryllium (0.77 mg/kg), cobalt (4.6 mg/kg), and vanadium (28.9 mg/kg) (see Table 14-6).

SWMU No. 83 - Sump

Volatile organic analysis occurred only at 5 feet. None were detected. TRPH was detected in all three boreholes with the highest concentrations at 2.5 feet (5000 mg/kg). Metals were detected above background at the surface and at depth (see Table 15-4). Metals include: silver (3.4 mg/kg), nickel (11.4 mg/kg), barium (2170 mg/kg), zinc (231 mg/kg), copper (18.0 mg/kg), beryllium (0.81 mg/kg), cobalt (5.0 mg/kg), manganese (271 mg/kg), mercury (0.15 mg/kg), lead (36.8 mg/kg), and chromium (13.2 mg/kg).

SWMU No. 108 - Explosive Ordnance Disposal Training Area

Nickel was detected in the surface samples of three out of five boreholes. The highest concentration detected was 11.4 mg/kg. No other priority metals were detected above background at this SWMU. Analysis for sulfide resulted in no detections.

Human Health Risk Assessment

A human health risk assessment (HRA) was performed using the site investigation data obtained for 15 SWMUs. The objectives of the HRA included assessing the carcinogenic risk and noncarcinogenic hazard posed by contaminated soil at the various SWMUs to potential human receptors. The information from the HRA can then be used to assist in determining if there should be further investigation, remedial action, or no further action for each of the SWMUs.

The HRA was conducted using the standard principles and approaches identified in "Risk Assessment Guidance for Superfund: Volume I: Human Health Evaluation Manual, Part A" (RAGS), (EPA 1989a). RAGS, which is the Superfund guidance document for human health risk assessment, was used instead of RFI guidance for human health risk assessment due to its more comprehensive nature. Assumptions made throughout this risk assessment were generally conservative, and therefore tend to overestimate the actual risk.

Based on the validated data, chemicals of concern (COCs) were identified for each SWMU, and the 15 SWMUs were grouped into four Risk Assessment Areas (RAAs) including the following: RAA #1 including SWMUs 1, 3, 5, 7, 8, 9, 11, 16, 32A, 33B, 38, and 39; RAA #2 including SWMU 48A and 48B; RAA #3 including SWMU 83; and RAA #4 including SWMU 108. An RAA is a group of SWMUs that are geographically close and have similar chemical release sources. Grouping the SWMUs into RAAs allows the identification of chemicals and pathways that result in significant contributions to risk and the assessment of whether potential human health impacts are related to a particular RAA or contamination source. A site-specific risk assessment was then performed for each of the four RAAs.

An HRA is based on an estimate of the reasonable maximum exposure (RME) expected to occur under current and future land use conditions. Although most of the SWMUs are currently covered by asphalt, it was conservatively assumed that the SWMUs are bare for the purposes of risk assessment. Current and future land uses were identified to be industrial/commercial use. The current and future scenarios under this land use include a baseline scenario and construction scenario. To quantify the risk with each scenario, exposure point concentrations for onsite soils for each COC were first calculated. Fate and transport modeling was then performed for the air pathway, the only transport mechanisms identified, for the baseline and construction scenario. Exposure dose estimations were then made for soil ingestion, dermal absorption, inhalation of vapors, and inhalation or airborne dusts from each scenario. These exposure dose estimations were compared with values from the toxicity assessment for carcinogenic and noncarcinogenic effects to arrive at a risk characterization for each RAA.

For noncarcinogenic effects, the EPA level of concern for hazard indexes is 1.0, that is, if the total exposure dose estimations for all COCs in an RAA is greater than the safe dose level determined by the toxicity assessment, then there could be the potential for adverse effects. In this case, the hazard quotients of the COCs for the RAA need to be further evaluated. If the hazard index is below 1.0, then it is expected that humans will not suffer harmful effects. The hazard indexes for all RAAs for the baseline scenario are all below 1.0. For the construction scenario, the hazard index for RAAs #1, #2, and #4 are below 1.0. The hazard index for the onsite construction worker and the onsite general duty worker under the construction scenario is 1.2 for RAA #3 (RAA #3 is comprised solely of SWMU #83). Because the total hazard index for this RAA under the construction scenario was above 1.0, an evaluation was made of each COC and whether the combination of the effects of the COCs is additive. The primary driver of risk for RAA #3 is manganese. It was determined that adverse effects from manganese do not interact additively with the other COCs, and thus the noncarcinogenic risks can be evaluated by individual COC. The hazard quotients for all of the COCs, including manganese, are below 1.0, thus indicating that there is not expected to be unacceptable noncarcinogenic risks.

For carcinogenic effects, the EPA's target risk range of acceptable levels of carcinogenic risk is 1×10^{-4} to 1×10^{-6}, that is, all estimates of carcinogenic risk below 1×10^{-4} are considered to be acceptable. For all RAAs under all scenarios, the carcinogenic risk is below 10^{-4}.

For effects from lead exposure, the EPA has set 10 μg-lead/dl-blood as the target blood lead concentration using the Biokinetic Model. For all RAAs under all scenarios, the estimated maximum blood lead concentration is below 10 μg-lead/dl-blood.

Based on the findings of the HRA, it was determined that the health effects to humans from the 15 SWMUs are not significant.

Ecological Risk Assessment

An ecological risk assessment (ERA) was conducted using the site investigation data obtained for 15 SWMUs at Cannon AFB. The objectives of the ERA were to evaluate the potential for adverse effects to the environment posed by contaminated soil to the environment. From the information gathered, a recommendation can be made for no further action or for futher study.

The ERA was performed using the guidelines presented in the "Risk Assessment Guidance for Superfund: Volume II: Environmental Evaluation Manual" (EPA, 1989b). Assumptions made throughout the ERA were generally conservative, and therefore tend to overestimate the actual risk. The approach employed was similar to that used for the HRA. The identified COCs and associated onsite soil exposures were obtained from the HRA. An ecological receptor, the deer mouse, was selected as being the most representative of exposures to all potential ecological receptors. For the ERA, the only complete pathway of exposure identified was onsite soil ingestion, therefore no fate and transport modeling was performed. Calculations were performed to estimate the daily ingestion dose of each COC by the deer mouse. These exposure dose estimations were compared with values considered to be safe as determined by the toxicity assessment for each of the identified COCs.

If the hazard quotient for a COC is greater than 1.0, that is, if the estimated exposure dose is greater than the identified safe level, then there could be the potential for adverse effects to the deer mouse, and by extension, to the ecosystem in general. If the hazard quotient is less than 1.0, then it is expected that the deer mouse and the ecosystem in general will not suffer harmful effects from the SWMUs. The hazard quotients for all COCs in all RAAs were below 1.0.

Based on the findings of the ERA, it was determined that adverse effects to the ecosystem from the 15 SWMUs are not significant.

1.0 INTRODUCTION

1.1 Purpose and Scope of Report

The purpose of this Resource Conservation and Recovery Act (RCRA) Facility Investigation Report is to present the results of the field activities and laboratory analyses conducted to characterize the nature and extent of contamination at 15 solid waste management units (SWMUs) at Cannon Air Force Base (AFB), New Mexico. The results of the field investigation and the laboratory analyses were used to develop a baseline risk assessment completed as part of the overall RFI of the 15 SWMUs. The LRL Sciences/Ogden Team (LRL) was contracted by the U.S. Army Corps of Engineers (USACE) Albuquerque Office to execute the RCRA Facility Investigation (RFI) presented in this report.

The RFI was performed to satisfy the requirements of the Cannon AFB RCRA permit. The RFI activities were conducted in accordance with the requirements of the RCRA Facility Investigation Work Plan (Volumes I and II) prepared and submitted to the Air Force by Lee Wan and Associates (1990) and RCRA Facility Investigation Plans prepared by the Environmental Management Branch, Civil Engineering Squadron, Cannon AFB, NM (1991). A specific Field Sampling Plan, Health and Safety Plan, and a Quality Control/Quality Assurance Project Plan were developed by the LRL Team for this RFI in accordance with the requirements and format of the above referenced documents.

1.2 Regulatory Framework

Cannon AFB is a permitted RCRA facility. The RCRA permit requires the facility to investigate both newly-identified SWMUs and those identified at the time of permit issuance (Cannon AFB RCRA Permit, EPA I.D. #NM7572124454, 1989). This RFI was conducted as part of the ongoing investigation of these SWMUs as required by the Cannon AFB RCRA permit.

1.2.1 IRP, RCRA, and the Use of Risk Assessment

The Installation Restoration Program (IRP) was developed in 1975 by the U.S. Army to evaluate waste disposal practices on DoD properties and to mitigate environmental hazards. The U.S. Air Force initiated the IRP at Cannon Air Force Base in 1983. Two of the SWMUs studied in this RCRA Facility Investigation are IRP sites (SWMUs 48A&B and 83). The 1986 Superfund Amendments and Reauthorization Act (SARA) Section 9620 stressed that the provisions of the National Contingency Plan (regulations for investigation and cleanup of superfund sites) apply to federal facilities in their implementation of the IRP. Under NCP and IRP, risk assessment is the primary mechanism for the determination of whether or not remedial action is necessary for a particular site. Therefore, a risk assessment, in compliance with IRP requirements, was performed for this investigation.

The Resource Conservation and Recovery Act (RCRA) was enacted in 1976 to regulate the generation, transportation, treatment, storage, and disposal of hazardous wastes. Subsequent amendments, called the Hazardous and Solid Waste Amendments (HWSA), enacted in 1984 require facilities (such as Cannon AFB) that seek a RCRA hazardous waste operating permit to

investigate and remediate the release of any hazardous wastes from active or inactive solid waste management units (SWMUs) under the corrective action program. Section 6961 of RCRA, as amended, applies RCRA to federal facilities as well as private facilities.

The EPA in the preamble to the proposed RCRA corrective action rules indicates that since the IRP and RCRA corrective action programs are individual environmental requirements, federal facilities must comply with the requirements of both programs (55 FR 30798, 30858).

Also in the preamble, EPA recognizes that at some facilities releases or suspected releases identified in a RCRA Facility Assessment may be non-existent or otherwise of such a nature that they do not pose a threat to human health or the environment. The Agency proposes providing a mechanism by which a permittee may request a permit modification to effectively terminate further requirements in these cases.

The agency further proposes that if the Regional Administrator, using all available information, determines that suspected releases do not pose a threat to human health or the environment that no further action may be appropriate even when there is a release above "action levels" (55 FR 30798, 30813). Therefore, the risk assessment provided with this RFI Report may be used by the Regional Administrator to determine if releases found at these SWMUs pose a threat to human health or the environment and what, if any, further action is appropriate.

1.3 Report Organization

The following sections, subsections, and appendices present the information obtained during the RFI of 15 SWMUs at Cannon AFB.

Section 1.0 presents the general description of the scope of work, regulatory framework, investigative objectives, methodology used for sample collection and analyses. A general description of the physical and historical setting of Cannon AFB is also included in this section.

Section 2.0 through 16.0 presents specific information for each SWMU under investigation. Included in each SWMU description is a short discussion of the setting, history of use, past investigations, land use, and demography. Information concerning the field investigation, physical characteristics, and the nature and extent of contamination is also presented.

1.4 Cannon Air Force Base Setting and Information

1.4.1 Facility Setting

Cannon Air Force Base (AFB) is sited in Curry County, New Mexico (Figure 1-1). The base occupies approximately 4,320 acres of land south of U.S. Highway 84/68, and approximately seven miles west of Clovis, New Mexico. Clovis is the county seat for Curry County. Portales is located approximately 12 miles south of the base. Clovis and Portales are the largest cities in proximity to Cannon AFB (Figure 1-1).

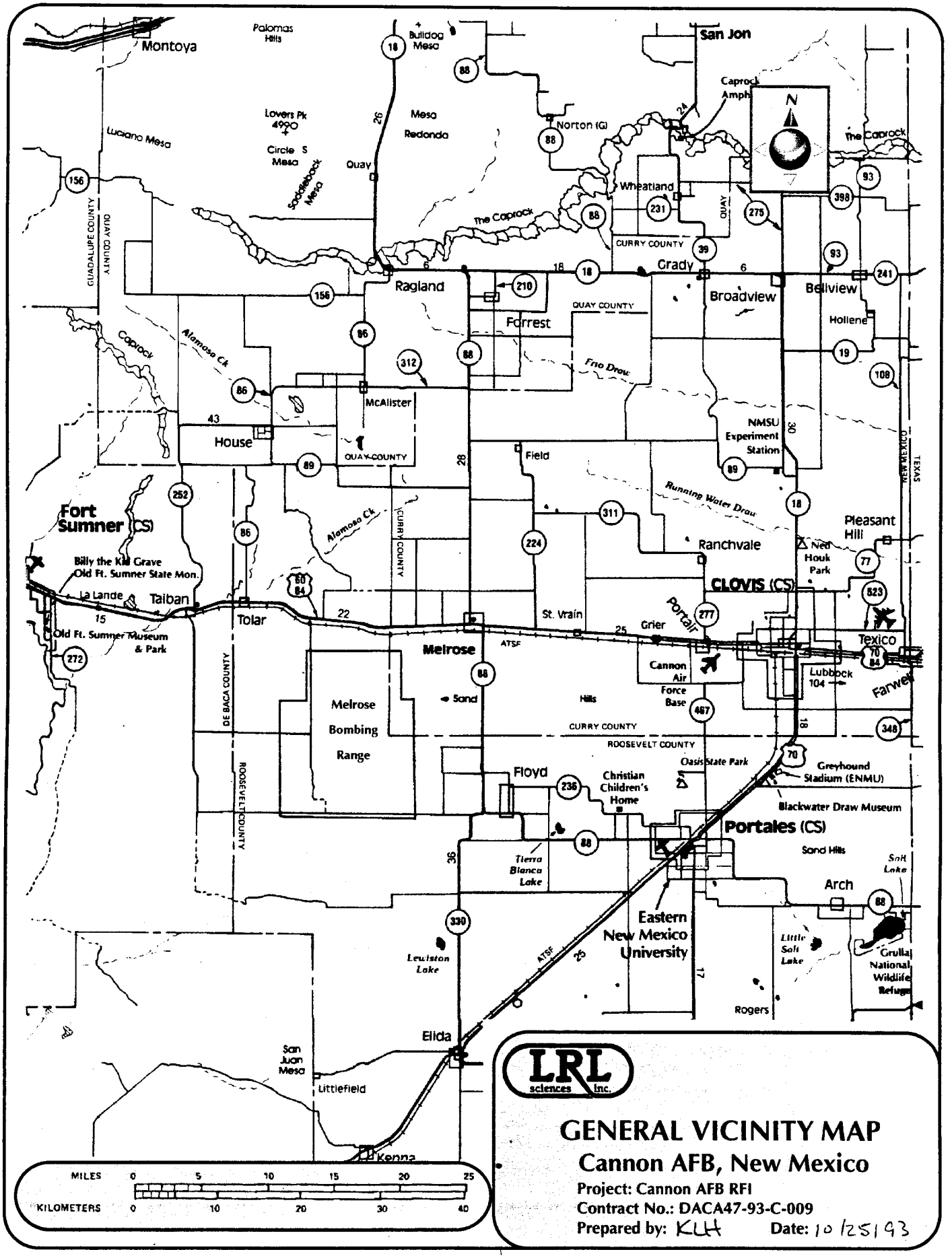

Montoya
Palomas Hills
Bulldog Mesa
San Jon
Caprock Amph
Lovers Pk 4990
Circle S Mesa
Mesa Redonda
Norton (G)
Luciano Mesa
Quay
Saddleback Mesa
The Caprock
Wheatland
GUADALUPE COUNTY
QUAY COUNTY
CURRY COUNTY
Grady
Ragland
Broadview
Bellview
Forrest
Hollene
Caprock
Alamosa Ck
Frio Draw
McAlister
House
NMSU Experiment Station
Field
Running Water Draw
Fort Sumner (CS)
Billy the Kid Grave
Old Ft. Sumner State Mon.
La Lande
Taiban
Tolar
Old Ft. Sumner Museum & Park
Ranchvale
Pleasant Hill
Ned Houk Park
CLOVIS (CS)
St. Vrain
Portales
Grier
Texico
Melrose
ATSF
Cannon Air Force Base
Lubbock 104
Farwell
Melrose Bombing Range
Sand Hills
DE BACA COUNTY
ROOSEVELT COUNTY
Oasis State Park
Greyhound Stadium (ENMU)
Floyd
Christian Children's Home
Blackwater Draw Museum
Portales (CS)
Sand Hills
Tierra Blanca Lake
Salt Lake
Arch
Eastern New Mexico University
Lewiston Lake
Little Salt Lake
Grulla National Wildlife Refuge
Rogers
Elida
San Juan Mesa
Littlefield
Kenna
MILES 0 5 10 15 20 25
KILOMETERS 0 10 20 30 40
LRL sciences Inc.
GENERAL VICINITY MAP
Cannon AFB, New Mexico
Project: Cannon AFB RFI
Contract No.: DACA47-93-C-009
Prepared by: KLH
Date: 10/25/93

Figure 1-1.

Air Force Base operations, maintenance, and support facilities are located along the northwest side of the airfield. Base housing is located northwest of the operations, maintenance, and support facilities (Figure 1-2). The wastewater lagoons, explosive ordnance disposal site, fire department and training area, munitions and petroleum storage areas are located to the south and east of the airfield.

1.4.2 Base History

Cannon AFB occupies a site that was originally designated as Portair Field. Portair Field was established in 1929 as an air terminal for passengers during the initial era of commercial transcontinental flights. The commercial airport was renamed in the 1930s as Clovis Municipal Airport. The first military use of the airfield occurred in 1942 when the Army obtained the base for training bomber squadrons. The Clovis Municipal Airport became known as Clovis Army Air Base at that time. The military base was renamed Clovis Army Air Field in 1945. The Army deactivated the base in 1947. The base was assigned to the Tactical Air Command (TAC) and formally reactivated as Clovis Air Force Base in 1951. Pilots and support personnel trained on a variety of Air Force fighters and fighter-bombers. The base became a major training ground for F-86 Sabre pilots. It was renamed Cannon Air Force Base in honor of General John K. Cannon, a former Commander of TAC, in 1957. At this time, the F-100 Super Sabre became the principal aircraft on the base. The Super Sabre was replaced by the F-111 in 1969. The F-111s of the 27th FW have remained the principal aircraft at Cannon AFB since their assignment. Cannon AFB was reassigned to the Air Combat Command (ACC) on June 1, 1992.

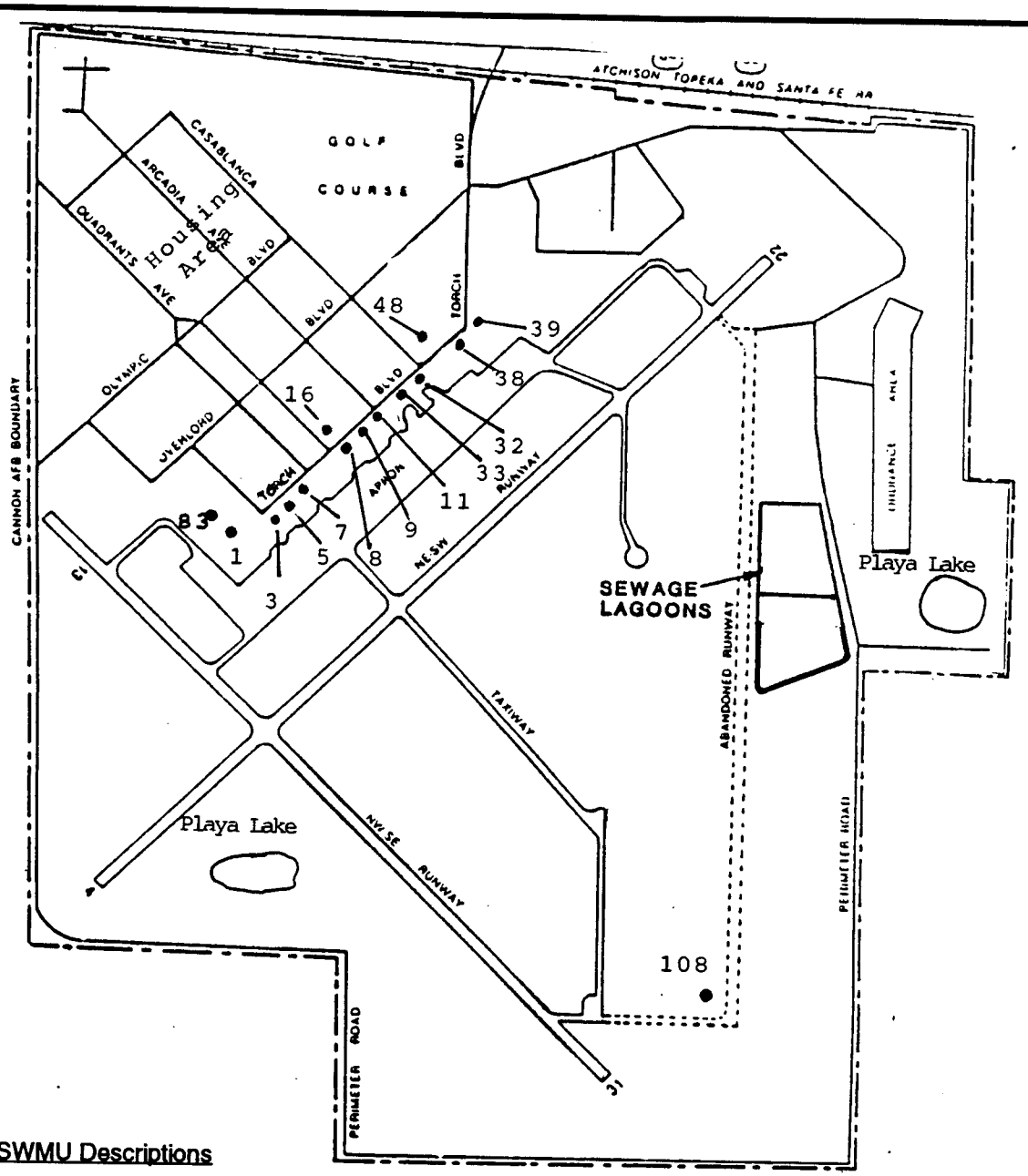
1.4.3 Natural Environment of Facility and Adjacent Areas

1.4.3.1 Physiography

Cannon AFB occupies an area of the Southern High Plains Physiographic Province known as the Llano Estacado. Elevations of the Llano Estacado Subprovince of the Southern High Plains range from 4,200 feet to 4,400 feet above mean sea level (MSL) in the vicinity of Cannon AFB. The topography of the Llano Estacado is very flat with a general slope to the east/southeast. Blowouts (broad shallow wind eroded depressions), broad valleys, and stabilized sand dunes characterize the area.

Blowouts occupy small to very large areas, and may collect surface runoff. Larger blowouts that occur at a site with a relatively large drainage area form "playas." Playas are ephemeral lakes that do not have external drainage. The water collected in a playa is lost by evaporation and infiltration to the soil. Playa lakes usually contain water for short periods, such as days or weeks.

Streams or broad valleys do not occur on or near the base. The nearest drainages of this type are the second order streams, called Running Water Draw and Frio Draw. Both streams are ephemeral with poorly developed drainage patterns. These streams drain in a southeast direction conforming to the general drainage pattern of the area.



SWMU Descriptions

1. Oil/Water Separator - bldg. 119
3. Oil/Water Separator - bldg. 108
5. Oil/Water Separator - bldg. 121
7. Oil/Water Separator - bldg. 129
8. Oil/Water Separator - bldg. 165
9. Aircraft Washrack Drain System - bldg. 165
11. Oil/Water Separator - bldg. 170
16. Oil/Water Separator - bldg. 680
32. Oil/Water Separator - bldg. 186-1
33. Oil/Water Separator - bldg. 186-2
38. Oil/Water Separator - bldg. 194
39. Oil/Water Separator - bldg. 195
48. A-Underground Waste Oil Tank
    B - Above ground overflow Capacity Tank
83. Sump
108. Explosive Ordinance Disposal Activities Area

N

LRL Sciences, Inc.

SWMU LOCATION MAP

CANNON AFB, NEW MEXICO

Project: Cannon AFB RFI	
Contract No: DACA47-93-C-009	
Prepared by: RLH	Date: 11-5-93

Figure 1-2.

1.4.3.2 Climatology

Cannon AFB is located in a climatological region classified as semiarid (Figure 1-3). The average annual temperature is 57.4°F with a monthly average for January of 37°F and for July of 77.5°F (SPS, 1993). The annual average precipitation is 16.48 inches with 11.1 inches of snow in the winter months (SPS, 1993a). Winds are primarily from the west. The average wind speed is 8 mph with gusts up to 73 mph (Table 1-1).

The air mass undergoes vertical mixing between 400 meters and 4,000 meters. The mixing occurs in response to temperature changes in the lower (near ground) portion of the air mass. The depth of mixing is less, in relative terms, during the winter and mornings than during summer and afternoons.

The strong winds of spring, with gusts over 40 mph, mix the air of the lower atmosphere. These gusty spring winds blowing across land with large and small areas of naturally exposed soil create frequent and sometimes severe dust storms in the area. The eastern New Mexico southern plains is part of an area recognized as having the most frequent and highest levels of windblown dust in the United States.

1.4.3.3 Soils

The distribution of soils in the vicinity of Cannon AFB are presently classified as SM (silty sand or silty gravelly sand) to SC (clayey sand or clayey gravelly sand) under the Unified Classification Systems of the USDA-Soil Conservation Service. The following descriptions are based on the draft "Soil Survey, Curry County, New Mexico" (USDA, 1993) and could be subject to minor changes. Figure 1-4 illustrates the various soil types mapped at Cannon AFB. A brief description of soil characteristics are included in the following paragraphs.

The most extensive soil association in Curry County, including Cannon AFB, are the Amarillo soils. The Amarillo series is characterized by three soil types: the Amarillo loam, Amarillo fine sandy loam, and Amarillo loamy fine sand. The Amarillo soils are formed by processes such as stream activity and constant reworking by wind, and generally consist of a loamy sand overlying a hard calcareous caliche layer. All of the Amarillo soils generally have well developed profiles.

The most predominate of these soil types is the Amarillo fine sandy loam, having an 0-2 percent slope phase (map symbol Ab). This soil consists of a thin sandy A horizon, well defined clayey B_{1-3} horizons, with a calcic B_3 horizon at depths below 40 inches. The calcic B_3 horizon lies on a calcic C horizon or on caliche. The color of the surface is brown (7.5YR 5/5, dry) and subsurface soils are reddish-brown (5YR 4/4, dry) to yellow-red (15YR 5/6,dry). The calcic C horizon underlying the Amarillo fine sandy loam is white in color. It occurs on relatively flat surfaces with slope phases of less than 2 percent. The Amarillo fine sandy loam, having an 2-5 percent slope phase (map symbol Ac), can also be found on Cannon AFB and is generally associated with playas. The Amarillo loamy fine sand, having an 0-2 percent slope phase (map symbol Ag), occurs along the southeast quadrant of the base. Amarillo soils typically have moderate hydraulic conductivity rates and range from 1×10^{-3} to 4×10^{-4} cm/sec (CH_2M Hill, 1983).

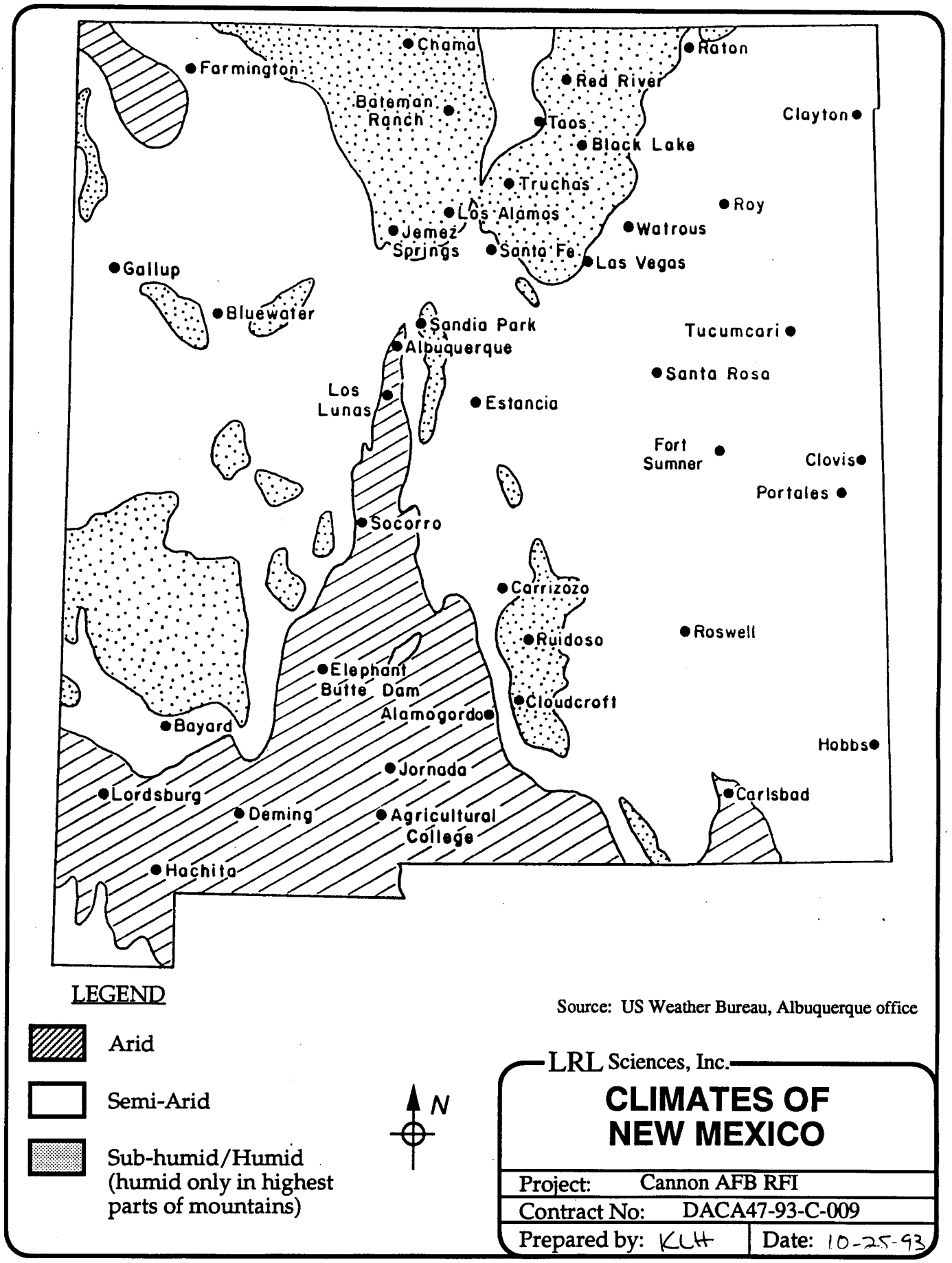
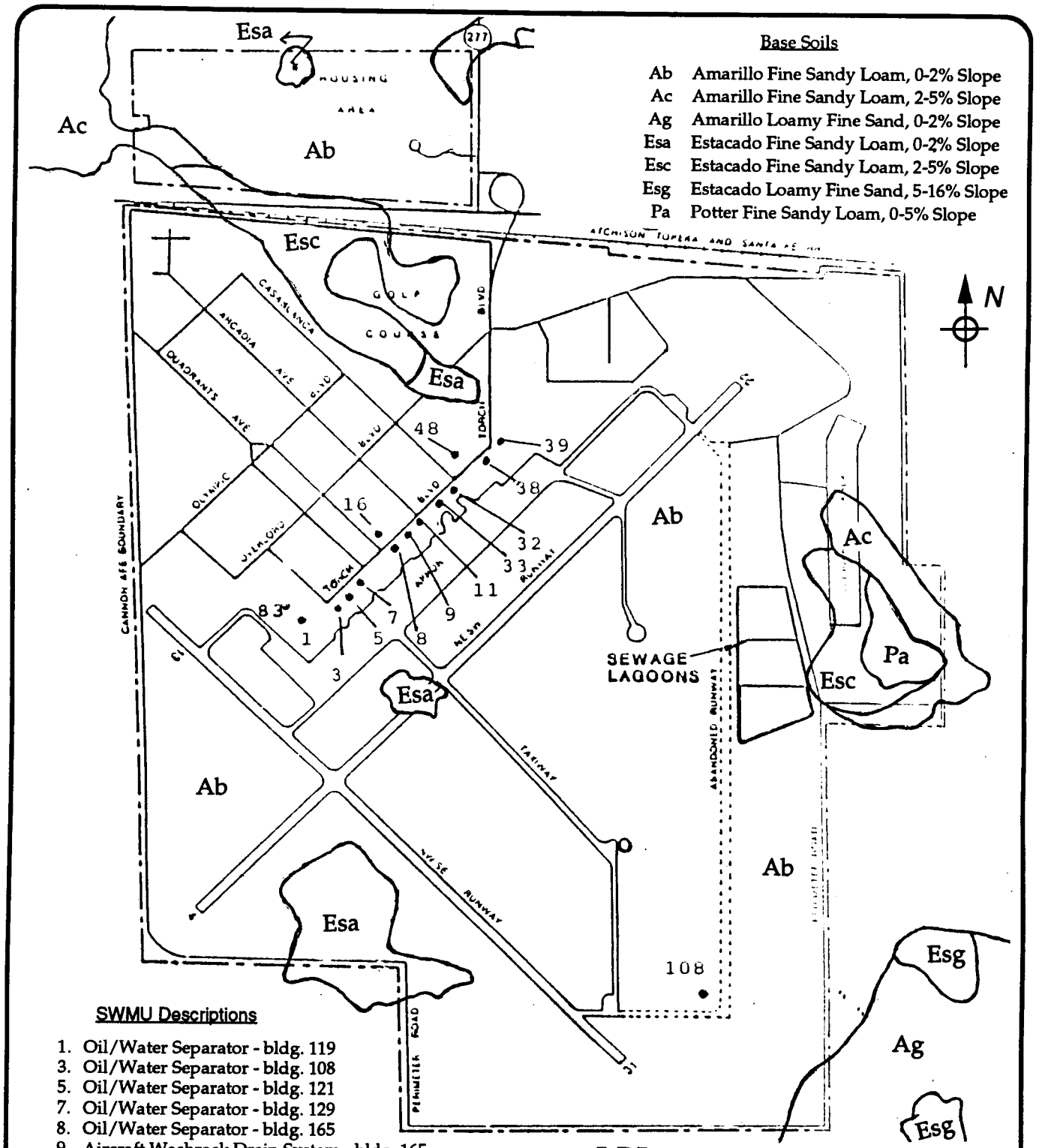

Chama
Raton
Farmington
Red River
Bateman Ranch
Taos
Clayton
Black Lake
Truchas
Roy
Los Alamos
Jemez Springs
Watrous
Santa Fe
Las Vegas
Gallup
Bluewater
Sandia Park
Albuquerque
Tucumcari
Santa Rosa
Los Lunas
Estancia
Fort Sumner
Clovis
Portales
Socorro
Carrizozo
Ruidoso
Roswell
Elephant Butte Dam
Cloudcroft
Alamogordo
Bayard
Hobbs
Jornada
Lordsburg
Carlsbad
Deming
Agricultural College
Hachita
LEGEND
Arid
Semi-Arid
Sub-humid/Humid (humid only in highest parts of mountains)
N
Source: US Weather Bureau, Albuquerque office
LRL Sciences, Inc.
CLIMATES OF NEW MEXICO
Project: Cannon AFB RFI
Contract No: DACA47-93-C-009
Prepared by: KLH
Date: 10-25-93

Figure 1-3.

Table 1-1. Monthly and Annual Surface Winds for Cannon AFB, New Mexico

MONTH	PREVAILING DIRECTION[1]	MEAN SCALAR SPEED (Knots)	MAX GUST (Knots)
January	W	8	60
February	W	8	61
March	W	9	73
April	W	9	59
May	W	8	65
June	S	7	64
July	S	6	66
August	S	5	69
September	S	6	70
October	W	7	64
November	W	7	59
December	W	8	67
Annual	W	7	73[2]
Period (yrs)	10	10	10

Source: Final EIS for Realignment of Cannon AFB
[1] Direction from which wind blows the greatest percentage of the time.
[2] Maximum annual wind gusts for 10-year sampling period.



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16. Oil/Water Separator - bldg. 680
32. Oil/Water Separator - bldg. 186-1
33. Oil/Water Separator - bldg. 186-2
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39. Oil/Water Separator - bldg. 195
48. A-Underground Waste Oil Tank
    B - Above ground overflow Capacity Tank
83. Sump
108. Explosive Ordinance Disposal Activities Area

LRL Sciences, Inc.

SOILS DISTRIBUTION MAP

CANNON AFB, NEW MEXICO

Project:	Cannon AFB RFI
Contract No:	DACA47-93-C-009
Prepared by: KLH	Date: 11-5-93

Source: USDA-S.C.S., Soil Survey of Curry County NM, 1993

Figure 1-4.

Other less extensive soil associations occurring at Cannon AFB include the Estacado soils, (formerly the Clovis and Mansker soils, USDA, 1993 Draft), and the Potter soils. Both soil types occur primarily in the areas of playa lakes. The USDA Soil Conservation Service describes the soils as follows.

The Estacado soils are extensive throughout Curry County, but only occur in a few areas on and around Cannon AFB. The Estacado soil series is represented by three soil types: the Estacado fine sandy loam (0-2 percent slope phase), the Estacado fine sandy loam (2-5 percent slope phase), and the Estacado loamy fine sand (map symbols Esa, Esc, Esg). The series consists of very deep, well drained, nearly level to moderately steep soils of uplands. The soil is formed from loamy, calcareous alluvial, or eolian materials. The surface layer is brown clay loam about 16 inches thick. The subsoil is calcareous clay loam with prominent accumulations of calcium carbonate. It is reddish brown in the next 32 inches, and reddish yellow below 60 inches and extending to depths greater than 80 inches. Slopes range from 0 to 16 percent. The individual soil profiles are generally poorly developed.

Potter soils occur in one location at Cannon AFB, but in many areas in Curry County they have a close association with the Estacado soils. They seem to have been formed from weathered caliche and other wind blown materials. They contain large amounts of calcium carbonate material, are shallow in depth and overlie a hard consolidated caliche layer. Potter soils (map symbol Pa) range in color from grayish brown at the surface to pale brown in the subsurface.

1.4.3.4 Geology

Cannon AFB is situated in the Southern High Plains (Llano Estacado) section of the Great Plains of eastern New Mexico and western Texas. The stratigraphic units of concern consist of the Ogallala Formation of late Miocene to early Pliocene epoch, 24-2 million years ago, and the Dockum Group of the late Triassic period, 240-205 million years ago (Figure 1-5). The Ogallala Formation extends from eastern New Mexico to the Pecos Valley in Texas and northward to parts of Oklahoma, Kansas, Colorado, Nebraska, Wyoming, and South Dakota. The Ogallala Formation is the principle geologic unit in the High Plains aquifer and underlies the area currently under study. The contact between the Ogallala Formation and its underlying Triassic Formation is an unconformity. The surface of this unconformity is apparently undulating; therefore, the thickness of the Ogallala Formation can vary significantly over local and regional distances. Recently completed studies in the Cannon area conclude that a minimum depth to the High Plains aquifer is about 250 feet below land surface.

The depositional history of the Ogallala Formation for the Southern High Plains section is complex. It involves the influences of eolian, fluvial, sandy alluvial and minor lacustrine deposits. The Ogallala Formation in the vicinity of Cannon AFB is composed of deposits which are unconsolidated, as well as poorly sorted sand, silt, clay, and gravel. Many of these deposits exist as lenticular beds or lenses of material cemented with varying degrees of calcium carbonate and are resistant to weathering. Studies in the area of Cannon have concluded that no faults or other dynamic geologic activity exist.

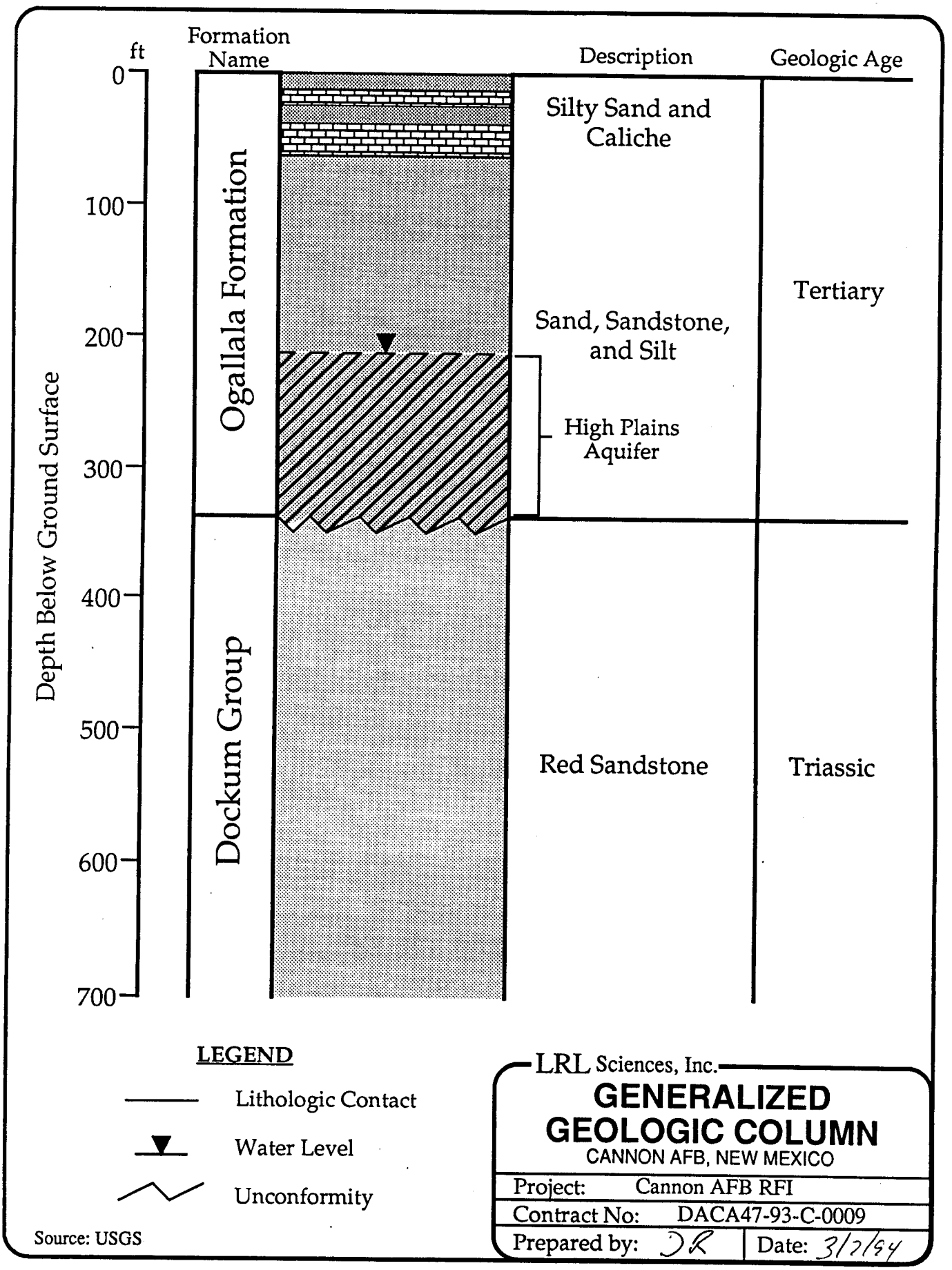

ft
Formation Name
Description
Geologic Age
0
100
200
300
400
500
600
700
Depth Below Ground Surface
Ogallala Formation
Dockum Group
Silty Sand and Caliche
Sand, Sandstone, and Silt
High Plains Aquifer
Red Sandstone
Tertiary
Triassic
LEGEND
Lithologic Contact
Water Level
Unconformity
Source: USGS
LRL Sciences, Inc.
GENERALIZED GEOLOGIC COLUMN
CANNON AFB, NEW MEXICO
Project: Cannon AFB RFI
Contract No: DACA47-93-C-0009
Prepared by: DR
Date: 3/2/94

Figure 1-5.

Caliche or calcium carbonate is another dominant characteristic in this area. It is hard, white to grey in color, and occurs in continuous or discontinuous layers throughout much of the uppermost part of the formation. Caliche layers in many instances consist of well developed accumulations of almost pure calcium carbonate material. The caliche material varies in thickness and depth over the areal extent of the base.

1.4.3.5 Hydrology

Cannon AFB lies over a small portion of the Ogallala Formation, which is the region's major water supply. The geographic extent of the Ogallala aquifer includes eastern New Mexico, western Texas, western Oklahoma, eastern Colorado, Nebraska, southwestern South Dakota and southeastern Wyoming, an area of 134,000 square miles (Gutentag et al., 1984). The aquifer is stratigraphically located above the Dockum group red beds. The aquifer is unconfined, with regional gradients of 10 to 15 ft/mile. Wells may yield up to 1600 gallons per minute (gpm) from the Ogallala sands and gravels (Woodward-Clyde, 1992). The overall water quality is good and is typically classified as "hard."

Ground water is the only water supply at Cannon AFB. Ground water is used for both irrigation and potable water. Water table elevation contours are shown in Figure 1-6 (Radian, 1986). The depth to the ground water table ranges from 300 feet in the northwest corner of the base to 260 feet in the southeast corner of the base (CH_2M Hill,1983). Saturated thickness varies from 93-143 feet. The local ground water gradient is southeast at 7 to 15 feet/mile (CH_2M Hill, 1983). The well production on Cannon AFB varies from 205 to 1150 gpm.

Hydraulic conductivity of the Ogallala Formation was estimated from aquifer pump tests. These test results showed a range of 2.0×10^{-3} to 2.0×10^{-2} cm/sec (Woodward-Clyde, 1992). Hydraulic conductivity values were also estimated from empirical relationship of hydraulic conductivity and specific yield for various grain sizes in well logs; values for the hydraulic conductivity showed a range of 3.9×10^{-3} cm/sec to 7.1×10^{-2} cm/sec with an average of 2.1×10^{-2} cm/sec. Values for the specific yield showed a range of 0.05 to 0.20 with an average of 0.15 (USGS, 1985).

Recharge to the Ogallala aquifer is mainly from infiltration of rain water on the high plains (14-16 in/yr rainfall). The recharge of the Ogallala aquifer varies by two orders of magnitude on the southern high plains, varying from 0.01 in /yr to 1.6 in/yr (Nativ and Riggio, 1990). The estimate of the 1.0 in/yr local recharge falls within this range (Woodward-Clyde, 1992). The recharge on Amarillo soils is 0.03 in/yr and 0.48 in/yr on playas (Stone, 1990). An additional recharge of an unknown amount is from irrigation return flow from areas where the water is continuously ponded.

Well pumping has greatly depleted the aquifer; water levels in wells at Cannon AFB have declined an average of 1.2 feet per year (USAF, 1990). Springs along the eroded margins of the Ogallala Formation are also discharge areas. These type of springs occur near Portales south of Cannon AFB.

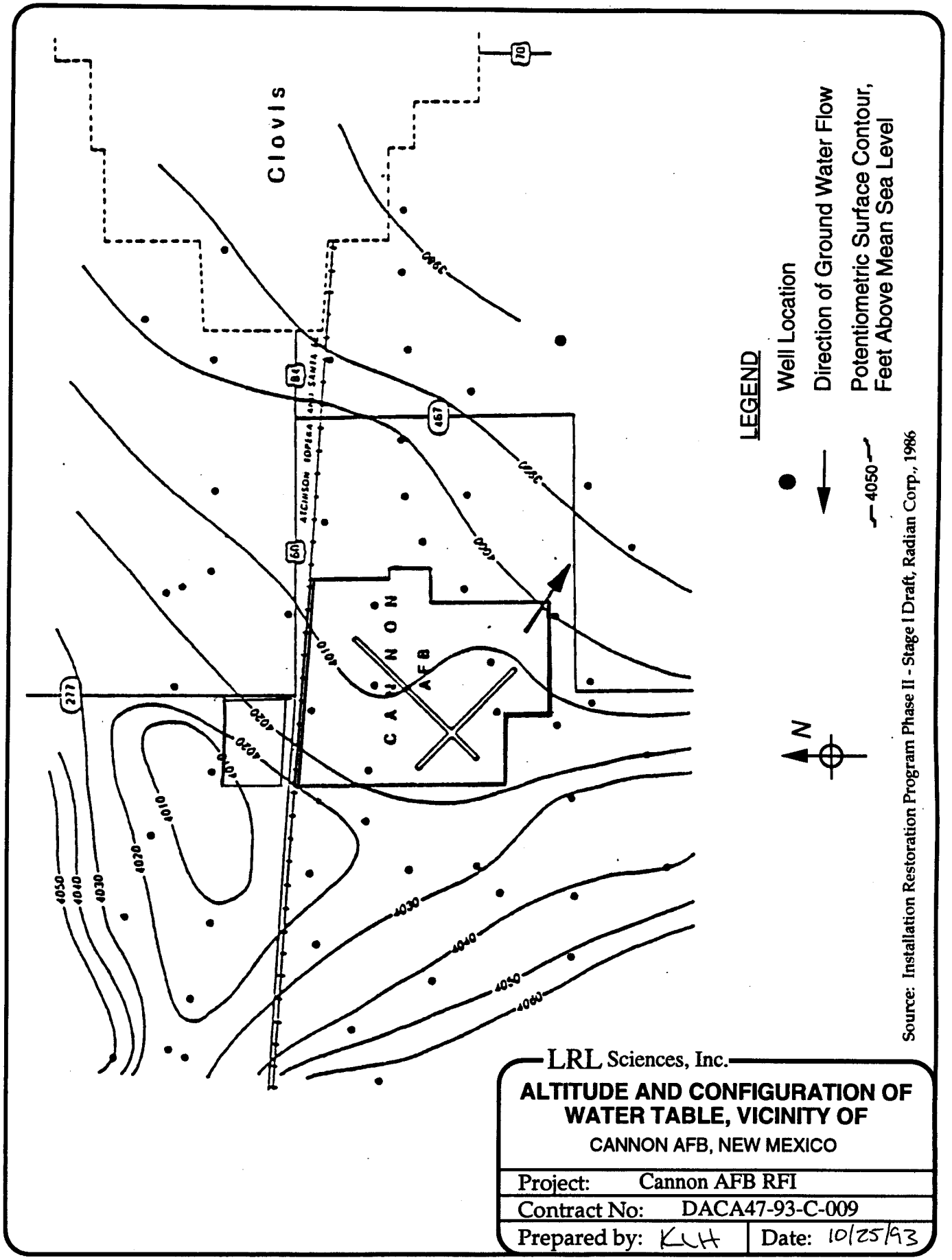

Clovis
CANNON AFB
ATCHISON TOPEKA AND SANTA FE
70
84
60
467
277
4050
4040
4030
4020
4010
4000
3980
LEGEND
Well Location
Direction of Ground Water Flow
Potentiometric Surface Contour, Feet Above Mean Sea Level
N
Source: Installation Restoration Program Phase II - Stage I Draft, Radian Corp., 1986
LRL Sciences, Inc.
ALTITUDE AND CONFIGURATION OF WATER TABLE, VICINITY OF
CANNON AFB, NEW MEXICO
Project: Cannon AFB RFI
Contract No: DACA47-93-C-009
Prepared by: KLH
Date: 10/25/93

Figure 1-6.

Potential for groundwater contamination is low because of low hydraulic conductivity units beneath the AFB. The hydraulic conductivity of the Amarillo soils, which range from 4×10^{-4} cm/sec to 1×10^{-3} cm/sec, is lower than the hydraulic conductivity range of the Ogallala aquifer (CH_2M Hill, 1983). The low recharge rate (USAF, 1990) and a relatively deep water table are also factors that indicate a low potential for groundwater contamination.

1.4.3.6 Land Use and Demography

Cannon AFB is located in Curry County, New Mexico. Clovis, the county seat, and Portales are the largest cities near the base. Clovis is approximately seven miles east of Cannon AFB and Portales lies approximately twelve miles to the south. Data presented in the Clovis-Curry County Chamber of Commerce (SPS, 1993a) Community Survey shows the population of Curry County as 42,207. The population of Clovis is 30,954 and the population of Portales is 11,000. The population of Cannon AFB is 4,653 (SPS, 1993a).

Major industries in Curry County include agriculture, retail trade, government, and services. Curry County consistently ranks second in New Mexico in agricultural production. A major share of the wheat, corn, peanuts, barley, cotton, milo, hay, and potatoes grown in New Mexico come from this county (SPS, 1993a). In addition to crop production, dairy farming, cattle ranching, and livestock feeding are important to the area's economy. The importance of agriculture in Curry County is apparent when one realizes that of the 897,000 acres within the county, over 837,000 of these acres are designated as farmland (USAF, 1990). The land surrounding Cannon AFB is irrigated farmland.

The Santa Fe Railroad and Cannon AFB also provide a significant economic boost to the county. Cannon AFB's related employment is approximately 6,000 individuals, which includes 5,098 military personnel and 900 civilians (USAF, 1993). The total of the base personnel makes Cannon AFB the largest employer in Curry County.

The type or amount of development on the lands surrounding Cannon is not controlled by land use or zoning restrictions at the present time. The Air Force has identified and designated Compatible Use Zones (CUZs) around Cannon AFB which provide land use recommendations for areas subject to noise and hazards associated with aircraft accidents. Commercial and residential land use that is incompatible with the Air Force CUZ designation has occurred to the northeast of the base because of the lack of zoning or land use controls.

Land use within the boundaries of Cannon AFB include base operation facilities (light industrial), businesses, offices, commissary, entertainment facilities (commercial), residential areas, water and sewage facilities (utilities), parks and playgrounds (recreational), and vacant land. There are 1,591 housing units on base with an additional 250 located off base. This housing consists of 830 on-base dormitory units for individual enlisted personnel, 1,011 on-base family units, and 250 off-base family units.

Educational facilities are available for Cannon AFB personnel and dependents through the Clovis Municipal School District, Portales Schools, other school systems in the local area, Eastern New Mexico University of Portales, and the Clovis Community College.

Portales is the home of Eastern New Mexico University, the third largest university in New Mexico. The enrollment is more than 3,800 students (SPS, 1993b). Clovis Community College offers a two-year community college program with an enrollment of more than 3,800 (SPS, 1993b).

Medical services for Cannon AFB personnel and their dependents are provided by the base hospital. Additional medical services are available locally at the Clovis High Plains Hospital, Roosevelt General Hospital in Portales, and the De Baca General Hospital in Fort Sumner.

1.4.3.7 Ecology

Cannon AFB is located on the Llano Estacado, a subprovince of the Southern High Plains Physiographic Province. Most of the High Plains is covered by a short-grass vegetation type. The short-grass vegetation type is dominated primarily by blue grama grass with galleta grass as a subdominant species. Areas with coarse soils or gravelly slopes also support sideoats grama, hairy grama, galleta grass, and little bluestem. Sand bluestem and sand dropseed are found growing on sandy soils. The heavier clay soil are occupied by big bluestem, buffalograss, and western wheatgrass. Meadows, valleys, and floodplains with alkali soil support alkali sacaton and desert saltgrass.

The short grass plains have numerous species of forbs and shrubs with few trees. The most common non-native forbs include kochia and russian thistle. Native species include asters, sunflowers, and cacti. Native shrubs found on the plains include soapweed yucca, four wing saltbush, winterfat, broom snakeweed, and mesquite. Trees are generally found growing in areas where water is more available. The trees growing on the plains include natives such as the plains cottonwood and introduced species such as russian olive and chinese elm.

The wildlife of the Llano Estacado consists of large and small mammals, waterfowl, shorebirds, raptor, and passerine birds. Reptiles and amphibians are also common in the area. The playa lakes are important to the area's wildlife because they provide drinking water, resting areas, and nesting sites with an increased food supply for migratory birds.

Table 1-2 presents a list of mammals that reside in the area of Cannon AFB.

Table 1-3 presents a listing of birds that occur in the Cannon AFB area.

Table 1-4 presents some of the common reptiles occurring in the vicinity of Cannon AFB.

Threatened and endangered species listed by the United States Fish and Wildlife Service (USFWS) are not known to exist on Cannon AFB. Threatened and endangered species listed by the USFWS for Curry and Roosevelt County in the vicinity of Cannon AFB are the Peregrine Falcon (Falco peregrinus) (USFWS, 1993), the Bald Eagle (Haliaectus leucocephalus), and the Black Footed Ferret (Mustela nigripes). Suitable nesting or roosting sites for the Bald Eagle and the Peregrine Falcon are not easily found on or adjacent to Cannon AFB. The Black-Footed Ferret has been reported in the past as occurring in Curry County. This ferret has not been identified in this area in recent history.

Table 1-2. Mammals in the Cannon AFB Area

GENUS-SPECIES	COMMON NAME
Antilocarpa americana	Pronghorn
Antrozous pallidus	Pallid Bat
Bassariscus astutus	Ringtail
Canis latrans	Coyote
Cynomys ludovicianus	Black-Tailed Prairie Dog
Dipodomys ordii	Ord's Kangaroo Rat
Dipodomys spectabilis	Banner-Tailed Kangaroo Rat
Erethizon dorsatum	Porcupine
Geomys bursarius	Plains Pocket Gopher
Lepus californicus	Black-Tailed Jack Rabbit
Mephitis mephitis	Striped Skunk
Mustela frenata	Long-Tailed Weasel
Neotoma micropus	Southern Plains Woodrat
Odocoileus hemionus	Mule Deer
Onychomys leucogaster	Northern Grasshopper Mouse
Perognathus hispidus	Hispid Pocket Mouse
Perognathus flavescens	Plains Pocket Mouse
Perognathus flavus	Silky Pocket Mouse
Peromyscus lucopus	White-Footed Mouse
Peromyscus maniculatus	Deer Mouse
Reithrodontomys megalotis	Western Harvest Mouse
Reithrodontomys montanus	Plains Harvest Mouse
Sigmodon hispidus	Hispid Cotton Rat
Spermophilus spilosoma	Spotted Ground Squirrel
Sylvilagus auduboni	Desert Cottontail
Tadarida brasiliensis	Brazilian Free-Tailed Bat
Taxidea taxus	Badger
Vulpes velox	Swift Fox

Table 1-3. Birds of the Cannon AFB Area

GENUS-SPECIES	COMMON NAME
Accipiter cooperii	Cooper's Hawk
Accipiter striatus	Sharp-Shinned Hawk
Actitis macularia	Spotted Sandpiper
Agelaius phoeniceus	Red-Winged Blackbird
Aimophila cassinii	Cassin's Sparrow
Ammodrumus savannarum	Grasshopper Sparrow
Anas acuta	Pintail Duck
Anas carolinensis	Green-Winged Teal
Anas cyanoptera	Cinnamon Teal
Anas discors	Blue-Winged Teal
Anas platyrhynchos	Mallard Duck
Anthus spinoletta	Water Pipit
Aquila chrysaetos	Golden Eagle
Archilochus alexandri	Black-Chinned Hummingbirg
Ardea herodias	Great Blue Heron
Asio flammeus	Short-Eared Owl
Athene cunicularia	Burrowing Owl
Branta canadensis	Canada Goose
Bubo virginianus	Great Horned Owl
Buteo jamaicensis	Red-Tailed Hawk
Buteo lagopus	Rough-Legged Hawk
Buteo regalis	Ferruginous Hawk
Buteo swainsoni	Swainson's Hawk
Calamospiza melanocorys	Lark Bunting
Calcarius ornatus	Chestnut-Collard Longspur
Callipepla squamata	Scaled Quail
Capella gallinago	Common Snipe
Carpodacus mexicanus	House Finch

Table 1-3. Birds of the Cannon AFB Area (continued)

GENUS-SPECIES	COMMON NAME
Casmerodius albus	Common Egret
Cathartes aura	Turkey Vulture
Charadrius vociferus	Killdeer
Chen hyperborea	Snow Goose
Chlidonias niger	Black Tern
Chondestes grammacus	Lark Sparrow
Chordeiles minor	Common Nighthawk
Colaptes cafer	Red-Shafted Flicker
Columba livia	Domestic Pigeon
Corvis brachyrhynchos	Common Crow
Corvis cryptoleucus	White-Necked Raven
Dendroica nigrescens	Black-Throated Gray Warbler
Eremophila alpestris	Horned Lark
Euphagus cyanocephalus	Brewer's Blackbird
Eupoda montana	Mountain Plover
Flaco mexicanus	Prairie Falcon
Falco sparverius	American Kestrel
Fulica americana	American Coot
Geococcyx californianus	Roadrunner
Grus canadensis	Sandhill Crane
Guiraca caerulea	Blue Grosbeak
Hesperiphona vespertina	Evening Grosbeak
Hirundo rustica	Barn Swallow
Hylocichla guttata	Hermit Thrush
Ictinia mississippiensis	Mississippi Kite
Lanius ludovicianus	Loggerhead Shrike
Limnodromus scholopaceus	Long-Billed Dowitcher
Megaceryle alcyon	Belted Kingfisher

Table 1-3. Birds of the Cannon AFB Area (concluded)

GENUS-SPECIES	COMMON NAME
Melospiza melodia	Song Sparrow
Mergus merganser	Common Merganser
Mimus polyglottos	Mockingbird
Molothrus ater	Brown-Headed Cowbird
Muscivora forfic	Scissor-Tailed Flycatcher
Oporornis tolmiei	MacGillivray's Warbler
Passer domesticus	House Sparrow
Passerculus sandwichensis	Savannah Sparrow
Piranga rubra	Summer Tanager
Pooecetes gramineus	Vesper Sparrow
Recurvirostra americana	American Avocet
Spinus tristis	American Goldfinch
Spizella arborea	Tree Sparrow
Spizella passerina	Chipping Sparrow
Sturnella magna	Eastern Meadowlark
Sturnella neglecta	Western Meadowlark
Sturnus vulgaris	Starling
Totanus flavipes	Lesser Yellowlegs
Toxostoma rufum	Brown Thrasher
Tryngites subruficollis	Buff-Breasted Sandpiper
Turdus migratorius	Robin
Tympanuchus pallidicinctus	Lesser Prairie Chicken
Tyrannus verticalis	Western Kingbird
Tyto alba	Barn Owl
Wilsonia pusilla	Wilson's Warbler
Zenaidura macroura	Mourning Dove
Zonotrichia leucophrys	White-Crowned Sparrow

Table 1-4. Reptiles in the Cannon AFB Area

GENUS-SPECIES	COMMON NAME
Ambystoms tigrinum	Tiger Salamander
Arizona elegans	Kansas Glossy Snake
Bufo cognatus	Great Plains Toad
Bufo debilis	Green Toad
Bufo punctatus	Red-Spotted Toad
Cnemidophorus sexlineatus	Six-Lined Racerunner
Crotalus viridis	Prairie Rattlesnake
Crotaphytus collaris	Collared Lizard
Diadophis punhctatus	Prairie Ringneck Snake
Elaphe guttata	Corn Snake
Eumeces obosoletus	Great Plains Skink
Hetrodon nasieus	Western Hognose Snake
Holbrookia maculata	Lesser Earless Lizard
Lampropeltis getulus	California Kingsnake
Lampropeltis triangulum	Central Plains Milk Snake
Leptotyphlops delcis	Texas Blind Snake
Masticophis flagellum	Western Coachwhip
Phyrnosoma cornutum	Texas Horned Lizard
Phyrnosoma modestum	Round-Tailed Horned Lizard
Pituophis melanoleucus	Bullsnake
Rhinocheilus lecontei	Texas Long-Nosed Snake
Scaphiopus bombifrons	Plains Spadefoot
Scaphiopus conchi	Conch's Spadefoot
Scaphiopus hammondi	Western Spadefoot
Sceloporus undulatus	Eastern Fence Lizard
Sistrurus caternatus	Massasauga
Sonora episcopa	Grand Snake
Tantilla migricejas	Plains Black-Headed Snake
Terapene ornata	Box Turtle
Thamnophis radix	Plains Garter Snake
Uta stansburiana	Side-Blotched Lizard

Baird's Sparrow (Ammodramus bairdii) is the only endangered species listed by the State of New Mexico known to occur in Curry County. It is found in the area mainly during autumn migration in the eastern plains and southern lowlands. Migrants appear as early as the first week of August and move farther south by November (USAF, 1990).

The Tall Plains Spurge (Euphorbia strictor) is listed as a Sensitive Species by the State of New Mexico. This species grows on sandy soils of the short grass plains. This species was not found during the recent vegetation survey of Cannon AFB (NMEMNRD, 1993).

1.4.4 Previous Investigations

The following discussion concerning previous investigations is modified from the Woodward-Clyde Remedial Investigation Report for 18 Solid Waste Management Units, Cannon AFB, Covis, NM (May 1992). This discussion also includes the Woodward-Clyde Investigation.

Prior to this RFI at Cannon AFB, past investigations had been performed for the majority of the SWMUs currently being investigated. These previous investigations were conducted under both the USAF IRP program and in relation to Cannon AFB's RCRA permit. The following is a brief description of the previous investigations which have been conducted at Cannon AFB. Additional information on previous investigations at the specific SWMUs investigated by this RFI is contained in Sections 2.0 through 16.0 of this RFI report.

In 1982-1983, CH_2M Hill conducted a records search in support of the USAF IRP program for Cannon AFB. The records search was conducted as Phase I of the IRP for Cannon AFB. This project included a detailed review of pertinent installation records, contact with government agencies, and a site visit. The purpose of this project was to identify and fully evaluate suspected problems associated with past hazardous material disposal sites, control the migration of hazardous contamination from such sites, and control hazards to health and welfare that may have resulted from these past operations. Results of this records search identified several sites on Cannon AFB which warranted further investigation (CH_2M Hill, 1983).

Based on the records search, Radian Corporation conducted a hydrogeological investigation of 16 sites on Cannon AFB to determine if environmental contamination resulted from past waste disposal and materials handling operations. The investigation was part of a Phase II Confirmation/Quantification Stage I of the IRP for Cannon AFB. The sites investigated during this 1984-1985 program included several landfills, fire training areas, fuel handling and spill areas. Results of this investigation documented the presence of oil and grease in the upper soil zone at several sites. Metals analyses indicated that metals were generally at background levels except for barium and selenium at several sites (Radian, 1986). No groundwater contamination was found as a result of this investigation.

As a result of the investigation performed by Radian in 1984-1985, a follow up investigation was performed by Radian at the AGE Drainage Ditch - Site 15, (SWMU 34/IRP No. SD-11). This investigation was conducted to determine whether toxic soils existed and if so, to assist Cannon AFB personnel in disposing the soils in a proper manner in compliance with applicable hazardous waste regulations. Results of this investigation indicated that the AGE Drainage Ditch

contained visibly discolored but nonhazardous soils (as defined by 40 CFR 261, Subpart D) (Radian, 1987). Recommendations for site restoration were provided to the USACE, Omaha District and Cannon AFB as a result of this investigation.

In 1987, A.T. Kearney, Inc. performed a Preliminary Review and Visual Site Inspection of Cannon AFB for the USEPA Region VI to identify and evaluate solid waste management units (SWMU) and other areas of concern. During that investigation, the potential for releases of hazardous wastes or constitutents to the environment was assessed, and where appropriate, the need for further action was identified. That investigation identified 128 SWMUs and 51 other areas of concern (Kearney, 1987).

Walk, Haydel & Associates conducted a remedial investigation at four sites (Underground Storage Tank Runoff Area at Fire Department Training Area No. 4, Engine Test Cell Overflow Pit and Leach Field, South Stormwater Collection Point, and Northeast Stormwater Collection Point) at Cannon AFB in 1987. The sites investigated during that investigation were selected for additional investigation based on the results of IRP Phase I and Phase II investigations. Results of that investigation suggested that no adverse impact to public health or the environment is expected based on conditions at each of the four sites (Walk, Haydel & Associates, 1990).

In 1988, an Environmental Assessment and Remedial Action Plan was prepared for the Old Entomology Rinse Area - Site 17 (SWMU 78/IRP No. SD-17) by Walk, Haydel & Associates. Their investigation was prompted by findings during the hydrogeologic investigation conducted previously by Radian Corporation. Results of that Environmental Assessment suggested that the site does not pose a significant impact to the environment and that no remedial action should be required at the Old Entomology Rinse Area (Walk, Haydel & Associates, 1988).

A Remedial Investigation (RI) was conducted in 1991-1992 by Woodward-Clyde Consultants. The RI was conducted to evaluate the nature and extent of potential contamination of 18 Solid Waste Management Units (SWMUs) located on Cannon AFB (Woodward-Clyde, 1992). Woodward-Clyde performed a Baseline Risk Assessment as part of the RI work. The RI work consisted of drilling and sampling. Sampling of surface and subsurface soil, groundwater, surface water, and sediment was conducted. The following SWMUs were investigated by Woodward-Clyde:

- No. 34 AGE Drainage Ditch (IRP SD-15)
- No. 76 Sludge Weathering Pit (IRP WP-14)
- No. 78 Fire Training Area No. 1 (IRP FT-6)
- No. 81 Solvent Disposal Area (IRP DP-16)
- No. 86-90 Engine Test Cell (IRP SD-11)
- No. 95 NE Stormwater Drainage (IRP SD-20)
- No. 96 Old Entomology Ravine (IRP SD-17)
- No. 98 Sanitary Sewer Line
- No. 101, 102 Wastewater Lagoons
- No. 106 Fire Training Area No. 2 (IRP FT-7)
- No. 107 Fire Training Area No. 3 (IRP FT-8)
- No. 109 Fire Training Area No. 4
- No. 113 Landfill No. 5 (IRP LF-5)

These SWMUs were identified during the RCRA Facility Assessment (RFA) performed by USEPA in 1987.

Petroleum products, metals, and pesticides were identified from the Woodward-Clyde RI. The risk assessment concluded that "potential health impacts to humans from the 18 SWMUs investigated during the RI are not significant" (Woodward-Clyde, 1992). The ecological risk assessment recommendations were "no action" for all the SWMUs except SWMU 109. Further investigation was recommended for this site.

1.5 Field Investigation Objectives and Methods

1.5.1 Field Investigation Objectives

The approach for investigating 15 Appendix II SWMUs at Cannon AFB was to review the results of past investigations, identify data needs and then formulate a sampling plan to collect the necessary data required to evaluate each SWMU. Data collection activities were designed to evaluate the nature and extent of contamination, if any, identify properties that control contaminant migration and perform a baseline risk assessment. If necessary, these data may be used to support the selection of remedial alternatives.

The SWMU-specific sampling programs were designed to sample all potentially affected media specific to each SWMU in a safe, efficient, and quality-controlled manner. Data collection activities were designed to be comparable and compatible with previous site investigations.

The rationale for selection of sampling locations, number of samples and analytical parameters is detailed in the Field Sampling Plan (FSP), RCRA Facility Investigation, Cannon AFB, New Mexico (LRL, 1993). In general, however, sample locations, frequencies and analyses were selected to find any hazardous or otherwise regulated waste constituents, if present, and characterize their nature and extent.

1.5.2 Field Investigation Methods

This section provides a discussion of the samples collected and the investigation methods used during sampling activities conducted at Cannon AFB in April of 1993. This includes: sampling equipment and procedures, sample designation, sample handling, documentation, and analysis.

The sampling activities at Cannon, as outlined in the FSP (LRL, 1993), consisted of drilling 3 to 5 boreholes in the vicinity of each SWMU and collecting surface and subsurface samples for chemical analysis (Table 1-5).

Table 1-5. Summary of Boreholes and Samples

NUMBER OF BOREHOLES	NUMBER OF SURFACE SOIL SAMPLES	NUMBER OF SUBSURFACE SOIL SAMPLES (including duplicates)
50	100	395

For some SWMUs, actual borehole locations differ slightly from the FSP. Borehole locations were moved in response to obstacles to the drilling equipment or improved information on SWMU location. In all cases the distances moved were marginal and were considered either similar to original locations or better for characterizing the SWMU.

In accordance with the Quality Assurance Plan (QAP) (LRL, 1993), QA/QC samples (duplicate soil samples, ambient blanks, rinsate blanks, trip blanks, and decontamination water blanks) were collected and submitted to Southwest Division Laboratory (SWDL). SWDL sorted the samples and sent them to their contract analytical laboratory for analyses. A second laboratory received duplicate samples to provide a means to assess the quality of the data from the field sampling program (Table 1-6).

Table 1-6. Summary of QA/QC Samples

QC DUPLICATES (analyzed at same laboratory as normal samples)	QA DUPLICATES (analyzed at different laboratory from normal samples)	AMBIENT BLANKS	RINSATE BLANKS	TRIP BLANKS	DECONTAMINATION WATER BLANKS
41	41	15	31	14	31

A summary of the QA/QC sampling program conducted at each of the SWMUs is presented in the sections that describe individual SWMUs at Cannon AFB. Fewer trip blanks were required than originally specified in the FSP since in many cases all the samples from a particular site were sent to the laboratories in a single cooler.

1.5.2.1 Sample Equipment and Procedures

The specific procedures employed for sample collection were consistant with the RCRA Facility Investigation, Field Sampling Plan, Environmental Management Branch, Divil Engineering Squadron, Cannon AFB, 1991 which specifies the use of the following Standard Operating Procedures (SOP):

SOP 1.3 Sample Control and Documentation
SOP 1.4 Sample Containers and Preservation
SOP 1.5 Guide to the Handling, Packaging and Shipping of Samples
SOP 1.6 General Equipment Decontamination
SOP 1.8 Personal Decontamination - Level D Protection
SOP 4.1 Soil Boring
SOP 5.1 Soil and Rock Borehole Logging and Sampling

At each site, prior to drilling and sampling, as specified by the QAP, a daily tailgate health and safety meeting was conducted. In addition, the following quality control forms and check lists were completed for each SWMU:

- Site Safety Briefing Form
- Site Safety Inspection Report
- Sample Identification QA Field Checklist
- Chain of Custodies
- Borehole Logs (Soil) Form
- Site Monitoring Data (HNU Meter)
- SWMU Site QAP Report (Field QC Checklist for Each)

Issues covered at meetings and on the safety form and report include:

- Review of site Health and Safety Plan
- Potential chemical hazards
- Emergency response procedures
- Persons in attendance
- Drilling and safety equipment - type and condition
- Personal Protective Equipment (PPE) required

The SWMU Site QAP Report was completed for each SWMU as an accounting method for data collection quality control. QA Field Checklist topics included:

- Predrilling and sampling requirements
- Equipment decontamination procedures
- Sample collection, identification, and shipping procedures
- Field logbook entry requirements
- Cuttings management and borehole closure

Chain of Custody forms (Appendix D) were completed for each sample and submitted, with the samples, to the laboratory.

1.5.2.1.1 *Surface Soil Sample Collection.* Surface soil samples were collected using a stainless steel trowel at each location. VOC samples were placed in narrow mouth, 60 ml, amber vials. Metal samples were placed in wide mouth, 500 ml, clear glass containers. Samples were collected, containerized, labeled, sealed, and placed on ice in a cooler. All containers were pre-preserved by the laboratory. Surface samples were collected to a maximum of 6" below ground level. At some locations asphalt removal was required to obtain surface soils.

1.5.2.1.2 *Subsurface Sample Collection.* All soil borings were drilled, sampled, lithologically logged and grouted with cement in accordance with SOPs 4.1 and 5.1. Drilling was conducted by Pool Environmental Drilling Company of Roswell, NM. Drilling was conducted with a CME-75 drill rig, using an 8" diameter hollow auger drill stem with an integrated continuous sampler. At SWMUs where boreholes were deepest, a split spoon sampler was also used. Where space limitations occurred, a hand auger was sometimes employed. At SWMU #s 1, 3, 5, 7, 8, 11, 16, 32A, 33B, 38, 39, and 83, three boreholes were drilled, at SWMU 9, four boreholes were drilled, and at SWMUs 48A&B and 108, five boreholes were drilled. For the purpose of worker protection, monitoring data was collected and documented at the drill stem and in ambient air with an HNU meter. Sample collection from the five foot long split spoon barrel sampler was conducted by placing the split barrel sampler onto a dry surface. Sample containers for VOCs, BTEX, and TRPH samples were placed adjacent to the interval from which the sample was to be collected. The sampler was then opened and sliced lengthwise with a stainless steel spatula into three sections. BTEX, VOCs, and/or TRPH were collected from the center slice, four inches from either end, containerized, sealed, labeled and placed on ice in a cooler. The remaining soil at each discrete sampling interval was mixed with a stainless steel spoon. Metals samples were taken from this mixture, containerized, labeled, sealed, and placed on ice in a cooler.

Borehole logs were generated for all boreholes. Information taken on these logs includes:

- Facility code and SWMU number
- Boring number and location
- Well diameter, depth and construction method
- Completion date
- Closure comments
- Depth, sample method, and lithologic description
- Technician and technical reviewer signatures

1.5.2.2 Sample Designation

The sample designation system for all field and QA/QC samples was also taken from the RCRA Facility Investigation, Field Sampling Plan, Environmental Management Branch, Civil Engineering Squadron, Cannon AFB, 1991. This system involved a three letter and eleven digit/letter unique identification for each sample (CANXXX-YYYY-ZZZZ). CANXXX is the

facility identifier with CAN identifying Cannon AFB and XXX identifying the specific SWMU. The next four digits/letters (YYYY) identify the specific sampled location i.e. the site number and borehole number. The last four digits (ZZZZ) were the sample identifier. The first number corresponds to the type of sample collected (i.e. 0 = normal analytical sample, 2 = ambient blank, 4 = trip blank, etc.). The second number corresponds to the analytical test type (i.e. BTEX, priority metals etc.). The third number corresponds to the sample number for each test type and the fourth number/letter corresponds to sample depth. Figure 1-7 shows the sample identification codes.

1.5.2.3 Sample Handling, Documentation and Analysis

All labeling, preservation, handling, shipping, documentation and tracking for samples collected were performed in accordance with SOPs 1.3 Sample Control and Documentation, 1.4 Sample Containers and Preservation and 1.5 Guide to Handling, Packaging, and Shipping of Samples (Cannon AFB, 1991).

All sample containers and coolers were supplied by the Army Corp of Engineers Southwest Division Laboratory. All sample labels were filled out with waterproof ink. After sample collection, the containers were placed into styrofoam packing material also provided by the lab and placed into the coolers. A completed and signed Chain-of-Custody was placed in each cooler. A custody seal was placed on each individual container and on the lid of each cooler. Southwest Division Laboratory submitted the QA duplicates to a second laboratory.

Table 1-7 presents a list of analyses performed and the analytical methods employed in this investigation. Tables of the specific analyses performed on each sample are presented in each SWMU chapter.

1.6 Data Validation

All data validation quality control criteria and quality control limits utilized in the data validation process for this investigation may be found in USEPA National Gunctional Guidelines, 1988 and 1991.

* There are several non-standard SWMU designators:
- 32A = SWMU #32, 186 (1)
- 33B = SWMU #33, 186 (2)
- 48A = SWMU #48A, a UST location
- 48B = SWMU #48B, an AST location
- 48C = SWMU #48 A & B, a fifth borehole

SAMPLE TYPE
- 0 = Normal Sample
- 1 = Duplicate Sample
- 2 = Ambient Blank
- 3 = Rinsate Blank
- 4 = Trip Blank
- 5 = Field Blank
- 6 = Decon Water
- 7 = QA
- 8 = QC

TEST TYPE
- 1 = BTEX
- 2 = Priority Metals
- 3 = TCL VOC
- 4 = TPH
- 5 = TAL Metals
- 6 = Reactive Materials

CANNON AFB

SAMPLE SEQUENCE ID
(For each test type)

C A N X X X X X X X X X X X

SWMU NO.*

SITE NO.**

Depth at which sample was taken
- A = 0
- B = 2.5'
- C = 5'
- D = 10'
- E = 15'
- F = 20'
- G = 30'
- Z = no depth

BORING NO.
In Sequence
1 to 6
0 = Blank or Decon Water not Associated with a Boring

** There are several non-standard site designators:
- AWD = Aircraft Washrack Drain System
- UST = Removed Underground Storage Tank
- AST = Removed Aboveground Storage Tank
- SUM = Sump
- EOD = Explosive Disposal Activities Area

SAMPLE IDENTIFICATION CODE

Figure 1-7. Sample Identification Code

Table 1-7. EPA Method Utilized for Evaluating Analytes

ANALYTE	METHOD
BTEX (Benzene, Toluene, Ethylbenzene, Xylene)	8020
Target Compound List Volatile Organic Compounds (TCL-VOC)	8240
Priority Metals (TCLP list metals plus nickel)	6010/7000S+
Target Analyte List Metals (TAL Metals)	6010/9012
Total Recoverable Petroleum Hydrocarbons (TRPH)	418.1
Cyanide	9010
Reactives	9010/9030++
Sulfides	9030

\+ Metals analyzed by the 7000 Series include: mercury, selenium, lead, and arsenic.
++ Chapter 7 of SW-846.

1.7 Background Concentrations of Inorganic Compounds

To describe the different levels of chemical contamination, several definitions are necessary. For organics, it is assumed that any chemical found at measurable quanities will be considered to be above background levels. Metals are compared to the 95% upper confidence level of background concentrations (Table 1-8).

In 1993, Woodward-Clyde (WWC) published background data on levels of inorganic chemical constituents at Cannon AFB, based on a compilation of three investigations:

1. WWC (1992) - RI at Cannon AFB conducted by WCC in 1991 included three off-site background soil samples.

2. WWC (1993) - RFI at Cannon AFB included samples from borings located outside Landfill No. 2 area.

3. Walk, Haydel, and Associates(1990) conducted an IRP RI at Cannon AFB and analyzed four background soil samples.

USGS 1984 data for the Clovis region and other reports on regional soil data were used to further substantiate field sampling.

Table 1-8. Summary of Background Elemental Concentrations (1) in Soil Samples (2) Cannon AFB, New Mexico

ELEMENT	MEAN ($\bar{x}$)	STANDARD DEVIATION (SD)	($\bar{x}$)$\pm$2SD	TYPICAL LEVEL IN CLOVIS, NM REGION
Aluminum	5,700	2,420	860 - 10,540	50,000
Antimony	6.75	2.71	1.33 - 12.2	<1
Arsenic	3.5	6.0	0 - 15.5	6.5
Barium	166	238	0 - 642	500
Beryllium	0.41	0.16	0.09 - 0.73	1 - 2
Cadmium	1.1	0.90	0 - 2.9	---
Calcium	69,200	58,600	0 - 186,400	7,900 - 18,000
Chromium	6.98	2.78	1.42 - 12.5	30
Cobalt	2.5	1.0	0.5 - 4.5	3 - 7
Copper	5.40	3.79	0 - 13.0	20
Iron	4,780	1,970	840 - 8,720	100 - 15,000
Lead	7.12	9.35	0 - 25.8	15
Magnesium	4,650	3,570	0 - 11,790	2,000 - 5,000
Manganese	72.0	46.0	0 - 164	500
Mercury	0.11	0.01	0.09 - 0.13	0.032 - 0.082
Nickel	5.0	2.0	1.0 - 9.0	15
Potassium	1,360	606	148 - 2,572	16,000
Selenium	8.23	24.2	0 - 56.6	0.15 - 0.30
Silver	1.2	0.5	0.2 - 2.2	---
Sodium	514	264	0 - 1,042	7,000
Thallium	0.50	0.36	0 - 1.2	---
Vanadium	14.9	5.20	4.50 - 25.3	30 - 70
Zinc	11.3	5.29	0.72 - 21.9	45

[1] All concentrations are in milligrams per kilogram (mg/kg).
[2] Compiled from data collected by WCC for the RFI and RI (WCC 1992 and WCC 1993) and Walk, Haydel & Associates for the IRP (Walk, Haydel & Associates 1990).

SOURCE: WWC 1993

2.0 OIL WATER SEPARATOR (SWMU NO. 1/SITE NO. 119)

2.1 SWMU Description

2.1.1 Setting

SWMU No. 1 is an oil/water separator with a skimmer located on the southeast corner of Building 119 next to the aircraft parking ramp. The separator is a self-contained, three-compartment underground unit, with a 700 gallon main compartment and a 280 gallon oil compartment. The top of this oil/water separator is approximately one foot above ground level. Three-compartment separators at Cannon AFB range between 7'2" and 10'8" in depth. Therefore, it is estimated that the bottom of the unit may be found at 6 to 10 feet of depth. The unit is constructed of concrete. The opening to the separator is in a concrete pad, surrounded on all sides by asphalt. Drilling activities required penetration and restoration of the surface with a concrete plug. Borehole locations were chosen, in part, to avoid underground utilities and a light pole. Figure 2-1 shows the SWMU setting and borehole locations.

2.1.2 History of Use

The oil/water separator No. 119 has been active since 1963 and is still in use. The recovered oils are directed to the 280 gallon concrete chamber and the wastewater is discharged to the storm drainage system which flows to the Stormwater Collection Point (SWMU No. 85). SWMU No. 85 was studied previously and no significant levels of contamination were found. Historically, the facility discharging to the separator was used for x-rays of aircraft and parts, and other operations which did not use chemicals. Aircraft fuels and fluids were disposed of through an established system which includes waste generation reporting procedures. The unit has received and now receives wash water generated from the clean-up of hanger floors.

2.1.3 Past Investigations

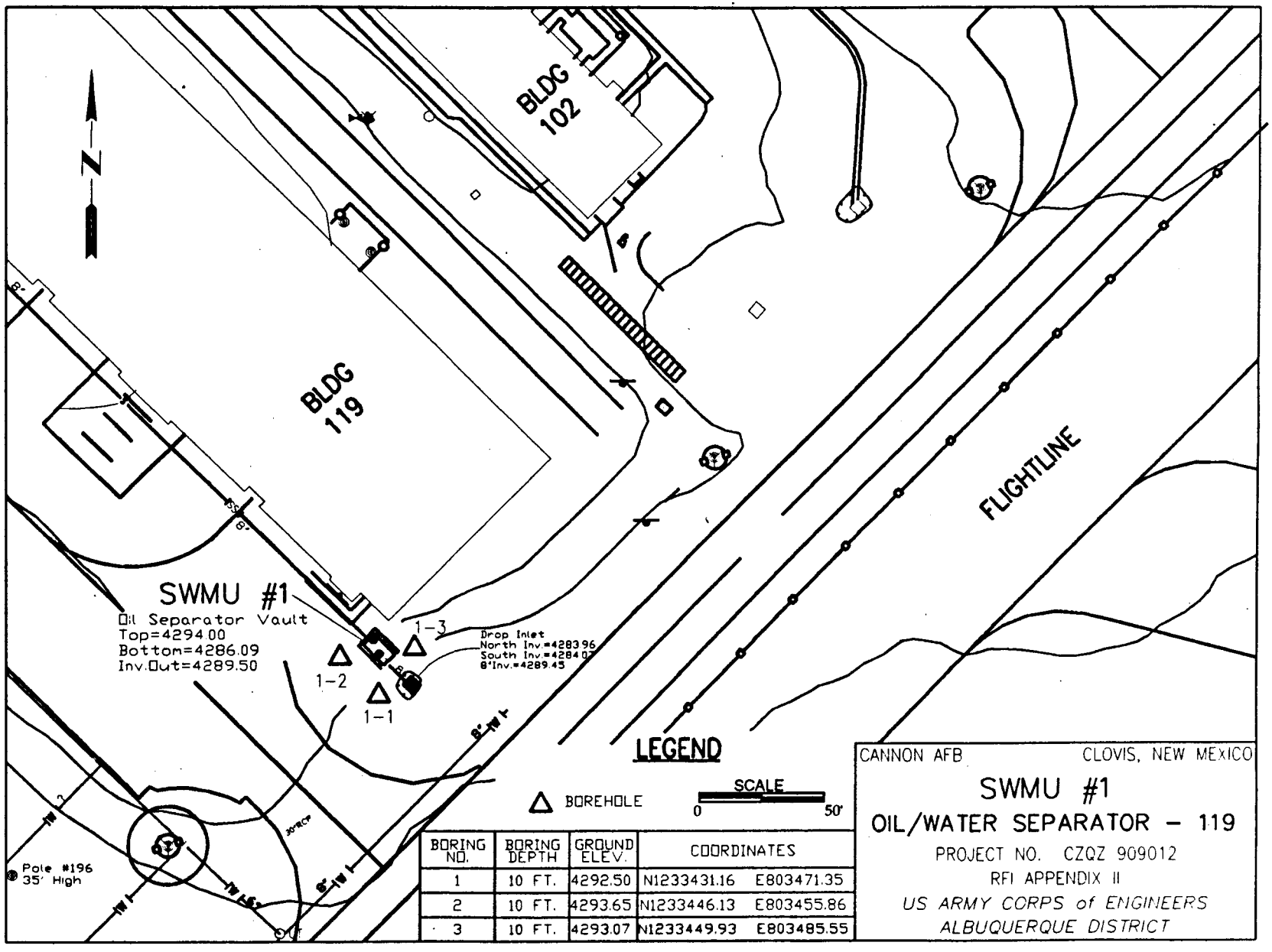
In 1987-1988 the Tulsa District Corps of Engineers sampled this and other oil/water separators at Cannon AFB. The results of this study were reported in Cannon Air Force Base Oil/Water Separators Sampling and Analytical Report, June, 1988. The results of this study indicated the presence of metals and organics in the liquid phase influent and/or effluent. The compounds found in either the influent, effluent or both include cadmium, chromium, nickel, lead, benzene, bromoform, bis(2-ethylhexyl)phthalate and di-n-butylphthalate.

2.1.4 Land Use and Demography

This SWMU is in an area of the base that is commonly frequented by flight line personnel. However, the separator is underground and the area is currently covered by asphalt.

2.2 Field Investigation

Drilling and sampling activities SWMU No. 1 occurred April 8, 1993 at 0805. The activities, as outlined in the FSP (LRL, 1993), consisted of drilling 3 boreholes, collecting 6 surface samples, 18 subsurface samples, 4 QA/QC duplicate samples, and 6 QA/QC water samples. Table 2-1 summarizes the field sampling program at SWMU 1. Table 2-2 summarizes the various samples collected and analyses performed.



BORING NO.	BORING DEPTH	GROUND ELEV.	COORDINATES	
1	10 FT.	4292.50	N1233431.16	E803471.35
2	10 FT.	4293.65	N1233446.13	E803455.86
3	10 FT.	4293.07	N1233449.93	E803485.55

Figure 2-1.

Table 2-1.
Summary of Drilling and Sampling
SWMU No. 1 - Oil/Water Separator No. 119

Borehole Number	Sampling Depth (ft.-BGS)	Drilling/ Sampling Methods	Drillrig Used	Borehole Diameter (in.)	Ground Elevation (ft.-MSL)	Date Grouted
1	0	NA/SSS	NA	NA	4292.50	4/9/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
2	0	NA/SSS	NA	NA	4293.65	4/9/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
3	0	NA/SSS	NA	NA	4293.07	4/9/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		

HSA = Hollow Stem Auger
HA = Hand Auger
NA = Not Applicable
SBC = Split Barrel Continuous Sampler
SS = Split Spoon
SSS = Stainless Steel Spoon

Table 2-2.
Summary of Sampling and Analyses
SWMU No. 1 - Oil/Water Separator No. 119

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
1	0	CAN001-1191-021A	N	Soil	0910	PM	6010/7000S+
		CAN001-1191-031A	N	Soil	0910	TCL VOC	8240
	2.5	CAN001-1191-022B	N	Soil	0927	PM	6010/7000S
		CAN001-1191-032B	N	Soil	0925	TCL VOC	8240
	5.0	CAN001-1191-011C	N	Soil	0922	BTEX	8020
		CAN001-1191-023C	N	Soil	0930	PM	6010/7000S
	10.0	CAN001-1191-012D	N	Soil	0935	BTEX	8020
		CAN001-1191-024D	N	Soil	0935	PM	6010/7000S
2	0	CAN001-1192-021A	N	Soil	1005	PM	6010/7000S
		CAN001-1192-031A	N	Soil	1005	TCL VOC	8240
	2.5	CAN001-1192-022B	N	Soil	1025	PM	6010/7000S
		CAN001-1192-032B	N	Soil	1015	TCL VOC	8240
		CAN001-1192-821B	QCD	Soil	1025	PM	6010/7000S
		CAN001-1192-831B	QCD	Soil	1020	TCL VOC	8240
		CAN001-1192-721B	QAD	Soil	1025	PM	6010/7000S
		CAN001-1192-731B	QAD	Soil	1020	TCL VOC	8240
	5.0	CAN001-1192-011C	N	Soil	1027	BTEX	8020
		CAN001-1192-023C	N	Soil	1030	PM	6010/7000S
	10.0	CAN001-1192-012D	N	Soil	1027	BTEX	8020
		CAN001-1192-024D	N	Soil	1030	PM	6010/7000S

Table 2-2. (Concluded)
Summary of Sampling and Analyses
SWMU No. 1 - Oil/Water Separator No. 119

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
3	0	CAN001-1193-021A	N	Soil	1110	PM	6010/7000S
		CAN001-1193-031A	N	Soil	1110	TCL VOC	8240
		CAN001-1193-022B	N	Soil	1125	PM	6010/7000S
		CAN001-1193-032B	N	Soil	1125	TCL VOC	8240
		CAN001-1193-011C	N	Soil	1120	BTEX	8020
		CAN001-1193-023C	N	Soil	1127	PM	6010/7000S
		CAN001-1193-012D	N	Soil	1131	BTEX	8020
		CAN001-1193-024D	N	Soil	1133	PM	6010/7000S
		CAN001-1190-431Z	QC	Water	1140	TCL VOC	8240
		CAN001-1190-321Z	QC	Water	1225	PM	6010/7000S
		CAN001-1190-331Z	QC	Water	1140	TCL VOC	8240
		CAN001-1190-231Z	QC	Water	1140	TCL VOC	8240
		CAN001-1190-621Z	QC	Water	1225	PM	6010/7000S
		CAN001-1190-631Z	QC	Water	1140	TCL VOC	8240

BTEX = Benzene, Toluene, Ethyl Benzene, Xylene
ft-BGS = feet below ground surface
N = Normal soil sample
PM = Priority metals = 8 TCLP metals + Ni
TCL VOC = Target Compound List Volatile Organic Compounds
\+ = Metals analyzed using the 7000 Series include: mercury, selenium, and arsenic.

QAD = Duplicate soil sample (analyzed at different laboratory from normal samples).
QCD = Duplicate soil sample analyzed at same laboratory as normal samples.
QC = Quality control water sample (ambient blank, trip blank, etc.)
TAL Metals = Target analyte list metals

2.2.1 Sampling Objectives

Borehole locations, sampling depth, and parameters for analysis were selected, to the greatest extent possible, to determine if a release from the oil/water separator has occurred. Borehole 2 was moved from the original FSP location due to utility lines. Figure 2-1 shows the borehole locations.

2.2.2 Surface and Subsurface Soil Investigation

Three boreholes were drilled at this SWMU. Borehole 1 was drilled 5 feet south of the separator. Borehole 2 was drilled 12 feet west of the separator. Borehole 3 was drilled 10 feet northeast of the separator. Drilling was advanced to depth of 10 feet. Samples were collected at the surface, 2.5, 5, and 10 feet in depth. Surface samples were collected with a stainless steel trowel and subsurface samples were collected with a split barrel continuous sampler. Samples were collected at discrete depths and locations. No composite samples were taken. Samples were analyzed for BTEX, priority metals, and TCL VOL. Duplicates, rinsate blanks, ambient blanks, and decontamination water samples were also submitted to the laboratory for this SWMU. Trip Blanks and Ambient Blanks were inadvertently opened to the air at this site but were still included for analysis.

2.3 Physical Characteristics

This section provides a discussion of the surface water drainage, groundwater, soils and geology at the No. 119 oil/water separator based on a review of information from previous investigations at Cannon AFB and from the lithologic descriptions from the split barrel continuous sampler.

2.3.1 Surface Water Drainage

A topographic/surface drainage map in addition to text found in Installation Restoration Program Records Search, August 1983 prepared by CH_2M Hill indicates that the surface water drainage in the vicinity of SWMU No. 1 enters the base storm water drainage system and flows to the Stormwater Collection Point (SWMU No. 85). SWMU No. 85 is an ephemeral lake basin (playa) located in the southwest corner of the base.

2.3.2 Groundwater

Depth to groundwater at Cannon AFB is approximately 250 feet or greater. Groundwater recharge rates for the High Plains Region are typically low. Localized recharge rates for Curry County range from 0.75 - 12.22 mm/yr (Stone, 1985). EPA, 1987 DRASTIC reports recharge rates of 1 in/yr. Section 1.4.3.5 of this report includes a discussion of groundwater hydrology for Cannon AFB.

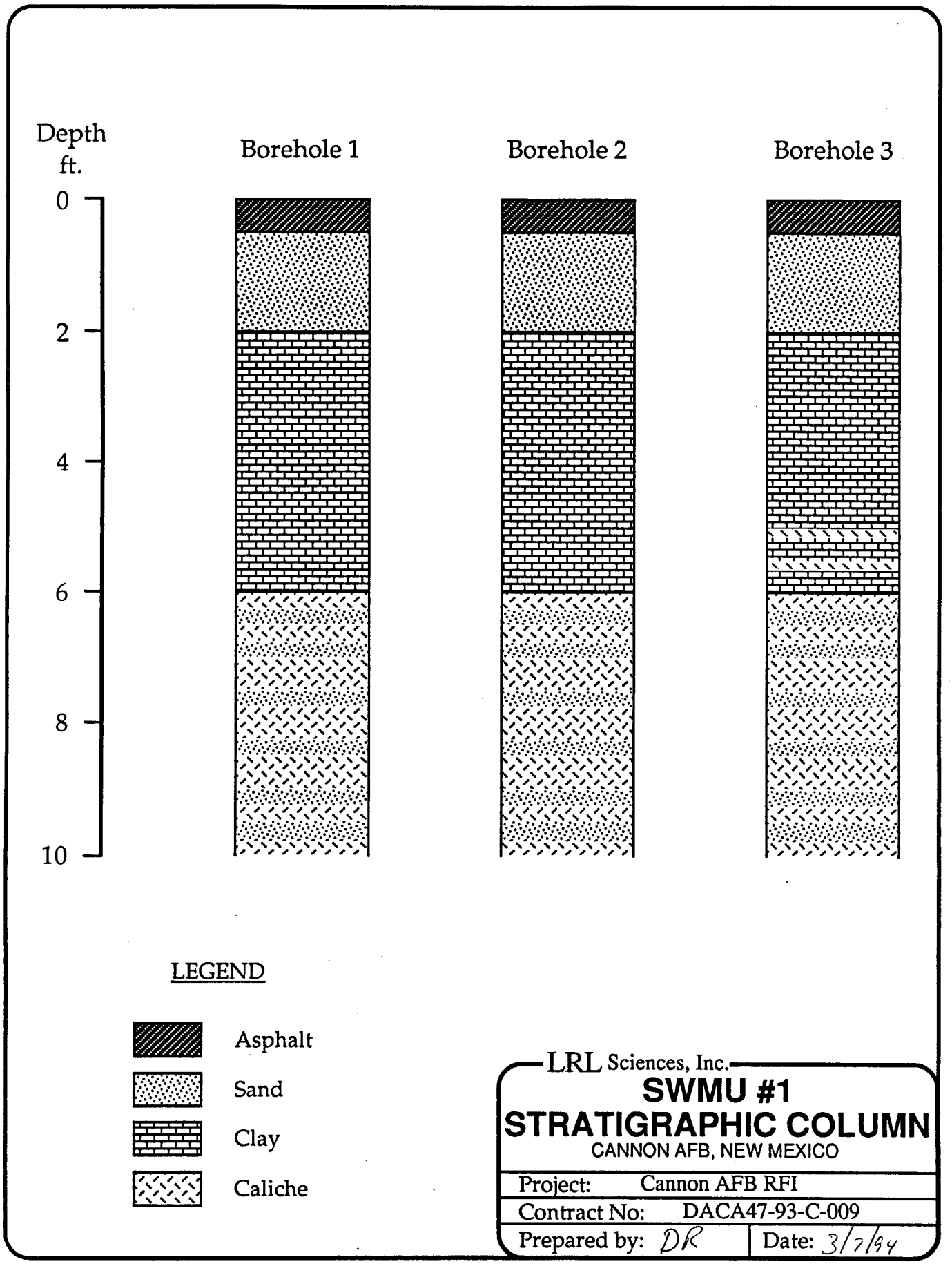

Depth
ft.
0
2
4
6
8
10
Borehole 1
Borehole 2
Borehole 3
LEGEND
Asphalt
Sand
Clay
Caliche
LRL Sciences, Inc.
SWMU #1
STRATIGRAPHIC COLUMN
CANNON AFB, NEW MEXICO
Project: Cannon AFB RFI
Contract No: DACA47-93-C-009
Prepared by: DR
Date: 3/7/94

Figure 2-2.

2.3.3 Soils and Geology

The near surface (upper ten feet) stratigraphy in the area surrounding this SWMU consist of Tertiary Miocene to Pliocene fluvial deposits of the Ogallala Formation. The soils have been described as a fine sandy loam (Ab) of the Amarillo soil group (USDA, 1993). Interpretations and correlation on the fluvial deposits for this area are based on samples collected with a split barrel continuous sampler during the drilling process. The soils consist of very fine to fine-grained, moderate to well sorted, submature to mature (textural), unconsolidated, calcareous, brown to reddish brown, clays, silts and sands. Thin to moderately thin layers of caliche material were interbedded throughout much of the samples collected. The sands were comprised of angular to subangular grains with varying amounts of silts, clays, and calcium carbonate (caliche) material. This description of lithology (Figure 2-2) is similiar to the description of soils given by the USDA Draft Soil Survey, 1993. The thickness of this particular unit remains unknown, due to the fact that boring levels did not exceed ten feet. The total thickness of the Ogallala Formation beneath this SWMU is not presently known, but regional information based on Curry County reports have suggested thicknesses of approximately 320-400 feet. No groundwater was encountered while drilling at these three borehole locations. The minimum depth of the High Plains aquifer is reported to be greater than 250 feet below ground surface.

2.4 Nature and Extent of Contamination

2.4.1 Volatile Organic Compounds

A series of HNU meter readings were taken at the well head and in the breathing zone of each borehole for the purpose of worker safety. Boreholes 1 and 2 contained positive readings ranging from 0.0 to 4.0 ppm (Table 2-3) in the borehole headspace. No positive readings occurred in the breathing zone at any borehole.

Table 2-3.
HNU Meter* Readings (PPM) in Borehole Headspace
SWMU No. 1 - Oil/Water Separator No. 119

DATE: 4/8/93					
TIME	BH1	TIME	BH2	TIME	BH3
0922	0.0	1005	0.1	1110	0.0
0933	4.0	1010	0.0	1117	0.0
		1025	0.4	1135	0.0

* Model: 101, Type: OVA PID, Make: HNU

Samples were collected from all three boreholes, at the surface and at 2.5 feet, and analyzed for Target Compound List Volatile Organic Compounds (TCL VOC). Following are the results of these analysis:

2.4.1.1 Borehole 1

Table 2-4 shows that in borehole 1 toluene was detected in the surface sample (CAN001-1191-031A) below the Contract Required Quantitation Limits (CRQL). TIC compounds were also detected. Acetone was detected in this sample but results were rejected during validation due to suspected co-elution with unknown contaminant(s).

Table 2-4.
Concentration (μg/kg) of Volatile Organic Compounds
SWMU No. 1 - Oil/Water Separator No. 119

BOREHOLE NUMBER	CANNON NUMBER	DEPTH (ft.)	CHEMICAL	
			TOLUENE	ACETONE
1	CAN001-1191-031A	Surface	9J	R
	CAN001-1191-032B	2.5	11U	11UJ
2	CAN001-1192-031A	Surface	36J	10UJ
	CAN001-1192-032B	2.5	11U	24J
3	CAN001-1193-031A	Surface	4J	R
	CAN001-1193-032B	2.5	11U	11UJ

Duplicate samples or laboratory repeat samples are presented only if they are different from the original sample and not rejected.
J = estimate
R = rejected
U = not detected at CRQL
UJ = estimated as non-detect at CRQL

At 2.5 feet no target compounds or TIC compounds were detected.

2.4.1.2 Borehole 2

In borehole 2, toluene was detected again at the surface (CAN001-1192-031A) at 36 μg/kg. This value is an estimate due to low internal standard areas. TIC compounds were detected.

At 2.5 feet (CAN001-1192-032B), acetone was detected at 24 μg/kg. This value is estimated since continuing calibration %D exceeded QC limits. No TIC compounds were detected. Two duplicate samples were also collected at 2.5 feet. The QC duplicate was analyzed by the same laboratory and the QA duplicate was analyzed at a second laboratory. The QC duplicate (CAN001-1192-831B) also contained 24 μg/kg of acetone but was qualified as an estimate since continuing calibration %D exceeded QC limits. The QA duplicate contained acetone, methylene chloride and 2-butanone. Nearly all of the samples analyzed at the QA lab contained acetone and methylene chloride. Approximately 25% of the samples contained 2-butanone. Methylene chloride and acetone due to their prevalence in all, or nearly all, the QA lab samples were

rejected as laboratory contaminants. 2-butanone, which is a common laboratory contaminant, was never detected at the QC laboratory and was, therefore, also rejected. No other target analyte was detected in the QA duplicate sample.

2.4.1.3 Borehole 3

In borehole 3, toluene was detected below the CRQL in the surface sample (CAN001-1193-031A). Acetone was also detected but rejected due to contaminant coelution. TIC compounds were detected also.

At 2.5 feet, no target compounds or TIC compounds were detected.

2.4.2 BTEX

In each borehole two samples were collected for BTEX analysis. Samples were collected at 5 and 10 feet. No BTEX compounds were detected in any of the samples. QA/QC duplicates were not collected and therefore no analysis for BTEX was performed.

2.4.3 Priority Metals

Total metals concentrations, using the RCRA SW-846 test methods for the analysis of metals in soils, were determined for the eight TCLP metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver), plus nickel. These are the priority metals. Samples were collected for priority metals analysis at the surface, 2.5, 5 and 10 feet.

In the following presentation of metals results, only metals concentrations in excess of background concentrations are presented. No background data was collected for this investigation, therefore, background concentrations were taken from Concentrations of Selected Naturally Occurring Chemical Constituents in Soil and Groundwater at Cannon Air Force Base Clovis, New Mexico, March 1993 prepared by Woodward-Clyde. For a discussion of Woodward-Clyde's background data see Section 1.7.

2.4.3.1 Borehole 1

In the surface sample (CAN001-1191-021A), chromium was detected at 13.6 mg/kg (Table 2-5). This value is an estimate since the matrix spike recovery was not within control limits. Background for chromium is 12.5 mg/kg. Silver was also detected above background at 5.8 mg/kg. This value is estimated also since matrix spike recovery was not within control limits. Background for silver is 2.2 mg/kg.

At 2.5, 5 and 10 feet, no priority metals were detected above background.

Table 2-5.
Concentration (mg/kg) of Priority Metals
SWMU No. 1 - Oil/Water Separator No. 119

Borehole Number	Sample Number (CAN001-119)	Sample Depth (feet)	Chromium		Mercury		Nickel		Silver	
1	1-021A	0	**13.6**	J	0.01	UJ	8	J	**5.8**	J
	1-022B	2.5	4.8	J	0.11	UJ	4.8	J	*	R
	1-023C	5	8.6	J	0.11	UJ	6.3	J	*	R
	1-024D	10	7.2	J	0.01	UJ	5.2	J	*	R
2	2-021A	0	**14.7**	J	0.01	UJ	5.8	J	*	R
	2-022B	2.5	8.5	J	0.11	UJ	6.5	J	*	R
(QAD)	2-721B	2.5	8.8		**0.15**		6.7		0.41	U
(QCD)	2-821B	2.5	4.5	J	0.02	UJ	5.2	J	*	R
	2-023C	5	10.2	J	0.11	UJ	**9.2**	J	*	R
	2-024D	10	4.1	J	0.11	UJ	5.1	UJ	*	R
3	3-021A	0	**34.6**	U	0.1	UJ	8	J	*	R
	3-022B	2.5	7.5	J	0.11	UJ	7	J	*	R
	3-023C	5	9.3	J	0.02	UJ	**9.6**	J	*	R
	3-024D	10	4.4		0.11	J	5.5	UJ	0.85	U
Background (95% UCL) (1)			12.50		0.13		9.00		2.20	

NOTES:
Duplicate samples (QAD) or (QCD) samples are presented only if they are different from the original sample and not rejected.

U indicates that the compound was analyzed for, but not detected at or above the standard limit.
J indicates and estimated value.
UJ indicates the compound was analyzed for but not detected. The sample quantification limit or reported detection limit is an estimated quantity.
*R indicates that the data was rejected because of quality control measures.

Boldface indicates a detection above the 95% UCL background level.

Only data for metals detected above background is presented.

(1) Background data is described in Section 1.7.

2.4.3.2 Borehole 2

In the surface sample (CAN001-1192-021A), chromium was detected at 14.7 mg/kg. This value is an estimate since the matrix spike recovery was not within control limits.

At 2.5 feet, no priority metals above background were detected. The QA/QC duplicates were collected at this depth. The QC duplicate, which was analyzed at the same lab as the normal sample, contained no priority metals above background. The QA duplicate, which was analyzed at a different lab than the normal sample, contained mercury at 0.15 mg/kg. Background for mercury is 0.13 mg/kg.

At 5 feet (CAN001-1192-023C), nickel was detected above background at 9.2 mg/kg. This value is an estimate since matrix spike recovery was not within control limits and contamination occurred in the method or calibration blank.

No priority metals were detected above background at 10 feet.

2.4.3.3 Borehole 3

In the surface sample (CAN001-1193-021A), chromium was detected at 34.6 mg/kg. This value is an estimate since matrix spike recovery was not within control limits.

At 2.5 feet, no priority metals above background were detected.

At 5 feet (CAN001-1193-023C), nickel was detected at 9.6 mg/kg. This value is an estimate since matrix spike recovery was not within control limits.

At 10 feet, no priority metals were detected above background concentration.

2.4.4 Summary of Data

Toluene, chromium, and TIC compounds were detected in low concentrations in the surface samples of all three boreholes. These analytes were not detected in the deeper samples collected. Borehole 2 contained the subsurface analytes acetone, mercury, and nickel, although concentrations were marginal. Borehole 3 contained only nickel in the subsurface. VOCs were not analyzed for at 10 feet. Metals and BTEX were not detected at 10 feet.

2.5 Recommendations

Concentrations of organics and metals found in soils around this SWMU are low and generally diminishing with depth. In addition, groundwater level is deep at approximately 250 feet below ground surface. The oil/water separator should be tested for structural integrity to determine that the unit contains no cracks or leaks. If none are found, based on the risk assessment information associated with this SWMU indicating minimal or no risk to human health or the environment, no further action is recommended. If the integrity test fails, however, it is recommended that the unit be removed and soils below the separator be analyzed. Further action would depend upon the results of these analyses.

3.0 OIL/WATER SEPARATOR (SWMU No. 3/SITE No. 108)

3.1 SWMU Description

3.1.1 Setting

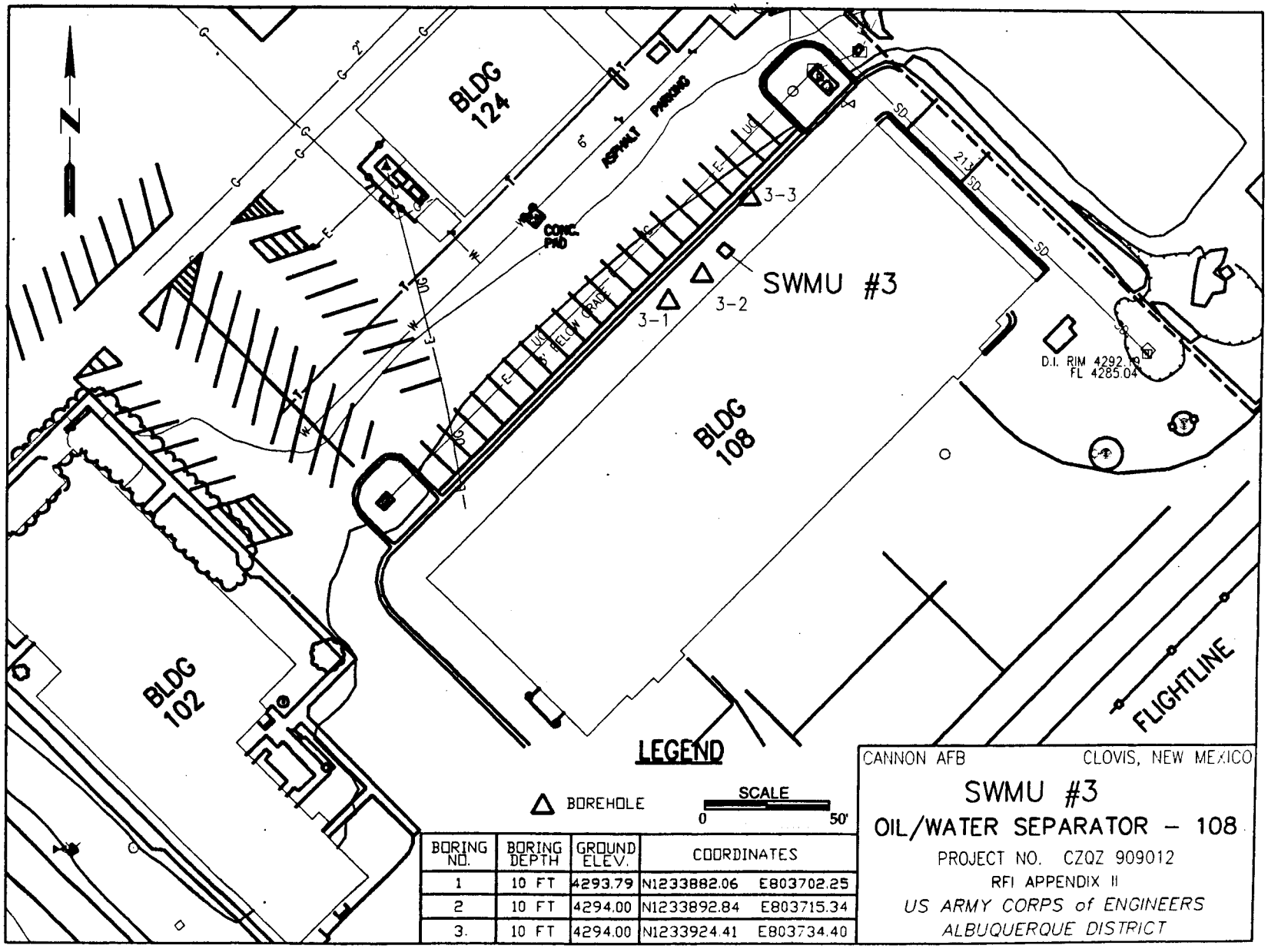
SWMU No. 3 is the location of a former oil/water separator or grease trap that was located on the west side of hangar 125. Hangar 125 was demolished and replaced with facility 108 in 1990. The unit that made up SWMU No. 3 was removed at that time. However, drawings of this facility were disposed of when hangar 125 was demolished, therefore, it is unknown if this unit was an actual oil/water separator, or a simple grease trap. The demolition plan for the project to replace these hangars makes no mention of an oil/water separator. The demolition plan merely instructs the contractor to remove all elements of the old sewer line from the hangars and cap off the main. Of the remaining two WWII hangars on base, which were of identical construction as hangar 108, both have grease traps installed, and both of those grease traps have been misidentified previously as oil/water separators. When in place, this unit was approximately 96 feet south of the NW corner of the building and 8 feet west of the building. The construction material for this unit was probably concrete. The former location of this unit is not visible as the area has been surfaced with asphalt. The depth of this unit is unknown. The driller was required to penetrate and restore the asphalt with a concrete plug. In the immediate vicinity (within approximately 30 feet) of this SWMU were eight 55-gallon drums labeled as waste coolant fluid, and five unlabeled 55-gallon drums, all stored on pallets. There were also several stacks of tires, and a hazardous spill response kit located nearby. Most of these pallets and drums were removed prior to drilling. Figure 3-1 shows the setting and borehole locations.

3.1.2 History of Use

This unit was active from 1943 until 1990 when it was removed during the construction of building 125. The remaining sewer line is active. This unit received discharge from building 102 and wash water generated from aircraft maintenance operations conducted in building 121. Wastewater discharged from this unit went to the Sanitary Sewer Line (SWMU No. 98) which ultimately discharged into one of two sewage lagoons (SWMU Nos. 101 and 102).

3.1.3 Past Investigations

In 1987-1988 the Tulsa District Corps of Engineers conducted a study of a number of oil/water separators on the base. The results of analyses performed on the influent and effluent from this separator are found in Cannon Air Force Base Oil/Water Separators Sampling and Analytical Report, June 1988. The following compounds were present in the influent and/or effluent of this oil/water separator: phenol, 4-methylphenol, benzoic acid, toluene, carbon disulfide, benzene, naphthalene, di-n-butylphthalate, bis(2-ehtylhexyl)phthalate, nickel, selenium and lead.



BORING NO.	BORING DEPTH	GROUND ELEV.	COORDINATES	
1	10 FT	4293.79	N1233882.06	E803702.25
2	10 FT	4294.00	N1233892.84	E803715.34
3.	10 FT	4294.00	N1233924.41	E803734.40

Figure 3-1.

3.1.4 Land Use and Demography

SWMU No. 3 is located in an area of the base which is commonly used by base personnel. However, the separator has been removed and the area is currently covered by asphalt.

3.2 Field Investigation

This SWMU area was sampled April 8, 1993 at 1400. The activities at SWMU No. 3 as outlined in the FSP (LRL, 1993) consisted of drilling 3 boreholes, and collecting 6 surface samples, 18 subsurface samples and 6 QA/QC samples. Table 3-1 summarizes the field sampling program at SWMU 3. Table 3-2 summarizes the various samples collected and analyses performed.

3.2.1 Sampling Objectives

Borehole locations, sampling depth, and parameters for analysis were selected, to the greatest extent possible, to determine if a release from the oil/water separator has occurred. All three borehole locations were changed from the FSP due to the presence of utility lines. However, a 6" sewer line which runs parallel to the hanger (Bldg. 108) and to the main line was hit during drilling of borehole 2. This feeder line feeds into the main line down stream from the former oil/water separator. Borehole locations are shown in Figure 3-1.

3.2.2 Surface and Subsurface Soil Investigation

Since this unit was removed some three years prior to drilling, the location of the actual OWS or grease trap could only be approximated, as the actual building it serviced is also gone. The final location of the three boreholes was determined by a senior Civil Engineering shop employee who performs maintenance on the sewer systems. His knowledge of the old system, and his distances paced off from other landmarks were used to select the borehole locations. borehole 1 was drilled southwest of the approximate location, borehole 2 was drilled north of the approximate location, and borehole 3 was drilled northeast of the approximate location. Drilling was advanced to a depth of 10 feet. Samples were collected at the surface, 2.5, 5, and 10 feet in depth. Surface samples were collected with a stainless steel trowel. Subsurface samples were collected with a split barrel continuous sampler. Samples were collected at discrete depths and locations. No composite samples were taken. Samples were analyzed for BTEX, priority metals, and TCL VOC. Duplicates, rinsate blanks, ambient blanks and decontamination water samples were also submitted to the laboratory for this SWMU site. Trip Blanks and Ambient Blanks were inadvertently opened to the air at this site but were still included for analysis.

3.3 Physical Characteristics

This section provides a discussion of the surface water drainage, groundwater, soils, and geology at the No. 108 oil/water separator based on a review of information from previous investigations at Cannon AFB and from the lithologic descriptions from the split barrel continuous sample.

Table 3-1.
Summary of Drilling and Sampling
SWMU No. 3 - Oil/Water Separator No. 108

Borehole Number	Sampling Depth (ft.-BGS)	Drilling/ Sampling Methods	Drillrig Used	Borehole Diameter (in.)	Ground Elevation (ft.-MSL)	Date Grouted
1	0	NA/SSS	NA	NA	429.79	4/9/93
	2.5	HSA/SBC	CM3-75	8.0		
	5.0	HSA/SBC	CM3-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
2	0	NA/SSS	NA	NA	Not Available	4/9/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
3	0	NA/SSS	NA	NA	Not Available	4/9/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		

HSA = Hollow Stem Auger
HA = Hand Auger
NA = Not Applicable
SBC = Split Barrel Continuous Sampler
SS = Split Spoon
SSS = Stainless Steel Spoon

Table 3-2.
Summary of Sampling and Analyses
SWMU No. 3 - Oil/Water Separator No. 108

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
1	0	CAN003-1081-021A	N	Soil	1345	PM	6010/7000S
		CAN003-1081-031A	N	Soil	NA	TCL VOC	8240
	2.5	CAN003-1081-011B	N	Soil	1400	BTEX	8020
		CAN003-1081-022B	N	Soil	1405	PM	6010/7000S
	5.0	CAN003-1081-023C	N	Soil	1405	PM	6010/7000S
		CAN003-1081-032C	N	Soil	1450	TCL VOC	8240
		CAN003-1081-821C	QCD	Soil	1410	PM	6010/7000S
		CAN003-1081-831C	QCD	Soil	1420	TCL VOC	8240
		CAN003-1081-721C	QCD	Soil	1411	PM	6010/7000S
		CAN003-1081-731C	QCD	Soil	1420	TCL VOC	8240
	10.0	CAN003-1081-012D	N	Soil	1425	BTEX	8020
		CAN003-1081-024D	N	Soil	1430	PM	6010/7000S
2	0	CAN003-1082-021A	N	Soil	1433	PM	6010/7000S
		CAN003-1082-031A	N	Soil	1435	TCL VOC	8240
	2.5	CAN003-1082-011B	N	Soil	1445	BTEX	8020
		CAN003-1082-022B	N	Soil	1445	PM	6010/7000S
	5.0	CAN003-1082-023C	N	Soil	1455	PM	6010/7000S
		CAN003-1082-032C	N	Soil	1450	TCL VOC	8240
	10.0	CAN003-1082-012D	N	Soil	1451	BTEX	8020
		CAN003-1082-024D	N	Soil	1455	PM	6010/7000S

Table 3-2. (Concluded)
Summary of Sampling and Analyses
SWMU No. 3 - Oil/Water Separator No. 108

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
3	0	CAN003-1083-021A	N	Soil	1540	PM	6010/7470
		CAN003-1083-031A	N	Soil	1540	TCL VOC	8240
	2.5	CAN003-1083-011B	N	Soil	1600	BTEX	8020
		CAN003-1083-022B	N	Soil	1600	PM	6010/7470
	5.0	CAN003-1083-023C	N	Soil	1605	PM	6010/7470
		CAN003-1083-032C	N	Soil	1605	TCL VOC	8240
	10.0	CAN003-1083-012D	N	Soil	1715	BTEX	8020
		CAN003-1083-024D	N	Soil	1715	PM	6010/7470
		CAN003-1080-431Z	QC	Water	1540	TCL VOC	8240
		CAN003-1080-321Z	QC	Water	1620	PM	6010/7470
		CAN003-1080-331Z	QC	Water	1430	TCL VOC	8240
		CAN003-1080-231Z	QC	Water	1725	TCL VOC	8240
		CAN003-1080-621Z	QC	Water	1520	PM	6010/7470
		CAN003-1080-631Z	QC	Water	1515	TCL VOC	8240

BTEX = Benzene, Toluene, Ethyl Benzene, Xylene
ft-BGS = feet below ground surface
N = Normal soil sample
PM = Priority metals = 8 TCLP metals + Ni
TCL-VOC = Target Compound List Volatile Organic Compound
\+ = Metals analyzed using the 7000 Series include: mercury, selenium, and arsenic.

QAD = Duplicate soil sample (analyzed at different laboratory from normal samples).
QCD = Duplicate soil sample analyzed at same laboratory as normal samples.
QC = Quality control water sample (ambient blank, trip blank, etc.)
TAL Metals = Target analyte list metals

3.3.1 Surface Water Drainage

A topographic/surface drainage map in addition to text found in Installation Restoration Program Records Search, August 1993, prepared by CH_2M Hill indicates that the surface water drainage in the vicinity of SWMU No. 3 enters the Base storm water drainage system and flows to the Stormwater Collection Point (SWMU No. 85). SWMU No. 85 is an ephemeral lake basin (playa) located in the southwest corner of the base.

3.3.2 Groundwater

Depth to groundwater at Cannon AFB is approximately 250 feet or greater. Groundwater recharge rates for the High Plains Region are typically low. Localized recharge rates for Curry County range from 0.75 - 12.22 mm/yr (Stone, 1985). EPA, 1987 DRASTIC reports recharge rates of 1 in/yr. Section 1.4.3.5 of this report includes a discussion of groundwater hydrology for Cannon AFB.

3.3.3 Soils and Geology

The near surface (upper ten feet) stratigraphy in the area surrounding this SWMU consist of Tertiary Miocene to Pliocene fluvial deposits of the Ogallala Formation. The soils have been described as a fine sandy loam (Ab) of the Amarillo soil group (USDA, 1993). Interpretations and correlation on the fluvial deposits for this area are based on samples collected with a split barrel continuous sampler during the drilling process. The soils consist of very fine to coarse-grained, poor to moderately sorted, submature to mature (textural), unconsolidated, calcareous, clays, silts, sands, and gravel. Thin to moderately thin layers of caliche material were interbedded throughout much of the samples collected. The sands were comprised of angular to subangular grains with varying amounts of silts, clays, and calcium carbonate (caliche) material. This description of lithology (Figure 3-2) is similiar to the description of soils given by the USDA Draft Soil Survey, 1993. The thickness of this particular unit remains unknown, due to the fact that boring levels did not exceed ten feet. The total thickness of the Ogallala Formation beneath this SWMU is not presently known, but regional information based on Curry County reports have suggested thicknesses of approximately 320-400 feet. No groundwater was encountered while drilling at these three borehole locations. The minimum depth of the High Plains aquifer is approximately 250 feet below ground surface.

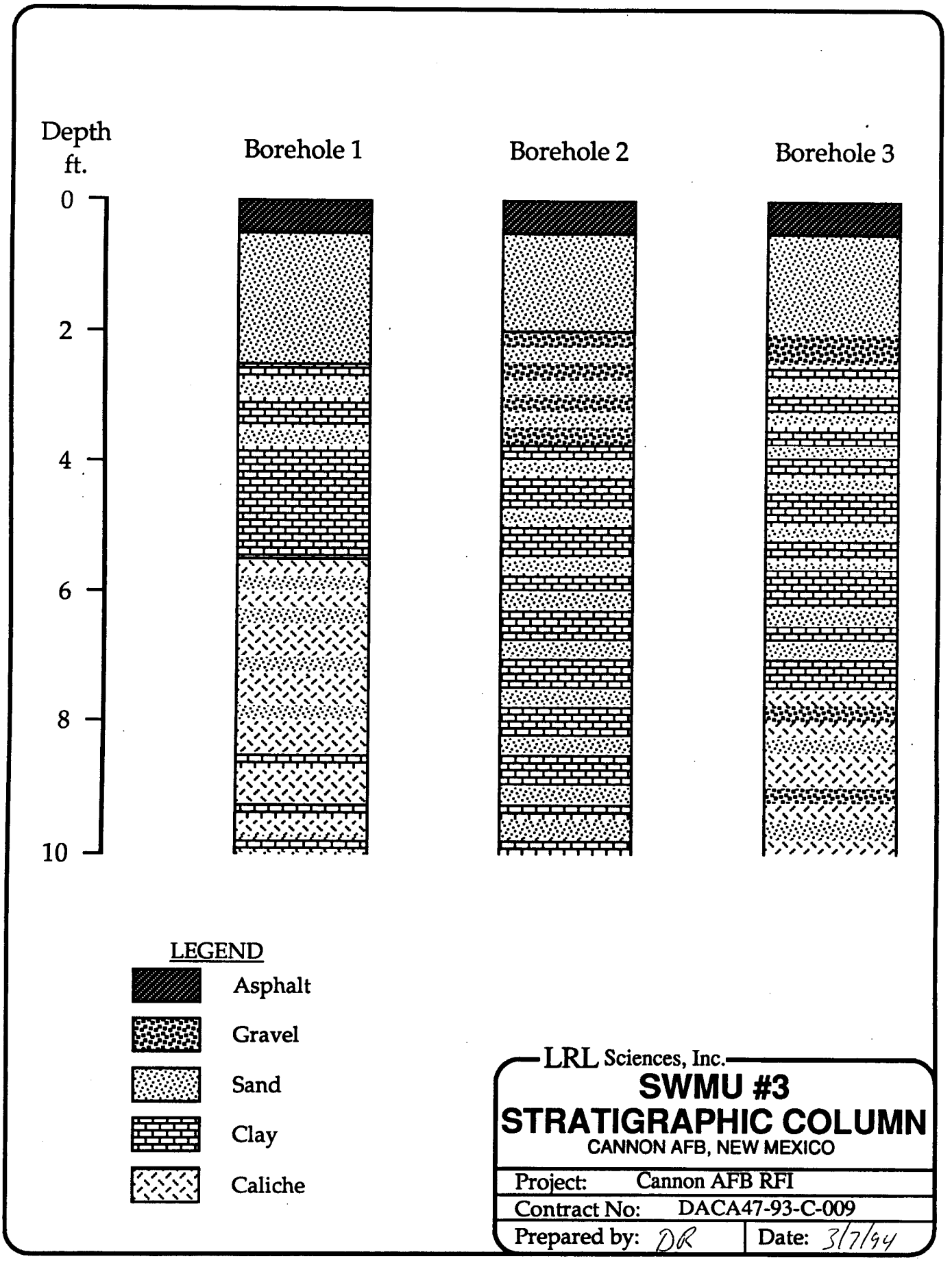

Depth
ft.
0
2
4
6
8
10
Borehole 1
Borehole 2
Borehole 3
LEGEND
Asphalt
Gravel
Sand
Clay
Caliche
LRL Sciences, Inc.
SWMU #3
STRATIGRAPHIC COLUMN
CANNON AFB, NEW MEXICO
Project: Cannon AFB RFI
Contract No: DACA47-93-C-009
Prepared by: DR
Date: 3/7/94

Figure 3-2.

3.4 Nature and Extent of Contamination

3.4.1 Volatile Organic Compounds

A series of HNU meter readings were taken over time at the well head and in the breathing zone of each borehole for the purpose of worker safety. A single positive reading occurred at the well head of borehole 3 in the amount of 3.6 ppm (Table 3-3).

Table 3-3.
HNU Meter* Readings (PPM) in Borehole Headspace
SWMU No. 3 - Oil/Water Separator No. 108

DATE: 4/8/93					
TIME	BH1	TIME	BH2	TIME	BH3
1350	0.0	1436	0.0	1540	0.0
1355	0.0	1440	0.0	1545	0.0
1405	0.0	1455	0.0	1550	3.6
				1706	0.0

* Model: 101, Type: OVA PID, Make: HNU

Samples were collected from three boreholes, at the surface and at 5 feet and analyzed for Target List Compound Volatile Organic Compounds (TCL VOC). Following are the results of these analyses:

3.4.1.1 Borehole 1

In the surface sample (CAN003-1081-031A) toluene was detected below the CRQL (Table 3-4). No other target analyte or TIC compound was detected.

At 5 feet, no target analytes or TIC compounds were detected. The QA and QC duplicate samples were taken in association with this sample. The QC duplicate (CAN003-1081-831C), which was analyzed at the same lab, contained acetone, the concentration of which is an estimate since continuing calibration %D was above QC limits and because it is below the CRQL. The QA sample contained acetone, methylene chloride and 2-butanone. The prevalence of methylene chloride and acetone in all, or nearly all, of the QA lab samples suggests that they may be laboratory contaminants and they were therefore rejected. Since 2-butanone is a common laboratory contaminant and did not occur at the QC laboratory, it was also rejected.

3.4.1.2 Borehole 2

In borehole 2, no target compounds or TIC compounds were detected at the surface or at 5 feet.

Table 3-4.
Concentration (μg/kg) of Volatile Organic Compounds
SWMU No. 3 - Oil/Water Separator No. 108

BOREHOLE NUMBER	CANNON NUMBER	DEPTH (ft.)	CHEMICAL	
			TOLUENE	ACETONE
1	CAN003-1081-031A	Surface	8J	11UJ
	CAN003-1081-032C	5.0	11U	11UJ
	CAN003-1081-831C	5.0		8J (QCD)
2	CAN003-1082-031A	Surface	11U	11UJ
	CAN003-1082-032C	5.0	11U	11UJ
3	CAN003-1083-031A	Surface	11UJ	11UJ
	CAN003-1083-032C	5.0	11U	11UJ

Duplicate samples or laboratory repeat samples are presented only if they are different from the original sample and not rejected.

J = estimate
R = rejected
U = not detected at CRQL
UJ = estimated as non-detect at CRQL
QCD = duplicate analyzed at the same lab as normal sample.

3.4.1.3 Borehole 3

In borehole 3, the surface sample and a laboratory repeat analysis of this sample contained no target compounds or TIC compounds. The laboratory repeated the analysis due to low internal standard recoveries.

At 5 feet, no target analytes or TIC compounds were detected.

3.4.2 BTEX

In each borehole, 2 samples were collected for BTEX analysis at 2.5 and 10 feet of depth. Following are the results of these analyses:

No BTEX compounds were detected in any of the samples. QA/QC duplicate samples were not collected and therefore analyses for BTEX was not performed.

3.4.3 Priority Metals

Total metals concentrations, using the RCRA SW-846 test methods for the analysis of metals in soils, were determined for the eight TCLP metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) plus nickel. These are the priority metals. Samples were collected for priority metals analyses at the surface, 2.5, 5 and 10 feet.

In the following presentation of metals results, only metals concentrations in excess of background concentrations are presented. No background data was collected for this investigation, therefore, background concentrations were taken from Concentrations of Selected Naturally Occurring Chemical Constituents in Soil and Groundwater at Cannon Air Force Base Clovis, New Mexico, March 1993 prepared by Woodward-Clyde. For a discussion of Woodward-Clydes background data see Section 1.7.

3.4.3.1 Borehole 1

In the surface sample (CAN003-1081-021A), chromium was detected at 17.8 mg/kg (Table 3-5). This value is an estimate since matrix spike recovery was not within control limits.

At 2.5, 5 and 10 feet no priority metals were detected above background. The QC duplicate, collected at 5 feet and analyzed at the same lab as the normal sample contained no priority metals above background. The QA duplicate (CAN003-1081-721C), which was analyzed at a different lab, contained nickel at 10.3 mg/kg and mercury at 0.15 mg/kg. Background values for these two metals are 9.0 and 0.13 mg/kg, respectively.

3.4.3.2 Borehole 2

In the surface sample (CAN003-1082-021A), nickel was detected at 9.2 mg/kg. This value is an estimate since the Laboratory Control Sample %R were not within control limits.

At 2.5 feet (CAN003-1082-022B), nickel was detected at 9.6 mg/kg. This value is an estimate since the Laboratory Control Sample %R were not within control limits.

No priority metals, above background, were detected in the 5 feet samples.

At 10 feet (CAN003-1082-024D), barium was detected at 816 mg/kg.

3.4.3.3 Borehole 3

In the surface sample (CAN003-1083-021A), chromium was detected at 16.4 mg/kg. This value is an estimate since matrix spike recovery was not within control limits.

No priority metals were detected above background at 2.5 or 5 feet.

At 10 feet (CAN003-1083-024D), barium was detected at 753 mg/kg.

3.4.4 Summary of Data

In borehole 1, toluene and chromium were detected in low concentrations only at the surface. At 5 feet, acetone, nickel, and mercury were detected in low concentrations. In boreholes 2 and 3, no organics were detected. In borehole 2, nickel was detected at the surface and at 2.5 feet. Barium was detected at 10 feet. In borehole 3, chromium was detected at the surface and barium at 10 feet. All subsurface metals concentrations were marginally above background.

Table 3-5.
Concentration (mg/kg) of Priority Metals
SWMU No. 3 - Oil/Water Separator No. 108

Borehole Number	Sample Number (CAN003-108)	Sample Depth (feet)	Barium	Chromium	Mercury	Nickel	Silver
1	1-021A	0	614	**17.8** J	0.01 U	8.1	1.6
	1-022B	2.5	70.4	10.7 J	0.02 U	7.3 J	0.85 U
	1-023C	5	63.6	6.2 J	0.02 U	7.5 J	0.93 U
(QAD)	1-721C	5	112	**10.2**	**0.15**	**10.3**	0.41 U
(QCD)	1-821C	5	80.9	8.5 J	0.02 U	8.3 J	0.93 U
	1-024D	10	54.3	4.8 J	0.1 U	4.8 J	0.92 U
2	2-021A	0	483	6.1 J	0.01 U	**9.2** J	**21.1** U
	2-022B	2.5	101	7.2 J	0.02 U	**9.6** J	0.93 U
	2-023C	5	91.8	6.5 J	0.01 U	6.9 J	0.89 U
	2-024D	10	**816**	3 J	0.01 U	4.4 J	0.88 U
3	3-021A	0	632	**16.4** J	0.01 U	7.5	1
	3-022B	2.5	196	7.7 J	0.02 U	6.8	0.92 U
	3-023C	5	66.5	5.9 J	0.03 U	8.5	0.95 U
	3-024D	10	**753**	2.7 J	0.02 U	4.4	0.98
Background (95% UCL) (1)			642.00	12.50	0.13	9.00	2.20

NOTES:

Duplicate samples (QAD) or (QCD) samples are presented only if they are different from the original sample and not rejected.

U indicates that the compound was analyzed for, but not detected at or above the standard limit.
J indicates and estimated value.
UJ indicates the compound was analyzed for but not detected. The sample quantification limit or reported detection limit is an estimated quantity.
*R indicates that the data was rejected because of quality control measures.

Boldface indicates a detection above the 95% UCL background level.

Only data for metals detected above background is presented.

(1) Background data is described in Section 1.7.

3.5 Recommendations

Concentrations of organics and metals found in soils around the former location of the SWMU are low and generally diminishing with depth. Groundwater level is deep at approximately 250 feet below ground surface. In addition, the risk assessment information associated with this SWMU indicates minimal or no risk to human health or the environment. Therefore, no further action is recommended.

4.0 OIL/WATER SEPARATOR (SWMU NO. 5/SITE NO. 121)

4.1 SWMU Description

4.1.1 Setting

This oil/water separator (OWS) or grease trap, No. 121, was located on the west side of Hangar 121. Everything associated with Hangar 121, including this unit was removed. No drawings can be found that detail what this unit actually was. The unit could have been an OWS or simply a single compartment grease trap. Two other WWII era hangers of the same design, hangars 129 and 170 , also have units previously identified as oil/water separators but are actually single compartment sand traps or grease traps. The unit was approximately 8 feet west, and 80 feet south of the NW corner of the new facility, building 126. The construction material was believed to be concrete. The entire area is now covered with asphalt. The exact location of this unit is unknown. boreholes were aligned exterior to the sewer line. The driller was required to penetrate and restore the surface with a concrete plug. Figure 4-1 shows the SWMU setting and borehole locations.

4.1.2 History of Use

This unit was active from 1943 until it was demolished around 1990. It received waste water from buildings 102 and 125. The unit also received wash water generated from aircraft maintenance operations conducted in building 121. The waste water was discharged to the Sanitary Sewer Line (SWMU No. 98).

4.1.3 Past Investigations

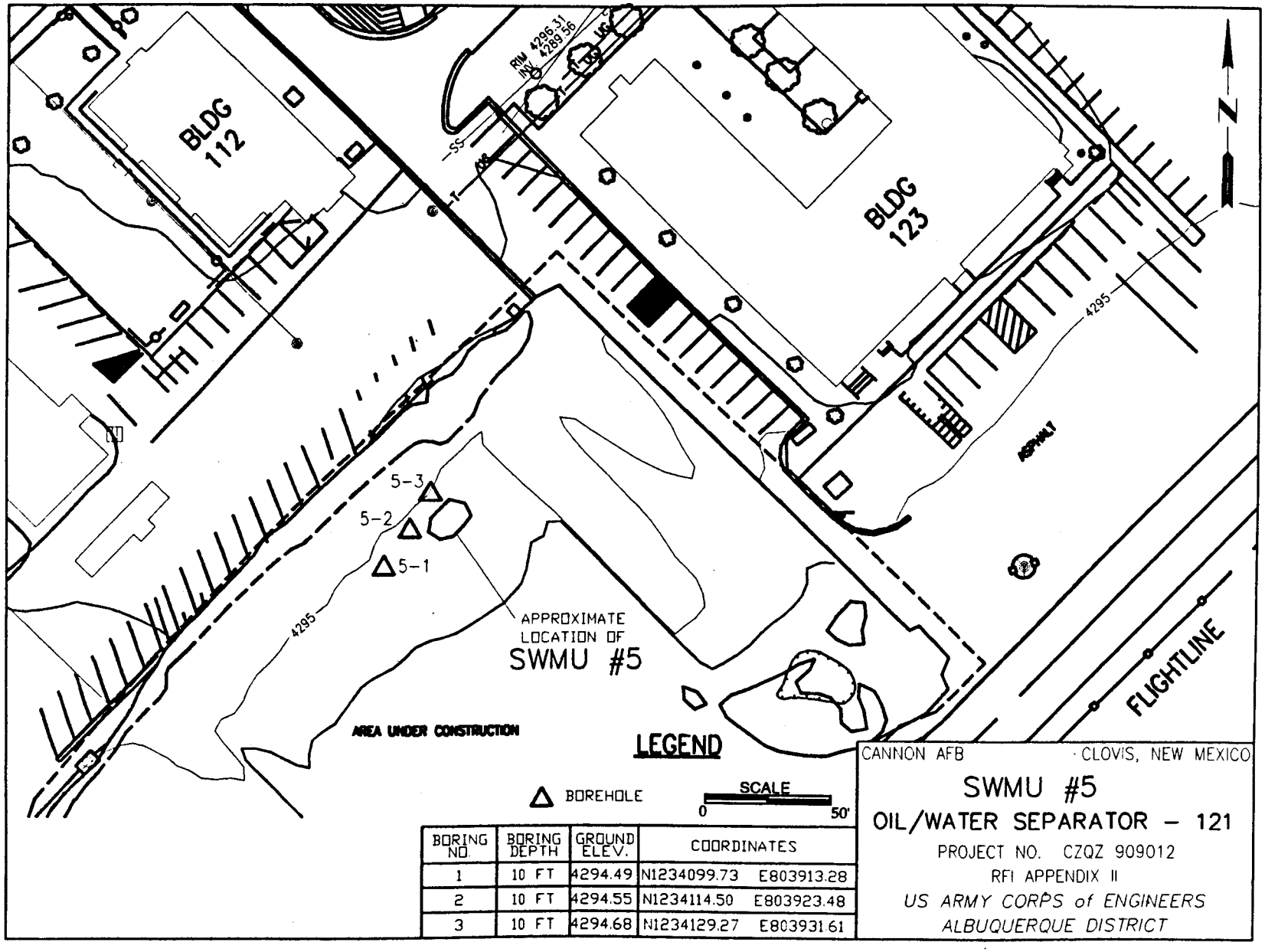
In 1987-1988 the Tulsa District Corps of Engineers sampled this and other oil/water separators at Cannon AFB. The results of this study were reported in Cannon Air Force Base Oil/Water Separators Sampling and Analytical Report, June, 1988. The results of this study indicated the presence of metals and organics in the liquid phase influent and/or effluent. The compounds found in either the influent, effluent or both include: lead, nickel and bis(2-ethylhexyl)phthalate.

4.1.4 Land Use and Demography

This SWMU is in an area of the base commonly used by base personnel. However, this unit was removed and the area is now covered by asphalt.

4.2 Field Investigation

This SWMU was sampled April 9, 1993 at 1300. The activities at SWMU No. 5 as outlined in the FSP (LRL, 1993) consisted of drilling 3 boreholes, collecting 6 surface samples, 18 subsurface samples, 4 QA/QC duplicate samples and 6 QA/QC water samples. Table 4-1 summarizes the field sampling program at SWMU 5. Table 4-2 summarizes the various samples collected and analyses performed.



BORING NO.	BORING DEPTH	GROUND ELEV.	COORDINATES	
1	10 FT	4294.49	N1234099.73	E803913.28
2	10 FT	4294.55	N1234114.50	E803923.48
3	10 FT	4294.68	N1234129.27	E803931.61

Figure 4-1.

Table 4-1.
Summary of Drilling and Sampling
SWMU No. 5 - Oil/Water Separator No. 121

Borehole Number	Sampling Depth (ft.-BGS)	Drilling/ Sampling Methods	Drillrig Used	Borehole Diameter (in.)	Ground Elevation	Date Grouted
1	0	NA/SSS	NA	NA	4294.49	4/09/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
2	0	NA/SSS	NA	NA	4294.55	4/09/93
	2.5	HSA/SSS	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
3	0	NA/SSS	NA	NA	42.9468	4/09/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		

HSA = Hollow Stem Auger
HA = Hand Auger
SBC = Split Barrel Continuous Sampler
SS = Split Spoon
SSS = Stainless Steel Spoon

Table 4-2.
Summary of Sampling and Analyses
SWMU No. 5 - Oil/Water Separator No. 121

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
1	0	CAN005-1211-021A	N	SOIL	1310	PM	6010\7000S+
		CAN005-1211-031A	N	SOIL	1310	TCL VOC	8240
	2.5	CAN005-1211-011B	N	SOIL	1320	BTEX	8020
		CAN005-1211-022B	N	SOIL	1320	PM	6010\7000S
	5.0	CAN005-1211-012C	N	SOIL	1325	BTEX	8020
		CAN005-1211-023C	N	SOIL	1325	PM	6010\7000S
	10.0	CAN005-1211-024D	N	SOIL	1330	PM	6010\7000S
		CAN005-1211-032D	N	SOIL	1330	TCL VOC	8240
2	0	CAN005-1212-021A	N	SOIL	1345	PM	6010\7000S
		CAN005-1212-031A	N	SOIL	1345	TCL VOC	8240
	2.5	CAN005-1212-011B	N	SOIL	1355	BTEX	8020
		CAN005-1212-022B	N	SOIL	1355	PM	6010\7000S
	5.0	CAN005-1212-012C	N	SOIL	1400	BTEX	8020
		CAN005-1212-023C	N	SOIL	1400	PM	6010\7000S
	10.0	CAN005-1212-024D	N	SOIL	1405	PM	6010\7000S
		CAN005-1212-032D	N	SOIL	1405	TCL VOC	8240
3	0	CAN005-1213-021A	N	SOIL	1440	PM	6010\7000S
		CAN005-1213-031A	N	SOIL	1440	TCL VOC	8240
	2.5	CAN005-1213-011B	N	SOIL	1445	BTEX	8020
		CAN005-1213-022B	N	SOIL	1445	PM	6010\7000S

Table 4-2. (Concluded)
Summary of Sampling Analyses
SWMU No. 5 - Oil/Water Separator No. 121

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
		CAN005-1210-431Z	QC	WATER	1530	TCL VOC	8240
		CAN005-1210-321Z	QC	WATER	1545	PM	6010\7000S
		CAN005-1210-331Z	QC	WATER	1550	TCL VOC	8240
		CAN005-1210-231Z	QC	WATER	1540	TCL VOC	8240
		CAN005-1210-621Z	QC	WATER	1545	PM	6010\7000S
		CAN005-1210-631Z	QC	WATER	1550	TCL VOC	8240

BTEX = Benzene, Toluene, Ethyl Benzene, Xylene
ft-BGS = feet below ground surface
N = Normal soil sample
PM = Priority metals = 8 TCLP metals + Ni
TCL VOC = Target Compound List Volatile Organic Compound
+ = Metals analyzed using the 7000 Series include: mercury, selenium, and arsenic.

QAD = Duplicate soil sample (analyzed at different laboratory from normal samples).
QCD = Duplicate soil sample analyzed at same laboratory as normal samples.
QC = Quality control water sample (ambient blank, trip blank, etc.)
TAL Metals = Target analyte list metals

4.2.1 Sampling Objectives

Borehole locations, sampling depth, and parameters for analysis were selected, to the greatest extent possible, to determine if a release from this unit has occurred. Boreholes 1 and 3 were moved from the original FSP locations in order to place them exterior to the sewer line. Borehole locations are shown in Figure 4-1.

4.2.2 Surface and Subsurface Soil Investigation

This unit was removed some three years prior to drilling, therefore, the location of the actual OWS or grease trap could only be approximated, as the actual building it serviced is also gone. The final location of the three boreholes was determined by a senior Civil Engineering shop employee who performs maintenance on the sewer systems. His knowledge of the old system, and his distances paced off from other landmarks was used to select the borehole locations. Borehole 1 was drilled southwest of the approximate location, borehole 2 was drilled west of the approximate location, and borehole 3 was drilled north of the approximate location. Drilling was advanced to a depth of 10 feet. Samples were collected at the surface, 2.5, 5 and 10 feet in depth. Surface samples were collected using a stainless steel trowel and subsurface samples were collected with a split barrel continuous sampler. Samples were collected at discrete depths and locations. No composite samples were taken. Samples were analyzed for BTEX, priority metals and TCL VOCs. Duplicates, rinsate blanks, ambient blanks, decontamination water, and trip blanks were also submitted to the laboratory for this SWMU.

4.3 Physical Characteristics

This section provides a discussion of the surface water drainage, groundwater, and soils and geology at the No. 121 oil/water separator or grease trap based on a review of information from previous investigations at Cannon AFB and from the lithologic descriptions from a split barrel continuous sampler.

4.3.1 Surface Water Drainage

A topographic/surface drainage map in addition to text found in Installation Restoration Program Records Search, August 1983 prepared by CH_2M Hill indicates that the surface water drainage in the vicinity of SWMU No. 5 enters the base storm water drainage system and flows to the Stormwater Collection Point (SWMU No. 85). SWMU No. 85 is an ephemeral lake basin (playa) located in the southwest corner of the base.

4.3.2 Groundwater

Depth to groundwater at Cannon AFB is approximately 250 feet or greater. Groundwater recharge rates for the High Plains Region are typically low. Localized recharge rates for Curry County range from 0.75 - 12.22 mm/yr (Stone, 1985). EPA, 1987 DRASTIC reports recharge rates of 1 in/yr. Section 1.4.3.5 of this report includes a discussion of groundwater hydrology for Cannon AFB.

4.3.3 Soils and Geology

The near surface (upper ten feet) stratigraphy in the area surrounding this SWMU consist of Tertiary Miocene to Pliocene fluvial deposits of the Ogallala Formation. The soils have been described as a fine sandy loam (Ab) of the Amarillo soil group (USDA, 1993). Interpretations and correlation on the fluvial deposits for this area are based on samples collected with a split barrel continuous sampler during the drilling process. The soils consist of very fine to fine-grained, moderately sorted, submature to mature (textural), unconsolidated, calcareous, dark red, clays, silts, and sands. Thin to moderately thin layers of caliche material were interbedded throughout much of the samples collected. The sands were comprised of angular to subangular grains with varying amounts of silts, clays, and calcium carbonate (caliche) material. This description of lithology (Figure 4-2) is similiar to the description of soils given by the USDA Draft Soil Survey, 1993. The thickness of this particular unit remains unknown, due to the fact that boring levels did not exceed ten feet. The total thickness of the Ogallala Formation beneath this SWMU is not presently known, but regional information based on Curry County reports have suggested thicknesses of approximately 320-400 feet. No groundwater was encountered while drilling at these three borehole locations. The minimum depth of the High Plains aquifer is reported to be greater than 250 feet below ground surface.

4.4 Nature and Extent of Contamination

4.4.1 Volatile Organic Compounds

A series of HNU meter readings were taken at each of the boreholes in the well head and in the breathing zone for the purpose of worker safety. Borehole 1 contained a single reading of 0.6 ppm (Table 4-3) at the wellhead.

Table 4-3.
HNU Meter* Readings (PPM) in Borehole Headspace
SWMU No. 5 - Oil/Water Separator No. 121

DATE: 4/ /93					
TIME	BH1	TIME	BH2	TIME	BH3
1317	0.0	1340	0.0	1439	0.0
1324	0.0	1344	0.0	1444	0.0
1330	0.6	1350	0.0	1447	0.0

* Model: 101, Type: OVA PID, Make: HNU

Samples were collected from three boreholes at the surface and at 10 feet and analyzed for Target List Compound Volatile Organic Compounds (TLC VOC). Following are the results of these analyses.

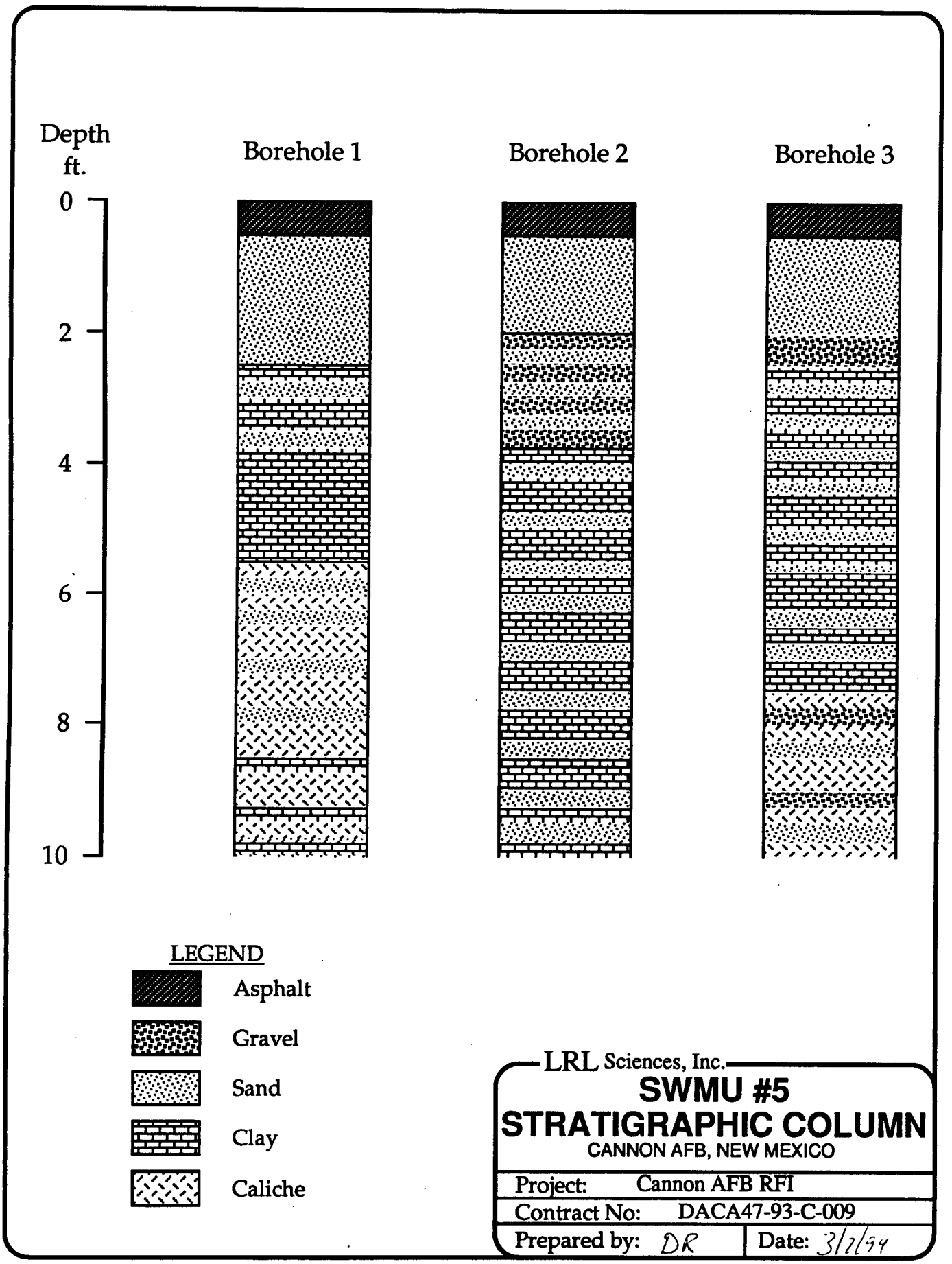

Depth
ft.
0
2
4
6
8
10
Borehole 1
Borehole 2
Borehole 3
LEGEND
Asphalt
Gravel
Sand
Clay
Caliche
LRL Sciences, Inc.
SWMU #5
STRATIGRAPHIC COLUMN
CANNON AFB, NEW MEXICO
Project: Cannon AFB RFI
Contract No: DACA47-93-C-009
Prepared by: DR
Date: 3/2/94

Figure 4-2.

4.4.1.1 Borehole 1

In borehole 1, no target compounds or TIC compounds were detected in the surface sample or at 10 feet.

4.4.1.2 Borehole 2

In borehole 2, the surface sample contained no target compounds or TIC compounds.

The sample at 10 feet (CAN005-1212-032D) contained acetone at 14 μg/kg (Table 4-4). The acetone concentration is considered an estimate since continuing calibration %D exceeded QC limits. One TIC compound was detected with the 10 foot sample.

Table 4-4.
Concentration (μg/kg) of Volatile Organic Compounds
SWMU No. 5 - Oil/Water Separator No. 119

Borehole Number	Cannon Number	Depth (ft.)	Chemical: Acetone
1	CAN005-1211-031A	Surface	11UJ
	CAN005-1211-032D	10.0	12UJ
2	CAN005-1212-031A	Surface	11UJ
	CAN005-1212-032D	10.0	14J
3	CAN005-1213-031A	Surface	11UJ
	CAN005-1213-032D	10.0	11UJ
	CAN005-1213-831D	10.0	16J (QCD)

Duplicate samples or laboratory repeat samples are presented only if they are different from the original sample and not rejected.

J = estimate
R = rejected
U = not detected at CRQL
UJ = estimated as non-detect at CRQL
QCD = duplicate analyzed at same lab as normal sample.

4.4.1.3 Borehole 3

In borehole 3, the surface sample contained no target compounds or TIC compounds.

The sample at 10 feet contained no target compounds or TIC compounds. One duplicate pair was collected in association with this sample. The QC duplicate (CAN005-1213-831D), analyzed at the same lab as the original sample, contained acetone at 16 μg/kg. This value is an estimate since continuing calibration %D exceeded QC limits. The QA duplicate, analyzed at a different

lab from the original sample, contained acetone and methylene chloride. However, in nearly all the samples analyzed at the QA laboratory contained these compounds, they were rejected as laboratory contaminants. No other target analytes or TIC compounds were detected.

4.4.2 BTEX

In each borehole, 2 samples were collected for BTEX analysis at 2.5 and 5 feet of depth. No BTEX compounds were detected in any of the samples. QA/QC duplicate samples were not collected for BTEX and therefore no analyses were performed.

4.4.3 Priority Metals

Total metals concentrations, using the RCRA SW-846 test methods for the analysis of metals in soils, were determined for the eight TCLP metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) plus nickel. These are the priority metals. Samples were collected for priority metals analysis at the surface, 2.5, 5, and 10 feet.

In the following presentation of metals results, only metals concentrations in excess of background concentrations are presented. No background data was collected for this investigation, therefore, background concentrations were taken from Concentrations of Selected Naturally Occurring Chemical Constituents in Soil and Groundwater at Cannon Air Force Base Clovis, New Mexico, March 1993 prepared by Woodward-Clyde. For a discussion of Woodward-Clydes background data see Section 1.7.

4.4.3.1 Borehole 1

No priority metals were detected above background in the surface sample of borehole 1.

At 2.5 feet (CAN005-1211-022B), nickel was detected at 10.10 mg/kg (Table 4-5). Background for nickel is 9.0 mg/kg.

No priority metals were detected above background at 5 and 10 feet.

4.4.3.2 Borehole 2

No priority metals were detected above background in the surface sample of borehole 2.

At 2.5 feet (CAN005-1212-022B), nickel was detected at 12.7 mg/kg.

No priority metals were detected above background in the sample collected at 5 feet.

At 10 feet (CAN005-1212-024D), nickel was detected at 10.1 mg/kg.

Table 4-5.
Concentration (mg/kg) of Priority Metals
SWMU No. 5 - Oil/Water Separator No. 121

Borehole Number	Sample Number (CAN005-121)	Sample Depth (feet)	Barium	Mercury		Nickel	
1	1-021A	0	341	0.1	U	7.3	
	1-022B	2.5	68.5	0.1	U	**10.1**	
	1-023C	5	90.3	0.1	U	6.5	
	1-024D	10	37.9	0.1	U	7.6	
2	2-021A	0	357	0.1	U	6	UJ
	2-022B	2.5	60.9	0.1	U	**12.7**	
	2-023C	5	118	0.1	U	7.4	
	2-024D	10	344	0.1	U	**10.1**	
3	3-021A	0	337	0.1	U	6.6	
	3-022B	2.5	65.4	0.1	U	**9.9**	
	3-023C	5	73.1	0.1	U	7.7	
	3-024D	10	597	0.1	U	5.9	
(QAD)	3-721D	10	**749**	**0.2**		8.1	
(QCD)	3-821D	10	**714**	0.1	U	5.2	
Background (95% UCL) (1)			642.00	0.13		9.00	

NOTES:

Duplicate samples (QAD) or (QCD) samples are presented only if they are different from the original sample and not rejected.

U indicates that the compound was analyzed for, but not detected at or above the standard limit.
J indicates and estimated value.
UJ indicates the compound was analyzed for but not detected. The sample quantification limit or reported detection limit is an estimated quantity.
*R indicates that the data was rejected because of quality control measures.

Boldface indicates a detection above the 95% UCL background level.

Only data for metals detected above background is presented.

(1) Background data is described in Section 1.7.

4.4.3.3 Borehole 3

No priority metals were detected above background in the surface sample.

At 2.5 feet (CAN005-1213-022B), nickel was detected at 9.9 mg/kg.

At 10 feet no priority metals were detected above background. The QA/QC duplicates were collected at this depth. The QC duplicate (CAN005-1213-821D), analyzed at the same lab as the normal sample, contained barium at 714 mg/kg. The QA duplicate (CAN005-1213-721D), analyzed at a different lab than the normal sample, also contained barium at 749 mg/kg and mercury at 0.2 mg/kg. Background for these metals is 642 and 0.13 mg/kg respectively.

4.4.4 Summary of Data

No VOCs or metals above background were detected in any of the surface samples for the three boreholes. Nickel was detected marginally above background in all three boreholes at 2.5 feet. Borehole 2 contained nickel and acetone at 10 feet, both in low concentrations. Borehole 3 contained acetone, barium, and mercury at 10 feet, all in low concentrations.

4.5 Recommendations

Concentrations of organics and metals found in soils around the former location of the SWMU are low and generally diminishing with depth. Groundwater level is deep at approximately 250 feet below ground surface. In addition, the risk assessment information associated with this SWMU indicates minimal or no risk to human health or the environment. Therefore, no further action is recommended.

5.0 OIL WATER SEPARATOR (SWMU NO. 7/SITE NO. 129)

5.1 SWMU Description

5.1.1 Setting

SWMU No. 7 is a grease trap or sand trap which has previously been misidentified as an oil/water separator. It is located on the northwest side of Building 129, approximately 33 feet east of the NW corner. The trap is a one-compartment underground unit. The unit is constructed of concrete. Access to the unit is a six inch diameter opening used for sampling and pumping out the unit's contents. It is covered on all sides by asphalt. The depth of the unit is unknown. Borehole locations were selected, in part, to avoid underground sewer, TV cable and electrical lines. The driller was required to penetrate the asphalt and restore the surface with a concrete plug. Setting and borehole locations are provided in Figure 5-1.

5.1.2 History of Use

The trap at facility 129 has been active since 1943 and is still in use. The unit receives wastewater from building 129. The unit discharges to the Sanitary Sewage Line (SWMU No. 98). The unit receives washwater generated from aircraft maintenance operations which contains petroleum, synthetic lubricating oils, and dirt.

5.1.3 Past Investigations

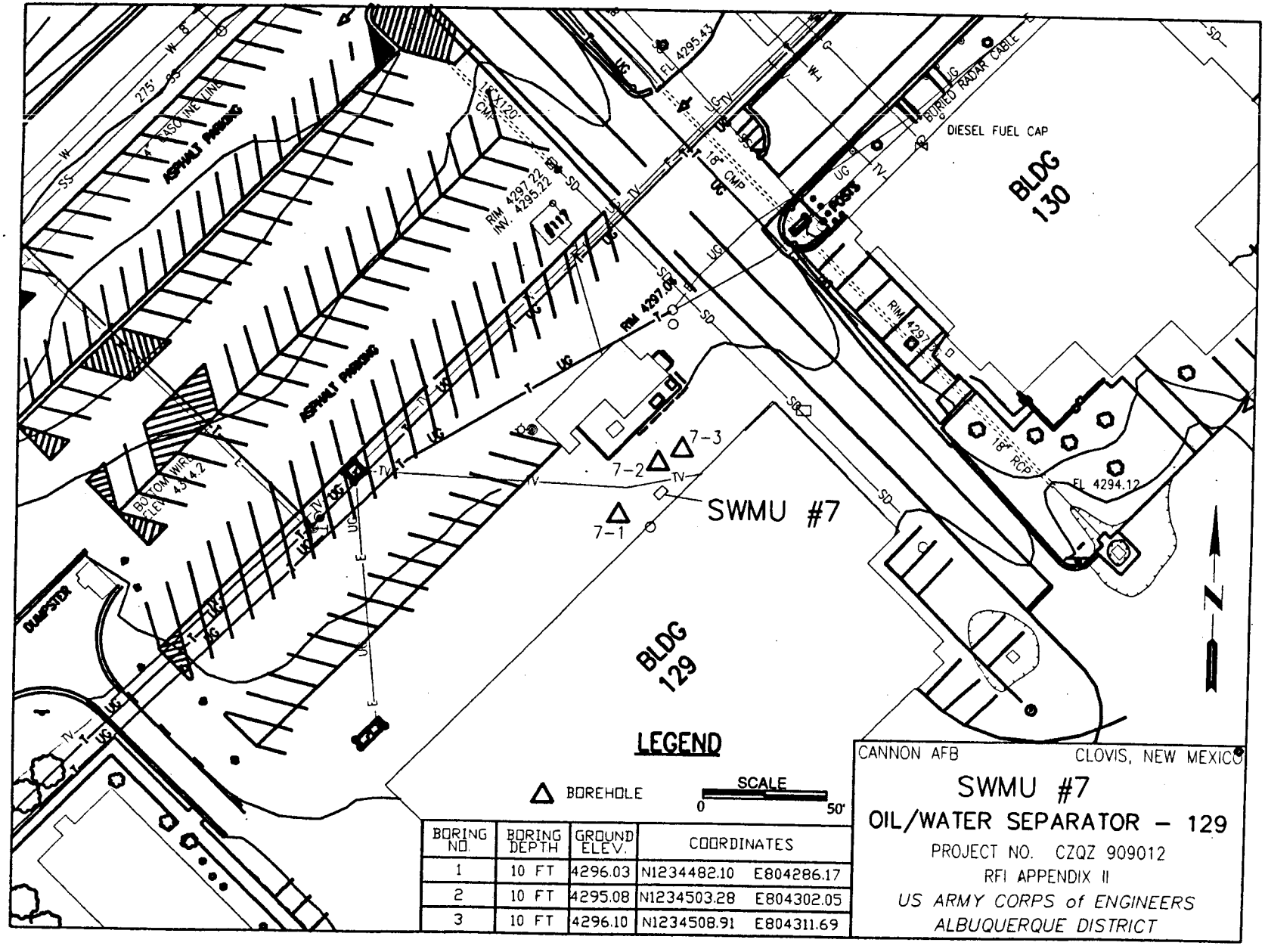
In 1987-1988 the Tulsa District Corps of Engineers sampled this and other oil/water separators at Cannon AFB. The results of this study were reported in Cannon Air Force Base Oil/Water Separators Sampling and Analytical Report, June, 1988. The results of this study indicated the presence of metals and organics in the liquid phase influent and/or effluent. The compounds found include: benzene, toluene, ethylbenzene, xylene, 2-hexanone, lead, cadmium, 2-methylnaphthalene, and several phthalates in the influent/effluent of this separator.

5.1.4 Land Use and Demography

This SWMU is located in an area of the base which is commonly used by base personnel. However, this SWMU is underground and presently covered by asphalt.

5.2 Field Investigation

SWMU 7 was sampled April 9, 1993 at 0830. The activities at this unit, as outlined in the FSP (LRL, 1993), consisted of drilling 3 boreholes, collecting 6 surface samples, 18 subsurface samples, 4 QA/QC duplicate samples and 6 QA/QC water samples. Table 5-1 summarizes the field sampling program at SWMU 7. Table 5-2 summarizes the various samples collected and analyses performed.



BORING NO.	BORING DEPTH	GROUND ELEV.	COORDINATES	
1	10 FT	4296.03	N1234482.10	E804286.17
2	10 FT	4295.08	N1234503.28	E804302.05
3	10 FT	4296.10	N1234508.91	E804311.69

Figure 5-1.

Table 5-1.
Summary of Drilling and Sampling
SWMU No.7 - Oil/Water Separator No. 129

BOREHOLE NUMBER	SAMPLING DEPTH (ft.-BGS)	DRILLING/ SAMPLING METHODS	DRILLRIG USED	BOREHOLE DIAMETER (in.)	GROUND ELEVATION	DATE GROUTED
1	0	NA/SSS	NA	NA	4296.03	4\09\93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
2	0	NA\SSS	NA	NA	4295.08	4/09/93
	2.5	HSA\SBC	CME-75	8.0		
	5.0	HSA\SBC	CME-75	8.0		
	10.0	HSA\SBC	CME-75	8.0		
3	0	NA\SSS	NA	NA	4296.10	4/09/93
	2.5	HSA\SBC	CME-75	8.0		
	5.0	HSA\SBC	CME-75	8.0		
	10.0	HSA\SBC	CME-75	8.0		

HSA = Hollow Stem Auger
HA = Hand Auger
SBC = Split Barrel Continuous Sampler
SS = Split Spoon
SSS = Stainless Steel Spoon

Table 5-2.
Summary of Sampling and Analyses
SWMU No. 7 - Oil/Water Separator No. 129

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
1	0	CAN007-1291-021A	N	SOIL	0850	PM	6010\7000S+
		CAN007-1291-031A	N	SOIL	0850	TCL VOC	8240
	2.5	CAN007-1291-011B	N	SOIL	0910	BTEX	8020
		CAN007-1291-022B	N	SOIL	0910	PM	6010\7000S
	5.0	CAN007-1291-023C	N	SOIL	0915	PM	6010\7000S
		CAN007-1291-032C	N	SOIL	0915	TCL VOC	8240
		CAN007-1291-821C	QCD	SOIL	0915	PM	6010\7000S
		CAN007-1291-831C	QCD	SOIL	0915	TCL VOC	8240
		CAN007-1291-721C	QAD	SOIL	0915	PM	6010\7000S
		CAN007-1291-731C	QAD	SOIL	0915	TCL VOC	8240
	10.0	CAN007-1291-012D	N	SOIL	0920	BTEX	8020
		CAN007-1291-024D	N	SOIL	0920	PM	6010\7000S
2	0	CAN007-1292-021A	N	SOIL	0950	PM	6010\7000S
		CAN007-1292-031A	N	SOIL	0950	TCL VOC	8240
	2.5	CAN007-1292-011B	N	SOIL	1005	BTEX	8020
		CAN007-1292-022B	N	SOIL	1007	PM	6010\7000S
	5.0	CAN007-1292-023C	N	SOIL	1015	PM	6010\7000S
		CAN007-1292-032C	N	SOIL	1015	TCL VOC	8240
	10.0	CAN007-1292-012D	N	SOIL	1017	BTEX	8020
		CAN007-1292-024D	N	SOIL	1017	PM	6010\7000S

Table 5-2. (Concluded)
Summary of Sampling and analyses
SWMU No. 7 - Oil/Water Separator No. 129

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
3	0	CAN007-1293-021A	N	SOIL	1035	PM	6010/7000S
		CAN007-1293-031A	N	SOIL	1035	TCL VOC	8240
	2.5	CAN007-1293-011B	N	SOIL	1100	BTEX	8020
		CAN007-1293-022B	N	SOIL	1100	PM	6010/7000S
	5.0	CAN007-1293-023C	N	SOIL	1107	PM	6010/7000S
		CAN007-1293-032C	N	SOIL	1105	TCL VOC	8240
	10.0	CAN007-1293-012D	N	SOIL	1107	BTEX	8020
		CAN007-1293-024D	N	SOIL	1110	PM	6010/7000S
		CAN007-1290-431Z	QC	WATER	1125	TCL VOC	8240
		CAN007-1290-321Z	QC	WATER	1130	PM	6010/7000S
		CAN007-1290-331Z	QC	WATER	1123	TCL VOC	8240
		CAN007-1290-231Z	QC	WATER	1120	TCL VOC	8240
		CAN007-1290-621Z	QC	WATER	1130	PM	6010/7000S
		CAN007-1290-631Z	QC	WATER	1123	TCL VOC	8240-

BTEX = Benzene, Toluene, Ethyl Benzene, Xylene
ft-BGS = feet below ground surface
N = normal soil sample
PM = Priority metals = 8 TCLP metals + Ni
TCL VOC = Target Compound List Volatile Organic Compounds
\+ = Metals analyzed using the 7000 Series include: mercury, selenium, and arsenic.

QAD = Duplicate soil sample (analyzed at different laboratory from normal samples).
QCD = Duplicate soil sample analyzed at same laboratory as normal samples.
QC = Quality control water sample (ambient blank, trip blank, etc.)
TAL Metals = Target analyte list metals

5.2.1 Sampling Objectives

Borehole locations, sampling depth, and parameters for analysis were selected, to the greatest extent possible, to determine if a release from the oil/water separator has occurred. Borehole 1 was moved from its original FSP location due to utility lines and restricted space considerations. Borehole locations are shown in Figure 5-1.

5.2.2 Surface and Subsurface Soil Investigation

Three boreholes were drilled at SWMU No.7. Borehole 1 was drilled southwest of the unit. Borehole 2 was drilled north of the unit and borehole 3 was drilled to the northeast of the unit. Drilling was advanced to a depth of 10 feet. Samples were collected at the surface, 2.5, 5 and 10 feet in depth. Surface samples were collected with a stainless steel trowel and subsurface samples were collected with a split barrel continuous sampler. Samples were collected at discrete depths and locations. No composite samples were taken. Samples were analyzed for BTEX, priority metals and TCL VOCs. Duplicates, rinsate blanks, ambient blanks and decontamination water samples were also submitted to the laboratory for this SWMU. Trip Blanks and Ambient Blanks were inadvertently opened to the air at SWMU No. 1; however, these blanks were used for analysis at SWMU No. 7.

5.3 Physical Characteristics

Following is a discussion of the surface water drainage, groundwater, and soils and geology at the No. 121 unit based on a review of information from previous investigations at Cannon AFB and from the lithologic descriptions from the split barrel continuous sampler.

5.3.1 Surface Water Drainage

A topographic/surface drainage map in addition to text found in Installation Restoration Program Records Search, August 1983 prepared by CH_2M Hill indicates that the surface water drainage in the vicinity of SWMU No.7 enters the base storm water drainage system and flows to the Stormwater Collection Point (SWMU No. 85). SWMU No. 85 is an ephemeral lake basin (playa) located in the southwest corner of the base.

5.3.2 Groundwater

Depth to groundwater at Cannon AFB is approximately 250 feet or greater. Groundwater recharge rates for the High Plains Region are typically low. Localized recharge rates for Curry County range from 0.75 - 12.22 mm/yr (Stone, 1985). EPA, 1987 DRASTIC reports recharge rates of 1 in/yr. Section 1.4.3.5 of this report includes a discussion of groundwater hydrology for Cannon AFB.

5.3.3 Soils and Geology

The near surface (upper ten feet) stratigraphy in the area surrounding this SWMU consist of Tertiary Miocene to Pliocene fluvial deposits of the Ogallala Formation. The soils have been

described as a fine sandy loam (Ab) of the Amarillo soil group (USDA, 1993). Interpretations and correlation on the fluvial deposits for this area are based on samples collected with a split barrel continuous sampler during the drilling process. The soils consist of very fine to fine-grained, moderately sorted, immature (textural), unconsolidated, calcareous, dark red, clays, silts, and sands. Thin to moderately thin layers and nodules of caliche material were interbedded throughout much of the samples collected. The sands were comprised of angular to subangular grains with varying amounts of silts, clays, and calcium carbonate (caliche) material. This description of lithology (Figure 5-2) is simuliar to the description of soils given by the USDA Draft Soil Survey, 1993. The thickness of this particular unit remains unknown, due to the fact that boring levels did not exceed ten feet. The total thickness of the Ogallala Formation beneath this SWMU is not presently known, but regional information based on Curry County reports have suggested thicknesses of approximately 320-400 feet. No groundwater was encountered while drilling at these three borehole locations. The minimum depth of the High Plains aquifer is reported to be greater than 250 feet below ground surface.

5.4 Nature and Extent of Contamination

5.4.1 Volatile Organic Compounds

A series of HNU meter readings were taken in the well head and in the breathing zone at each borehole for the purpose of worker safety. No positive readings occurred.

Samples were collected from the three boreholes at the surface and at 5 feet and analyzed for Target List Compound Volatile Organic Compounds (TCL VOC). Following are the results of these analyses:

5.4.1.1 Borehole 1

In borehole 1, the surface sample (CAN007-1291-031A) contained 1,1,1-trichlorethane below the CRQL, toluene at 15 μg/kg and xylene below the CRQL (Table 5-3). This sample also contained TIC compounds. The laboratory conducted a repeat of this sample due to one of the internal standard areas being outside the QC limits. The repeat sample contained 1,1,1-trichlorethane below the CRQL, toluene at 20 μg/kg and xylene at 11 μg/kg. The repeat sample also contained acetone at 40 mg/kg. The repeat sample had the same internal standard problem that original analysis had. All results, except for acetone in the repeat sample, are therefore estimates either because they are below the CRQL or because of the internal standard problems.

The sample collected at 5 feet (CAN007-1291-032C) contained no target analytes or TIC compounds. Two duplicate samples were collected in association with the 5 foot sample. The QC sample, analyzed at the same lab, contained no target compounds or TIC compounds. The QA duplicate, analyzed at a different lab, contained methylene chloride and acetone. Due to the prevalence of these two compounds in nearly all of the samples run at the QA lab, these compounds were considered contaminants and rejected.

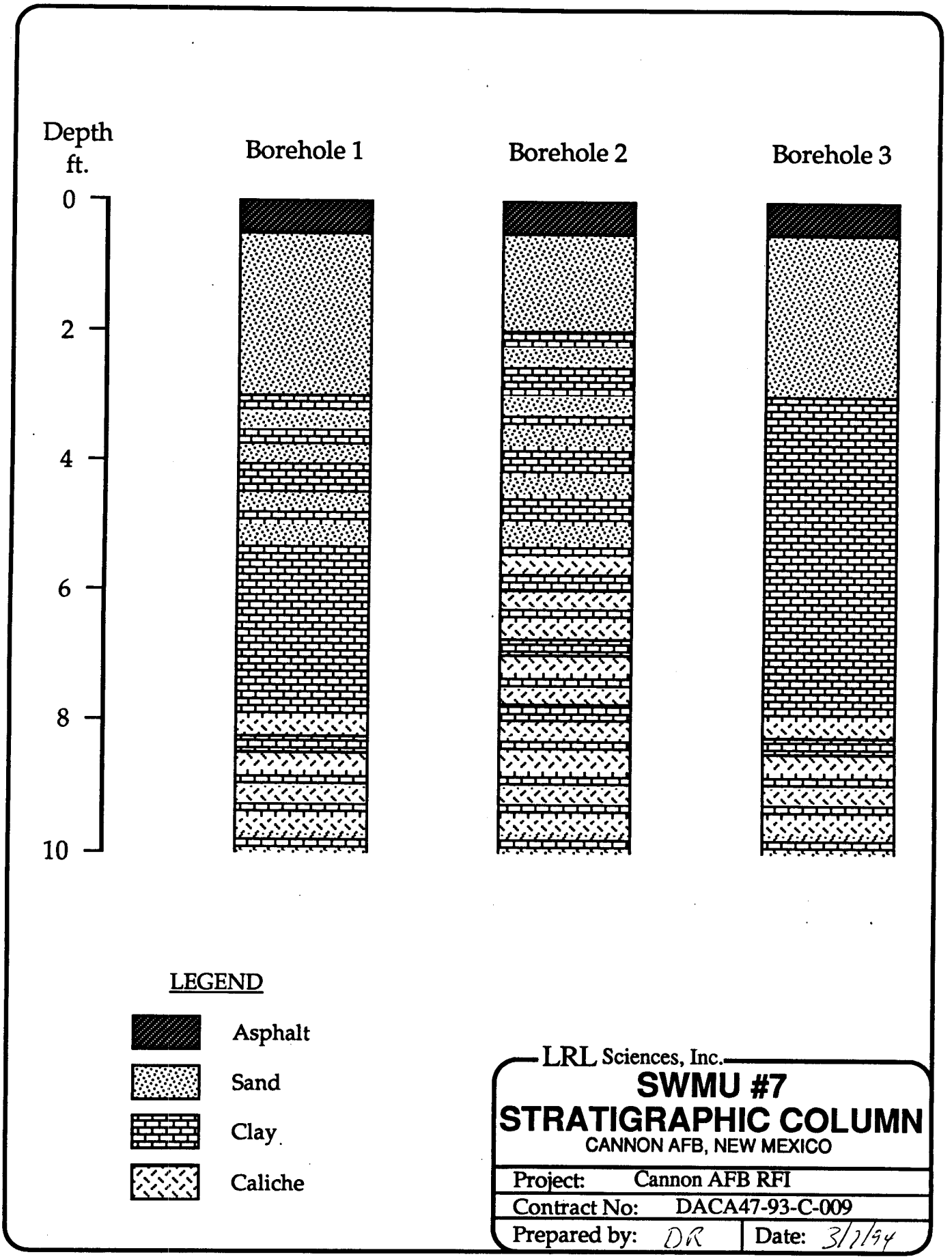

Depth
ft.
0
2
4
6
8
10
Borehole 1
Borehole 2
Borehole 3
LEGEND
Asphalt
Sand
Clay
Caliche
LRL Sciences, Inc.
SWMU #7
STRATIGRAPHIC COLUMN
CANNON AFB, NEW MEXICO
Project: Cannon AFB RFI
Contract No: DACA47-93-C-009
Prepared by: DR
Date: 3/7/94

Figure 5-2.

Table 5-3.
Concentration (μg/kg) of Volatile Organic Compounds
SWMU No.7 - Oil/Water Separator No. 129

Borehole Number	Cannon Number	Depth (ft.)	Chemical			
			Toluene	Acetone	1,1,1-Trichloroethane	Xylene
1	CAN007-1291-031A	Surface	15J	10UJ	5J	7J
	CAN007-1291-032C	5.0	20J (RE)	40 (RE)	11U	11J (RE)
	CAN007-1291-032C	5.0	11J	11U		11U
2	CAN007-1292-031A	Surface	11U	11U	11U	11U
	CAN007-1292-032C	5.0	11U	11U	11U	11U
3	CAN007-1293-031A	Surface	6J	10UJ	10U	10U
	CAN007-1293-032C	5.0	11U	24J	11U	11U

Duplicate samples or laboratory repeat samples are presented only if they are different from the original sample and not rejected.

J = estimate
R = rejected
RE = laboratory repeat
U = not detected at CRQL
UJ = estimated as non-detect at CRQL

5.4.1.2 Borehole 2

In borehole 2, the surface sample contained no target compounds. Although acetone was detected, validation revealed acetone contamination in the method blank associated with this sample. No TIC compounds were detected in this sample.

The sample collected at 5 feet contained no target compounds. Again, an acetone detection was eliminated during validation due to contamination of the associated method blank. No TIC compounds were detected.

5.4.1.3 Borehole 3

In borehole 3, the surface sample (CAN007-1293-031A) contained toluene below the CRQL. No other target compounds were detected. No TIC compounds were detected.

The sample collected at 5 feet (CAN007-1293-032C) contained 24 μg/kg acetone. This value is an estimate since continuing calibration %D exceeded QC limits. No other target compounds were detected. No TIC compounds were detected.

5.4.2 BTEX

In each borehole, 2 samples were collected for BTEX analysis at 2.5 and 10 feet of depth. No BTEX compounds were detected in any of the samples. QA/QC duplicate samples were not collected for BTEX, therefore no analyses were performed.

5.4.3 Priority Metals

Total metals concentrations, using the RCRA SW-846 test methods for the analysis of metals in soils, were determined for the eight TCLP metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) plus nickel. These are the priority metals. Samples were collected for priority metals analysis at the surface, 2.5, 5 and 10 feet.

In the following presentation of metals results, only metals concentrations in excess of background concentrations are presented. No background data was collected for this investigation, therefore, background concentrations were taken from Concentrations of Selected Naturally Occurring Chemical Constituents in Soil and Groundwater at Cannon Air Force Base Clovis, New Mexico, March 1993 prepared by Woodward-Clyde. For a discussion of Woodward-Clydes background data see Section 1.7.

5.4.3.1 Borehole 1

In the surface sample (CAN007-1291-021A), chromium was detected at 38.7 mg/kg (Table 5-4). This value is an estimate since the matrix spike recovery was not within control limits.

No priority metals were detected above background at 2.5, 5 or 10 feet. The QA/QC samples were collected at 5 feet. The QC duplicate, analyzed at the same lab as the normal sample and collected at 5 feet, contained no priority metals above background. The QA duplicate (CAN007-1291-721C), analyzed at a different laboratory, contained mercury at 0.20 mg/kg.

5.4.3.2 Borehole 2

In the surface sample (CAN007-1292-021A), arsenic was detected at 31.8 mg/kg and chromium was detected at 20.6 mg/kg. Both values are estimates since matrix spike recovery was not within control limits. The background value for arsenic is 15.5 mg/kg and for chromium 12.5 mg/kg.

No priority metals were detected above background at 2.5 feet.

Nickel was detected at 5 feet (CAN007-1292-023C) at 9.8 mg/kg.

No priority metlas were detected above background at 10 feet.

Table 5-4.
Concentration (mg/kg) of Priority Metals
SWMU No. 7 - Oil/Water Separator No. 129

Borehole Number	Sample Number (CAN007-129)	Sample Depth (feet)	Arsenic		Chromium		Mercury		Nickel
1	1-021A	0	5.2	J	**38.7**	J	0.01	U	8.1
	1-022B	2.5	2.7	J	8.1	J	0.02	U	8.2
	1-023C	5	2.1	J	5.5	J	0.01	U	7.3
(QAD)	1-721C	5	3.1	UJ	8		**0.2**		
(QCD)	1-821C	5	2.2	J	5.5	J	0.01	U	7.1
	1-024D	10	0.98	J	6.5	J	0.01	U	7.5
2	2-021A	0	**31.8**	J	**20.6**	J	0.01	U	7.5
	2-022B	2.5	13.6	J	7.6	J	0.02	U	8.2
	2-023C	5	3.1	J	8		0.02	U	**9.8**
	2-024D	10	4.3	J	5.2	J	0.02	U	7.8
3	3-021A	0	4.8	J	**15.6**	J	0.01	U	7.5
	3-022B	2.5	2.8	J	6.3	J	0.07	U	6.3
	3-023C	5	3.3	J	3.6	J	0.02	U	6.4
	3-024D	10	4.4	J	5.3	J	0.01	U	7
Background (95% UCL) (1)			15.50		12.50		0.13		9.00

NOTES:

Duplicate samples (QAD) or (QCD) samples are presented only if they are different from the original sample and not rejected.

U indicates that the compound was analyzed for, but not detected at or above the standard limit.
J indicates and estimated value.
UJ indicates the compound was analyzed for but not detected. The sample quantification limit or reported detection limit is an estimated quantity.
*R indicates that the data was rejected because of quality control measures.

Boldface indicates a detection above the 95% UCL background level.

Only data for metals detected above background is presented.

(1) Background data is described in Section 1.7.

5.4.3.3 Borehole 3

In the surface sample (CAN007-1293-021A), chromium was detected at 15.6 mg/kg. This value is an estimate since matrix spike recovery was not within control limits.

No priority metals were detected at 2.5, 5 or 10 feet in depth.

5.4.4 Summary of Data

Chromium was detected in the surface samples of all three boreholes. Arsenic and several VOCs (xylene, acetone, and toluene) were also detected in the surface sample of some boreholes. At 5 feet, borehole 1 contained mercury, borehole 2 contained nickel, and borehole 3 contained acetone. All concentrations detected were low. VOCs were not analyzed for at 10 feet, however, metals were tested for and none were detected above background. BTEX compounds were also analyzed for at 10 feet and none were detected.

5.5 Recommendations

Concentrations of organics and metals found in soils around this SWMU are low and generally diminishing with depth. In addition, groundwater level is deep at approximately 250 feet below ground surface. The oil/water separator should be tested for structural integrity to determine that the unit contains no cracks or leaks. If none are found, based on the risk assessment information associated with this SWMU indicating minimal or no risk to human health or the environment, no further action is recommended. If the integrity test fails, however, it is recommended that the unit be removed and soils below the separator be analyzed. Further action would depend upon the results of these analyses.

6.0 OIL WATER SEPARATOR (SWMU NO. 8/SITE NO. 165)

6.1 SWMU Description

6.1.1 Setting

The oil/water separator No. 165 is located on the south end of the aircraft washrack at Facility 165. The separator is a 3-compartment underground unit with a 4,500 gallon main compartment and a 710 gallon oil compartment. The unit is constructed of concrete. The separator is surrounded by grass on three sides and a concrete-covered washing area (SWMU No. 9) on the other side. This separator sits approximately 1 foot above ground, with the remainder below ground. The top of the oil/water separator is covered by a corrugated metal roof. The bottom of the unit is estimated to be between 6 and 10 feet deep. Boreholes were hand augered at this site and not drilled using the CME 75 drill rig in order to avoid crushing shallow sprinklers and water lines. Due to the thickness of the concrete of this oil/water separator, any leakage that may have occurred is suspected to be associated with the joints between the sewer drains and the SWMU unit and not from the SWMU unit itself. Borehole locations were selected to test areas where leaky joints may have affected the surrounding soil. The SWMU setting and borehole locations are presented in Figure 6-1.

6.1.2 History of Use

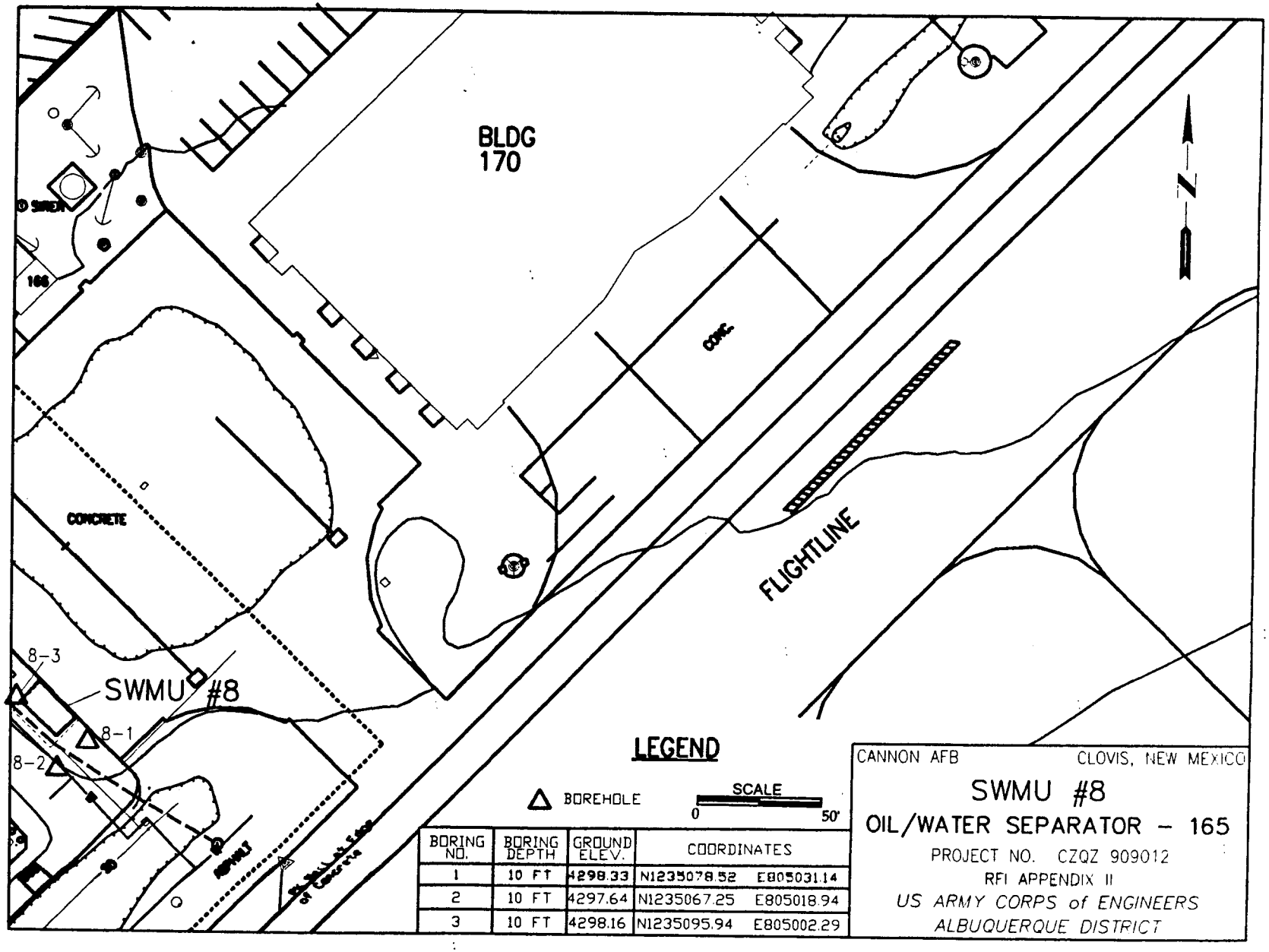
The oil/water separator No. 165 has been active since 1963 and is still in use. This SWMU receives wastewater from the washing of aircraft. The recovered oils are directed to the 710 gallon concrete holding chamber and the wastewater is discharged to the Storm Drainage System which flows to the Stormwater Collection Point (SWMU No. 85). During field reconnaissance, this tank contained material with a strong sewage odor. Currently, in the immediate area of the SWMU, aircraft washing is infrequent. The area is used instead for logistics where materials, supplies and goods are temporarily staged for air shipment. Rain water collection through a grill, in the middle of the washrack, comes to SWMU 8.

6.1.3 Past Investigations

No previous investigations are availble for this SWMU; however, chemical components which might appear in the influent and effluent would be similar to compounds associated with SWMU No. 9 which is served by this separator. Compounds include ethylene glycol n-mono butyl ether and PD-680 constituents. Washrack components would include fuels, solvents and lubricating oils.

6.1.4 Land Use and Demography

This SWMU is located in an area of the base which is commonly used by base personnel. This SWMU is mostly underground but not covered by asphalt.



BORING NO.	BORING DEPTH	GROUND ELEV.	COORDINATES	
1	10 FT	4298.33	N1235078.52	E805031.14
2	10 FT	4297.64	N1235067.25	E805018.94
3	10 FT	4298.16	N1235095.94	E805002.29

Figure 6-1.

6.2 Field Investigation

SWMU 8 was sampled April 15, 1993 at 1600. The activities at oil/water separator No. 165, as outlined in the FSP (LRL, 1993), consisted of hand augering 3 boreholes, 6 surface samples, 18 subsurface samples, 4 QA/QC duplicate samples, and 6 QA/QC water samples. Table 6-1 summarizes the field sampling program at SWMU 8. Table 6-2 summarizes the various samples collected and analyses performed.

6.2.1 Sampling Objectives

Borehole locations, sampling depth, and parameters for analysis were selected, to the greatest extent possible, to determine if a release from the oil/water separator has occurred. All three boreholes were moved form the original FSP locations in order to test soils near the joints between the sewer drains and the separator. It was assumed for this site that any leaks would have occurred from these joints rather than the unit itself, as it was made of very thick concrete. Borehole locations are shown in Figure 6-1.

6.2.2 Surface and Subsurface Soil Investigation

Three boreholes were hand augered at this SWMU. Borehole 1 was located 8 feet 6 inches to the southeast of the unit. Borehole 2 was placed 12 feet 6" inches to the south of the unit and borehole 3 was placed 3 feet to the west of the unit. Augering was advanced to a depth of 10 feet. Samples were collected at the surface, 2.5, 5 and 10 feet in depth. Surface samples were collected using a stainless steel trowel and subsurface samples were collected by hand auger. Samples were collected at discrete depths and locations. No composite samples were taken. Samples were analyzed for BTEX, priority metals and TCL VOCs. Duplicates, rinsate blanks, ambient blanks and decontamination water samples were also submitted to the laboratory for this SWMU site.

6.3 Physical Characteristics

This section provides a discussion of the surface water drainage, groundwater, soils, and geology at the No. 165 oil/water separator based on a review of information from previous investigations at Cannon AFB and from the lithologic descriptions from the soils removed with a hand auger.

6.3.1 Surface Water Drainage

A topographic/surface drainage map in addition to text found in Installation Restoration Program Records Search, August 1983 prepared by CH_2M Hill indicates that the surface water drainage in the vicinity of SWMU No. 8 enters the base storm water drainage system and flows to the Stormwater Collection Point (SWMU No. 85). SWMU No. 85 is an ephemeral lake basin (playa) located in the southwest corner of the base.

Table 6-1.
Summary of Drilling and Sampling
SWMU No.8 - Oil/Water Separator No. 165

Borehole Number	Sampling Depth (ft.-BGS)	Drilling/ Sampling Methods	Drillrig Used	Borehole Diameter (in.)	Ground Elevation	Date Grouted
1	0	HA	NA	NA	4298.33	4/15/93
	2.5	HSA/SBC	CME-75	3.0		
	5.0	HSA/SBC	CME-75	3.0		
	10.0	HSA/SBC	CME-75	3.0		
2	0	NA/SSS	NA	NA	4297.64	4/15/93
	2.5	HSA/SBC	CME-75	3.0		
	5.0	HSA/SBC	CME-75	3.0		
	10.0	HSA/SBC	CME-75	3.0		
3	0	NA/SSS	NA	NA	4298.16	4/15/93
	2.5	HSA/SBC	CME-75	3.0		
	5.0	HSA/SBC	CME-75	3.0		
	10.0	HSA/SBC	CME-75	3.0		

HSA = Hollow Stem Auger
HA = Hand Auger
SBC = Split Barrel Continuous Sampler
SS = Split Spoon
SSS = Stainless Steel Spoon

Table 6-2.
Summary of Sampling and Analyses
SWMU No. 8 - Oil/Water Separator No. 165

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
1	0	CAN008-1651-021A	N	SOIL	1605	PM	6010\7000S+
		CAN008-1651-031A	N	SOIL	1605	TCL VOC	8240
	2.5	CAN008-1651-022B	N	SOIL	1630	PM	6010\7000S
		CAN008-1651-032B	N	SOIL	1625	TCL VOC	8240
		CAN008-1651-821B	QCD	SOIL	1650	PM	6010\7000S
		CAN008-1651-831B	QCD	SOIL	1625	TCL VOC	8240
		CAN008-1651-721B	QAD	SOIL	1630	PM	6010/7000S
		CAN008-1651-731B	QAD	SOIL	1625	TCL VOC	8240
	5.0	CAN008-1651-011C	N	SOIL	1640	BTEX	8020
		CAN008-1651-023C	N	SOIL	1640	PM	6010\7000S
	10.0	CAN008-1651-024D	N	SOIL	1655	PM	6010\7000S
		CAN008-1651-012D	N	SOIL	1655	BTEX	8020
2	0	CAN008-1652-021A	N	SOIL	1645	PM	6010\7000S
		CAN008-1652-031A	N	SOIL	1645	TCL VOC	8240
	2.5	CAN008-1652-022B	N	SOIL	1710	PM	6010\7000S
		CAN008-1652-032B	N	SOIL	1710	TCL VOC	8240
	5.0	CAN008-1652-011C	N	SOIL	1720	BTEX	8020
		CAN008-1652-023C	N	SOIL	1720	PM	6010\7000S
	10.0	CAN008-1652-022D	N	SOIL	1740	PM	6010\7000S
		CAN008-1652-014D	N	SOIL	1740	BTEX	8020

Table 6-2. (Concluded)
Summary of Sampling and Analyses
SWMU No. 8 - Oil/Water Separator No. 165

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
3	0	CAN008-1653-021A	N	SOIL	1750	PM	6010\7000S
		CAN008-1653-031A	N	SOIL	1750	TCL VOC	8240
	2.5	CAN008-1653-022B	N	SOIL	1805	PM	6010\7000S
		CAN008-1653-032B	N	SOIL	1800	TCL VOC	8240
		CAN008-1653-821B	QCD	SOIL	1805	PM	6010\7000S
		CAN008-1653-831B	QCD	SOIL	1800	TCL VOC	8240
		CAN008-1653-721B	QAD	SOIL	1805	PM	6010\7000S
		CAN008-1653-731B	QAD	SOIL	1800	TCL VOC	8240
	5.0	CAN008-1653-011C	N	SOIL	1810	BTEX	8020
		CAN008-1653-023C	N	SOIL	1815	PM	6010\7000S
	10.0	CAN008-1653-022D	N	SOIL	1805	PM	6010\7000S
		CAN008-1653-014D	N	SOIL	1825	BTEX	8020
		CAN008-1650-431Z	QC	WATER	1830	TCL VOC	8240
		CAN008-1650-321Z	QC	WATER	1835	PM	6010\7000S
		CAN008-1650-331Z	QC	WATER	1840	TCL VOC	8240
		CAN008-1650-231Z	QC	WATER	1840	TCL VOC	8240
		CAN008-1650-621Z	QC	WATER	1835	PM	6010\7000S
		CAN008-1650-631Z	QC	WATER	1840	TCL VOC	8240

BTEX = Benzene, Toluene, Ethyl Benzene, Xylene
ft-BGS = feet below ground surface
N = Normal soil sample
PM = Priority metals = 8 TCLP metals + Ni
TCL VOC = Target Compound List Volatile Organic Compounds
+ = Metals analyzed using the 7000 Series include: mercury, selenium, and arsenic.

QAD = Duplicate soil sample (analyzed at different laboratory from normal samples).
QCD = Duplicate soil sample analyzed at same laboratory as normal samples.
QC = Quality control water sample (ambient blank, trip blank, etc.)
TAL Metals = Target analyte list metals

6.3.2 Groundwater

Depth to groundwater at Cannon AFB is approximately 250 feet or greater. Groundwater recharge rates for the High Plains Region are typically low. Localized recharge rates for Curry County range from 0.75 - 12.22 mm/yr (Stone, 1985). EPA, 1987 DRASTIC reports recharge rates of 1 in/yr. Section 1.4.3.5 of this report includes a discussion of groundwater hydrology for Cannon AFB.

6.3.3 Soils and Geology

The near surface (upper ten feet) stratigraphy in the area surrounding this SWMU consist of Tertiary Miocene to Pliocene fluvial deposits of the Ogallala Formation. The soils have been described as a fine sandy loam (Ab) of the Amarillo soil group (USDA, 1993). Interpretations and correlation on the fluvial deposits for this area are based on hand augered samples collected during the drilling process. The soils consist of very fine to coarse-grained, poorly to moderately sorted, submature to mature (textural), unconsolidated, calcareous, dark reddish brown, clays, silts, sands, and gravel. Thin to moderately thin layers of caliche material were interbedded throughout much of the samples collected. The sands were comprised of angular to subangular grains with varying amounts of silts, clays, and calcium carbonate (caliche) material. This description of lithology (Figure 6-2) is similiar to the description of soils given by the USDA Draft Soil Survey, 1993. The thickness of this particular unit remains unknown, due to the fact that boring levels did not exceed ten feet. The total thickness of the Ogallala Formation beneath this SWMU is not presently known, but regional information based on Curry County reports have suggested thicknesses of approximately 320-400 feet. No groundwater was encountered while drilling at these three borehole locations. The minimum depth of the High Plains aquifer is reported to be greater than 250 feet below ground surface.

6.4 Nature and Extent of Contamination

6.4.1 Volatile Organic Compounds

A series of HNU meter readings were taken at each of the boreholes in the well head and in the breathing zone for the purpose of worker safety. In borehole 3, all the well head readings were positive ranging from 0.2 to 2.4 ppm (Table 6-3).

Samples were collected from the three boreholes at the surface and at 2.5 feet and analyzed for Target List Compound Volatile Organics Compounds (TCL VOC). Following are the results of these analyses.

6.4.1.1 Borehole 1

In borehole 1, no target compounds or TIC compounds were detected at the surface.

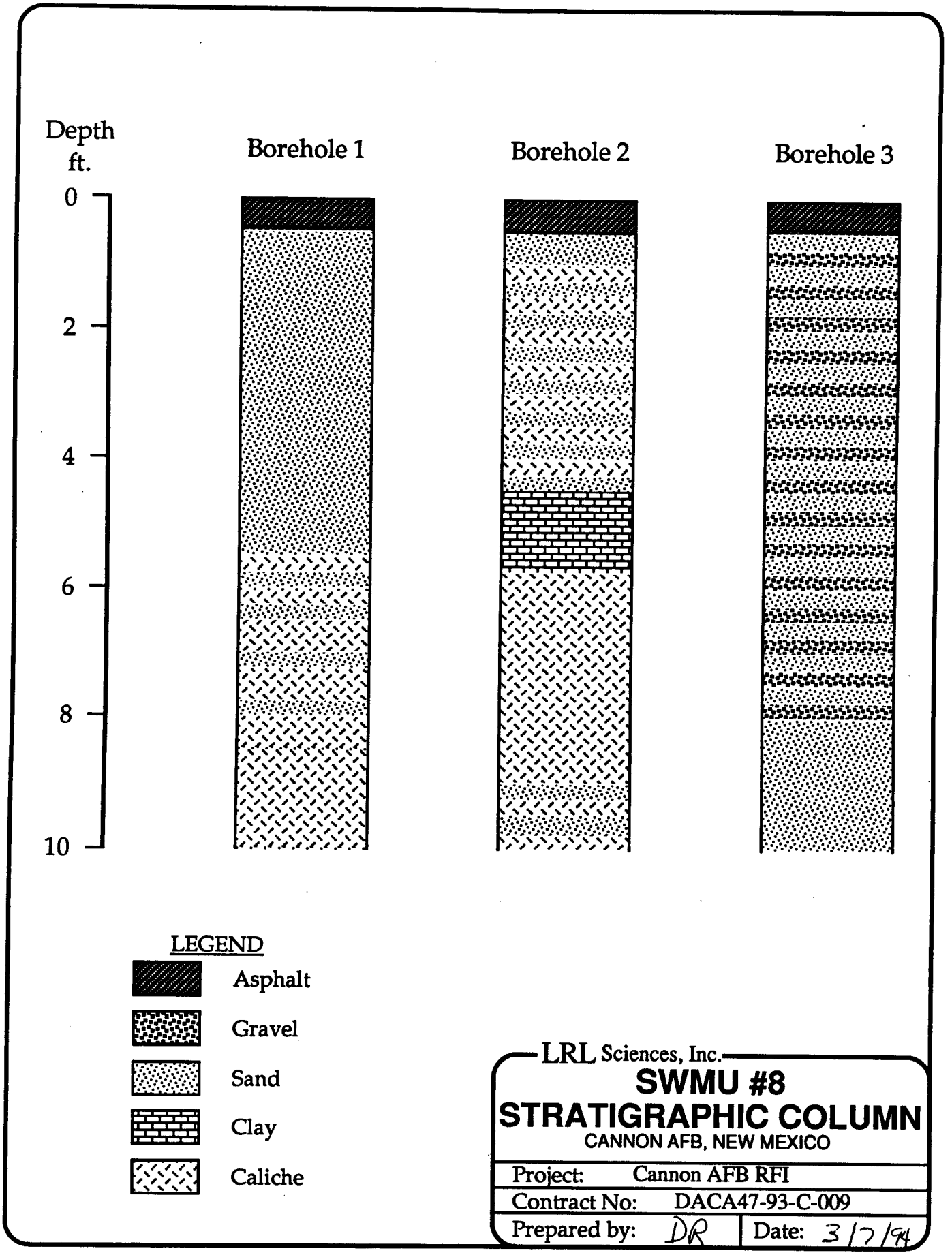

Depth
ft.
0
2
4
6
8
10
Borehole 1
Borehole 2
Borehole 3
LEGEND
Asphalt
Gravel
Sand
Clay
Caliche
LRL Sciences, Inc.
SWMU #8
STRATIGRAPHIC COLUMN
CANNON AFB, NEW MEXICO
Project: Cannon AFB RFI
Contract No: DACA47-93-C-009
Prepared by: DR
Date: 3/7/94

Figure 6-2.

Table 6-3.
HNU Meter* Readings (PPM) in Borehole Headspace
SWMU No. 8 - Oil/Water Separator No. 165

DATE: 4/15/93					
TIME	BH1	TIME	BH2	TIME	BH3
1610	0.0	1705	0.0	1745	1.2
1643	0.0	1710 1720	0.0 0.0	1755 1758	2.4 0.8
1655	0.0	1725 1735	0.0 0.0	1805 1810	0.2 0.4
* Model: 101, Type: OVA PID, Make: HNU					

No target compounds or TIC compounds were detected at 2.5 feet. Two duplicate samples were collected with the 2.5 foot sample from borehole 1. The QC duplicate was analyzed at the same lab and the QA duplicate was analyzed at a different lab. The QC duplicate contained no target compounds or TIC compounds. The QA duplicate contained acetone and methylene chloride. Since nearly all of the samples at the QA laboratory contained these compounds, they were considered laboratory contaminants and rejected. The QA duplicate also contained marginal amounts of unidentified TIC compounds. These data were rejected during validation since there was no agreement with the QC laboratory and concentrations were marginal.

6.4.1.2 Borehole 2

In borehole 2, no target compounds or TIC compounds were detected at the surface or at 2.5 feet.

6.4.1.3 Borehole 3

In borehole 3, no target compounds or TIC compounds were detected at the surface.

No target compounds or TIC compounds were detected at 2.5 feet. Two duplicate samples were collected with the 2.5 foot sample form borehole 3. The QC duplicate contained acetone. The acetone result was rejected, however, due to co-elution with unknown contaminants. The QA duplicate once again contained acetone and methylene chloride which were considered lab contaminants due to their prevalence in nearly all the samples. A single unknown TIC compound was detected but rejected due to its marginal presence and since TIC compounds were not detected in the QC duplicate or the normal lab sample.

6.4.2 BTEX

In each borehole, two samples were collected for BTEX analysis at 5 and 10 feet of depth. In borehole 3, at 5 feet, xylenes were detected at 2.4 μg/kg (Table 6-4). This result is estimated, however, since internal standard problems occurred.

Table 6-4.
Concentration (μg/kg) of BTEX
SWMU No. 8 - Oil/Water Separator No. 165

Borehole Number	Cannon Number	Depth (ft.)	Chemical				
			Benzene	Ethly Benzene	Toluene	Xylene	BTEX Total
1	CAN008-1651-011C	5.0	2U	2U	2U	2U	2U
	CAN008-1651-012D	10.0	2U	2U	2U	2U	2U
2	CAN008-1652-011C	5.0	2U	2U	2U	2U	2U
	CAN008-1652-012D	10.0	2U	2U	2U	2U	2U
3	CAN008-1653-011C	5.0	2UJ	2UJ	2UJ	2J	2J
	CAN008-1653-012D	10.0	2U	2U	2U	2U	2U

Duplicate samples or laboratory repeat samples are presented only if they are different from the original sample and not rejected.
J = estimate
R = rejected
U = not detected at CRQL
UJ = estimated as non-detect at CRQL

6.4.3 Priority Metals

Total metals concentrations, using the RCRA SW-846 test methods for the analysis of metals in soils, were determined for the eight TCLP metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) plus nickel. These are the priority metals. Samples were collected for priority metals analysis at the surface, 2.5, 5, and 10 feet.

In the following presentation of metals results, only metals concentrations in excess of background concentrations are presented. No background data was collected for this investigation, therefore, background concentrations were taken from Concentrations of Selected Naturally Occurring Chemical Constituents in Soil and Groundwater at Cannon Air Force Base Clovis, New Mexico, March 1993 prepared by Woodward-Clyde. For a discussion of Woodward-Clydes background determination see Section 1.7.

6.4.3.1 Borehole 1

In the surface sample, no priority metals were detected above background.

At 2.5 feet (CAN008-1651-022B), nickel was detected at 31.6 mg/kg (Table 6-5). The QA/QC field duplicated samples were collected at this depth. The QC duplicate (CAN008-1651-821B), analyzed at the same lab as the normal sample, contained nickel at 9.1 mg/kg. The QA duplicate (CAN008-1651-721B), analyzed at a separate laboratory, contained nickel at 9.7 mg/kg. Background for nickel is 9.0 mg/kg.

At 5 feet (CAN008-1651-023C), chromium was detected at 13.2 and nickel at 11.4 mg/kg. Background for chromium and nickel are 12.5 and 9.0 mg/kg respectively.

No priority metals were detected above background at 10 feet.

6.4.3.2 Borehole 2

In the surface sample, no priority metals were detected above background.

At 2.5 feet (CAN008-1652-022B), nickel was detected at 11.0 mg/kg.

At 5 feet (CAN008-1652-023C) chromium and nickel were detected at 12.9 and 12.2 mg/kg respectively.

At 10 feet (CAN008-1652-022D), barium was detected at 712 mg/kg. Background for barium is 642 mg/kg.

6.4.3.3 Borehole 3

No priority metals were detected in the surface sample, 2.5 or 5 feet. The QA/QC field duplicates collected at 2.5 feet also contained no priority metals above background.

At 10 feet (CAN008-1653-022D), barium was detected at 812 mg/kg. This value is an estimate because the matrix spike recovery was not within control limits.

6.4.4 Summary of Data

No VOCs were detected in the surface samples or at 2.5 feet by Method 8240. No metals were detected above background in any of the surface samples. All three boreholes contained subsurface metals including nickel, chromium, and barium at low concentrations, and only barium was detected at 10 feet. Borehole 3 contained xylene, below the CRQL, at 10 feet by BTEX analysis.

Table 6-5.
Concentration (mg/kg) of Priority Metals
SWMU No. 8 - Oil/Water Separator No. 165

BOREHOLE NUMBER	SAMPLE NUMBER (CAN008-165)	SAMPLE DEPTH (feet)	BARIUM		CHROMIUM	NICKEL	
1	1-021A	0	203	J	12.2	8.9	U
	1-022B	2.5	194	J	9.3	**13.6**	
(QAD)	1-721B	2.5	204		12.3	**9.7**	
(QCD)	1-821B	2.5	155	J	11.3	**9.1**	
	1-023C	5	107	J	**13.2**	**11.4**	
	1-024D	10	423	J	5.7	8.3	
2	2-021A	0	198	J	11.2	7.9	
	2-022B	2.5	100	J	12.5	**11**	
	2-023C	5	71.1	J	**12.9**	**12.2**	
	2-022D	10	**712**	J	4.3	4.9	
3	3-021A	0	250	J	8.3	7.7	
	3-022B	2.5	196	J	8.3	7.4	
(QAD)	3-721B	2.5	195		12.5	8.4	
(QCD)	3-821B	2.5	208	J	8.6	7.3	
	3-023C	5	209	J	8.3	7.7	
	3-022D	10	**812**	J	2.1	2	
Background (95% UCL) (1)			642.00		12.50	9.00	

NOTES:

Duplicate samples (QAD) or (QCD) samples are presented only if they are different from the original sample and not rejected.

U indicates that the compound was analyzed for, but not detected at or above the standard limit.
J indicates and estimated value.
UJ indicates the compound was analyzed for but not detected. The sample quantification limit or reported detection limit is an estimated quantity.
*R indicates that the data was rejected because of quality control measures.

Boldface indicates a detection above the 95% UCL background level.

Only data for metals detected above background is presented.

(1) Background data is described in Section 1.7.

6.5 Recommendations

Concentrations of organics and metals found in soils around this SWMU are low and generally diminishing with depth. In addition, groundwater level is deep at approximately 250 feet below ground surface. The oil/water separator should be tested for structural integrity to determine that the unit contains no cracks or leaks. If none are found, based on the risk assessment information associated with this SWMU indicating minimal or no risk to human health or the environment, no further action is recommended. If the integrity test fails, however, it is recommended that the unit be removed and soils below the separator be analyzed. Further action would depend upon the results of these analyses.

7.0 AIRCRAFT WASHRACK DRAIN SYSTEM (SWMU NO. 9)

7.1 SWMU Description

7.1.1 Setting

SWMU No. 9 is a drain in the center of a concrete washrack pad used for cleaning aircraft. The washrack pad slopes to this drain which discharges to Oil/Water Separator No. 165 (SWMU No. 8). The washrack pad is located near SWMU No. 8 and is proximate to the flight line. The borehole locations were chosen, in part, to detect any leakage which may have occurred around the drain fixture and the plumbing joints. Figure 7-1 shows the setting of SWMU No. 9 and the borehole locations. The driller was required to penetrate concrete and restore the surfaces with a concrete plug.

7.1.2 History of Use

The washrack drain system has been active since 1966 and is still in use. Currently, approximately four aircraft frames are cleaned per week with a water and aircraft cleaning compound solution. Washdown water, from aircraft frame cleaning operations conducted from 1984 till the present, contains a biodegradable cleaning compound that consists of 5% by weight ethylene glycol n-mono butyl ether. Prior to 1984, approximately 3,600 gallons of PD-680 and 1,700 gallons of aircraft cleaning compound drained into Oil/Water Separator No. 165 (SWMU No. 8), which empties into the Storm Water Drainage Area (SWMU No. 85). This washrack pad is also used currently as a staging area for mobilization exercises/air shipments.

7.1.3 Past Investigations

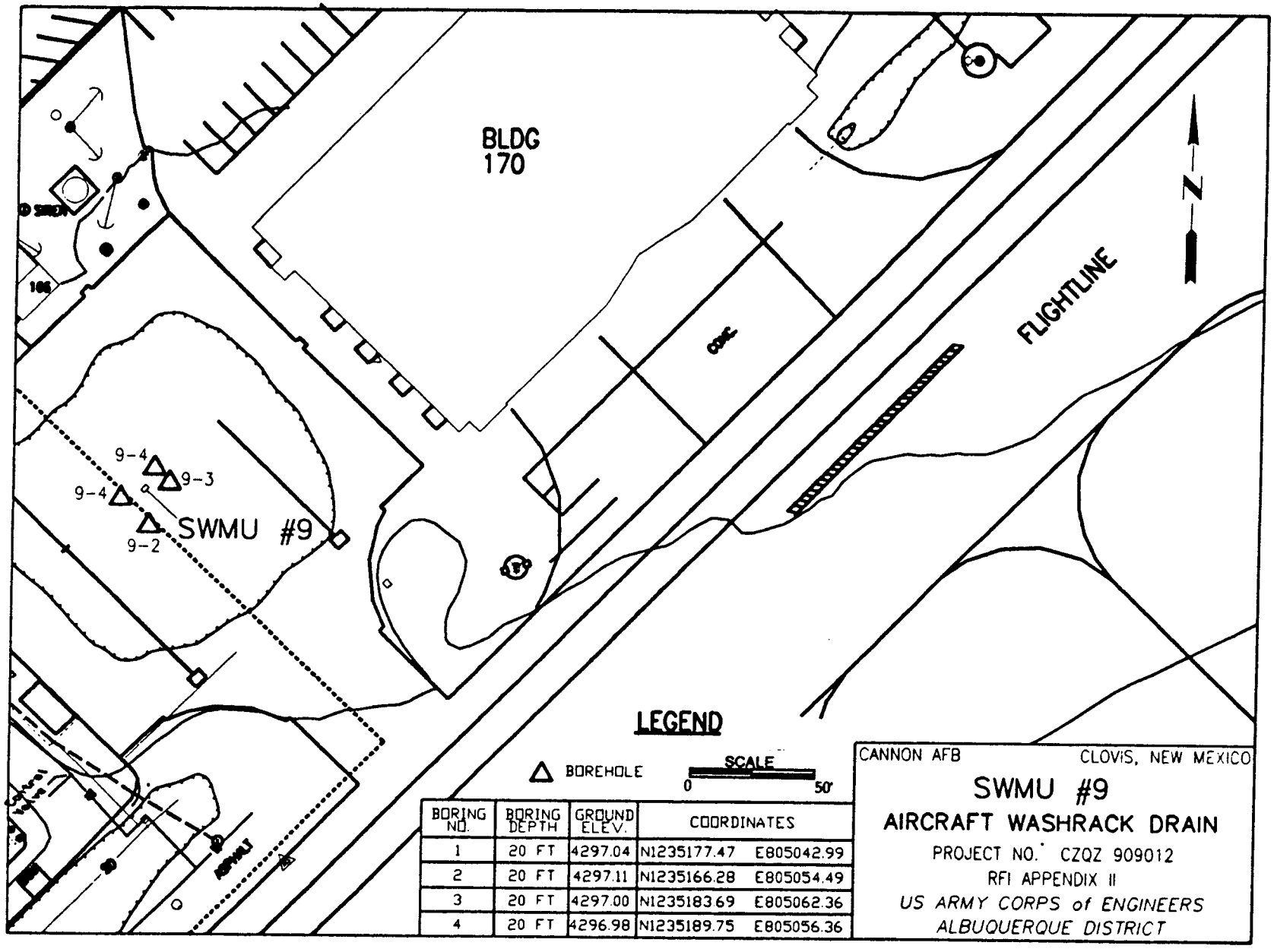
No previous studies of SWMU No. 9 or the oil/water separator (SWMU No. 8) that receives effluent from SWMU No. 9 were found.

7.1.4 Land Use and Demography

This SWMU is in an area of the base that is commonly frequented by personnel. However, the drain leads underground and the area is currently covered by asphalt.

7.2 Field Investigation

Preparation for the drilling and sampling activities occurred April 15, 1993. This included using a concrete saw to cut the cement/concrete ramp and then a jack hammer to breakout the concrete and rebar down to the soil. The drilling and sampling activities occurred the following day, April 16, 1993 at 0840. The washrack was closed for the duration of the field sampling and was only reopened after the boreholes had been filled and sealed with concrete plugs. The activities at SWMU No. 9, as outlined in the FSP (LRL, 1993), consisted of drilling 4 boreholes, collecting 8 surface samples, 32 normal subsurface samples, 8 duplicate subsurface samples and 6 QA/QC samples. Table 7-1 summarizes the field sampling program at SWMU No. 9. Table 7-2 summarizes the various samples collected and analyses performed.



BORING NO.	BORING DEPTH	GROUND ELEV.	COORDINATES	
1	20 FT	4297.04	N1235177.47	E805042.99
2	20 FT	4297.11	N1235166.28	E805054.49
3	20 FT	4297.00	N1235183.69	E805062.36
4	20 FT	4296.98	N1235189.75	E805056.36

Figure 7-1.

Table 7-1.
Summary of Drilling and Sampling
SWMU No. 9 - Aircraft Wash Drain (AWD)

Borehole Number	Sampling Depth (ft.-BGS)	Drilling/ Sampling Methods	Drillrig Used	Borehole Diameter (in.)	Ground Elevation	Date Grouted
1	0	NA/SSS	NA	NA	4296.98	4/16/93
	5.0	HSA/SS	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
	15.0	HSA/SS	CME-75	8.0		
	20.0	HSA/SS	CME-75	8.0		
2	0	NA/SSS	NA	NA		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SS	CME-75	8.0	4297.00	4/16/93
	15.0	HSA/SBC	CME-75	8.0		
	20.0	HSA/SBC	CME-75	8.0		
3	0	NA/SSS	NA	NA	4297.11	4/16/93
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SS	CME-75	8.0		
	15.0	HSA/SS	CME-75	8.0		
	20.0	HSA/SS	CME-75	8.0		
4	0	NA/SSS	NA	NA	4297.04	4/16/93
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
	15.0	HSA/SS	CME-75	8.0		
	20.0	HSA/SS	CME-75	8.0		

HSA = Hollow Stem Auger
HA = Hand Auger
SBC = Split Barrel Continuous Sampler
SS = Split Spoon
SSS = Stainless Steel Spoon

Table 7-2.
Summary of Sampling and Analyses
SWMU No. 9 - Aircraft Wash Drain (AWD)

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
1	0	CAN009-AWD1-021A	N	SOIL	0905	PM	6010/7000S
		CAN009-AWD1-031A	N	SOIL	0905	TCL VOC	8240
	5.0	CAN009-AWD1-011C	N	SOIL	0920	BTEX	8020
		CAN009-AWD1-022C	N	SOIL	0920	PM	6010/7000S
	10.0	CAN009-AWD1-023D	N	SOIL	0930	PM	6010/7000S
		CAN009-AWD1-032D	N	SOIL	0925	TCL VOC	8240
		CAN009-AWD1-821D	QCD	SOIL	0930	PM	6010/7000S
		CAN009-AWD1-831D	QCD	SOIL	0925	TCL VOC	8240
		CAN009-AWD1-721D	QAD	SOIL	0925	PM	6010/7000S
		CAN009-AWD1-731D	QAD	SOIL	1050	TCL VOC	
	15.0	CAN009-AWD1-012E	N	SOIL	0940	BTEX	8020
		CAN009-AWD1-024E	N	SOIL	0940	PM	6010/7000S
	20.0	CAN009-AWD1-013F	N	SOIL	0955	BTEX	8020
		CAN009-AWD1-025F	N	SOIL	0955	PM	6010/7000S

Table 7-2. (Continued)
Summary of Sampling and Analyses
SWMU No. 9 - Aircraft Wash Drain (AWD)

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
2	0	CAN009-AWD2-021A	N	SOIL	1030	PM	6010/7000S
		CAN009-AWD2-031A	N	SOIL	1030	TCL VOC	8240
	5.0	CAN009-AWD2-011C	N	SOIL	1045	BTEX	8020
		CAN009-AWD2-022C	N	SOIL	1045	PM	6010/7000S
	10.0	CAN009-AWD2-023D	N	SOIL	1050	PM	6010/7000S
		CAN009-AWD2-032D	N	SOIL	1050	TCL VOC	8240
		CAN002-AWD2-821D	QCD	SOIL	1050	PM	6010/7000S
		CAN009-AWD2-831D	QCD	SOIL	1050	TCL VOC	8240
		CAN009-AWD2-721D	QAD	SOIL	1050	PM	6010/7000S
		CAN009-AWD2-731D	QAD	SOIL	1050	TCL VOC	8240
	15.0	CAN009-AWD2-012E	N	SOIL	1100	BTEX	8020
		CAN009-AWD2-024E	N	SOIL	1100	PM	6010/7000S
	20.0	CAN009-AWD2-013F	N	SOIL	1110	BTEX	8020
		CAN009-AWD2-025F	N	SOIL	1110	PM	6010/7000S

Table 7-2. (Continued)
Summary of Drilling and Sampling
SWMU No. 9 - Aircraft Wash Drain (AWD)

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
3	0	CAN009-AWD3-021A	N	SOIL	1155	PM	6010/7000S
		CAN009-AWD3-031A	N	SOIL	1155	TCL VOC	8240
	5.0	CAN009-AWD3-011C	N	SOIL	1205	BTEX	8020
		CAN009-AWD3-022C	N	SOIL	1205	PM	6010/7000S
	10.0	CAN009-AWD3-023D	N	SOIL	1215	PM	6010/7000S
		CAN009-AWD3-032D	N	SOIL	1215	TCL VOC	8240
	15.0	CAN009-AWD3-012E	N	SOIL	1226	BTEX	8020
		CAN009-AWD3-024E	N	SOIL	1226	PM	6010/7000S
	20.0	CAN009-AWD3-013F	N	SOIL	1240	BTEX	8020
		CAN009-AWD3-025F	N	SOIL	1240	PM	6010/7000S
4	0	CAN009-AWD4-021A	N	SOIL	1440	PM	6010/7000S
		CAN009-AWD4-031A	N	SOIL	1440	TCL VOC	8240
	5.0	CAN009-AWD4-011C	N	SOIL	1455	BTEX	8020
		CAN009-AWD4-022C	N	SOIL	1455	PM	6010/7000S
	10.0	CAN009-AWD4-023D	N	SOIL	1510	PM	6010/7000S
		CAN009-AWD4-032D	N	SOIL	1510	TCL VOC	8240
	15.0	CAN009-AWD4-012E	N	SOIL	1520	BTEX	8020
		CAN009-AWD4-024E	N	SOIL	1520	PM	6010/7000S
	20.0	CAN009-AWD4-013F	N	SOIL	1530	BTEX	8020
		CAN009-AWD4-025F	N	SOIL	1530	PM	6010/7000S

Table 7-2. (Concluded)
Summary of Sampling and Analyses
SWMU No. 9 - Aircraft Wash Drain (AWD)

BOREHOLE NUMBER	SAMPLING DEPTH (ft.-BGS)	SAMPLE ID NUMBER	SAMPLE TYPE	SAMPLE MATRIX	SAMPLE TIME	ANALYTICAL PARAMETER	TEST METHOD
		CAN009-AWD0-431Z	QC	WATER	1440	TCL VOC	8240
		CAN009-AWD0-321Z	QC	WATER	1535	PM	6010/7000S
		CAN009-AWD0-331Z	QC	WATER	1545	TCL VOC	8240
		CAN009-AWD0-231Z	QC	WATER	1545	TCL VOC	8240
		CAN009-AWD0-621Z	QC	WATER	1535	PM	6010/7000S
		CAN009-AWD0-631Z	QC	WATER	1545	TCL VOC	8240

BTEX = Benzene, Toluene, Ethyl Benzene, Xylene
ft-BGS = feet below ground surface
N = Normal soil sample
PM = Priority metals = 8 TCLP metals + Ni
TCL VOC = Target Compound List Volatile Organic Compound
+ = Metals analyzed using the 7000 Series include: mercury, selenium, and arsenic.

QAD = Duplicate soil sample (analyzed at different laboratory from normal samples).
QCD = Duplicate soil sample analyzed at same laboratory as normal samples.
QC = Quality control water sample (ambient blank, trip blank, etc.)
TAL Metals = Target analyte list metals

7.2.1 Sampling Objectives

Borehole locations, sampling depth, and parameters for analysis were selected, to the greatest extent possible, to determine if a release from the washrack drain or the pipe joints has occurred. The boreholes were moved from the FSP selected locations to avoid the drain and drainline leading to Oil/Water Separator No. 165 (SWMU No. 8). They were also moved closer in toward the drain grill. Borehole locations are shown in Figure 7-1.

7.2.2 Surface and Subsurface Soil Investigation

Four boreholes were drilled at this SWMU using a CME-75 hollow stem auger drill rig. Borehole 1 was drilled 9 feet west of the drain. Borehole 2 was drilled 11 feet 6 inches south of the drain. Borehole 3 was drilled 7 feet east of the drain. Borehole 4 was drilled 7 feet 6 inches northeast of the drain. Drilling was advanced to the depth of 20 feet. Samples were collected at the surface, 5, 10, 15 and 20 feet in depth. A stainless steel spoon was employed for taking surface samples. A split spoon sampler was used for subsurface sample collection except at depths where duplicate samples were also taken. At those depth a split barrel continuous sampler was employed. Samples were collected at discrete depths and locations. No composite samples were taken. Samples were analyzed for BTEX, priority metals and TCL VOC. Duplicates, rinsate blanks, ambient blanks and decontamination water samples were also submitted to the laboratory for this SWMU site.

7.3 Physical Characteristics

This section provides a discussion of the surface water drainage, groundwater, soils, and geology at the Aircraft Wash Drain based on the lithologic descriptions of split barrel continuous samples and other observations from this investigation. Some information was obtained from other published documents.

7.3.1 Surface Water Drainage

A topographic/surface drainage map in addition to text found in Installation Restoration Program Records Search, August 1983, prepared by CH_2M Hill indicates that surface water drainage in the vicinity of this SWMU is directed topographically and through a series of ditches to Stormwater Collection Point (SWMU No. 85). SWMU No. 85 is an ephemeral lake basin (playa) located in the southwest corner of the base. Stormwater can also enter the pad drain which flows to SWMU No. 85.

7.3.2 Groundwater

Depth to groundwater at Cannon AFB is approximately 250 feet or greater. Groundwater recharge rates for the High Plains Region are typically low. Localized recharge rates for Curry County range from 0.75 - 12.22 mm/yr (Stone, 1985). EPA, 1987 DRASTIC reports recharge rates of 1 in/yr. Section 1.4.3.5 of this report includes a discussion of groundwater hydrology for Cannon AFB.

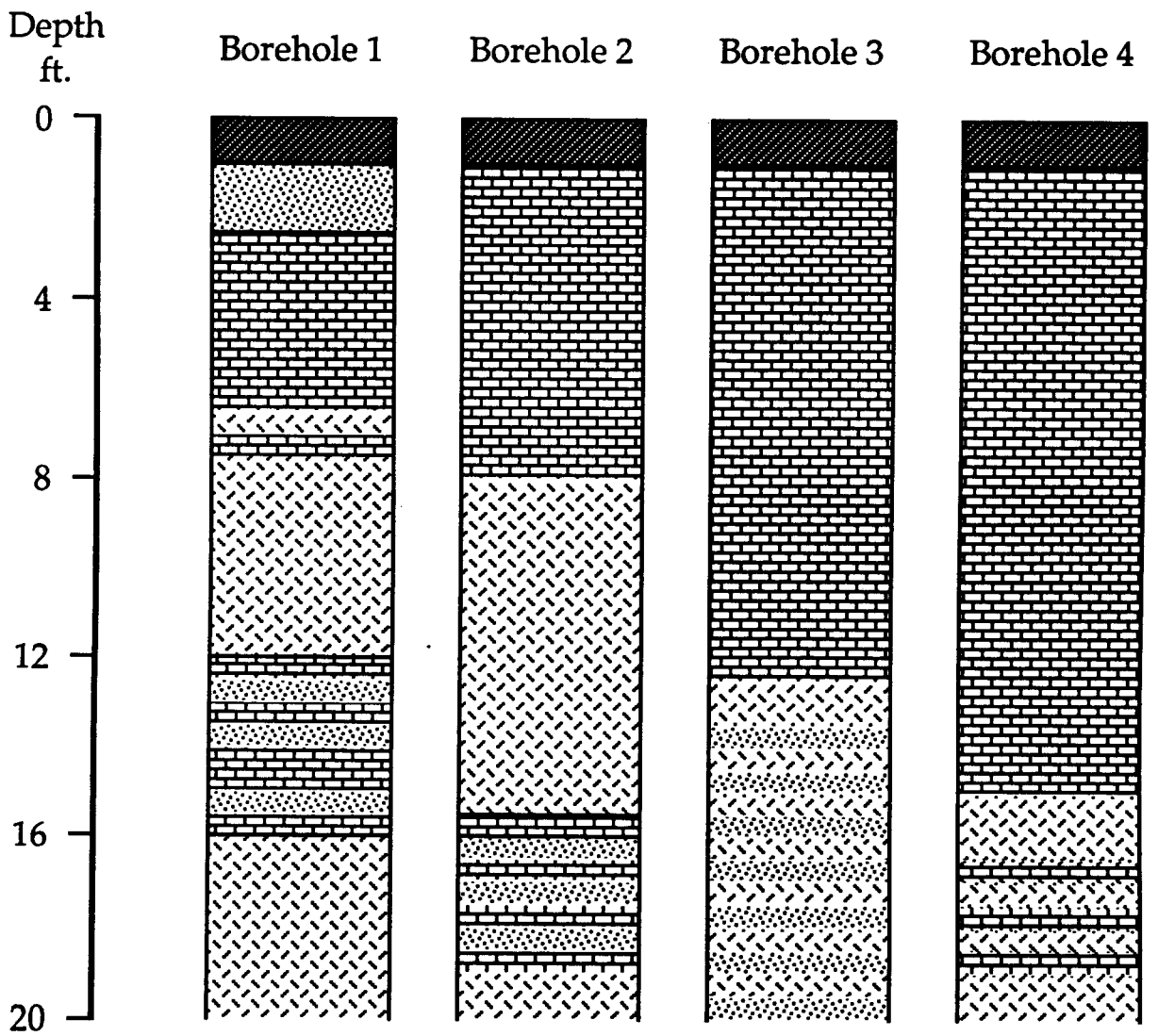
7.3.3 Soils and Geology

The near surface (upper twenty feet) stratigraphy in the area surrounding the aircraft washrack drain system consist of Tertiary Miocene to Pliocene fluvial deposits of the Ogallala Formation. The soils have been described as a fine sandy loam (Ab) of the Amarillo soil group (USDA, 1993). Interpretations and correlation on the fluvial deposits for this area are based on split spoon samples collected during the drilling process. The soils consist of very fine to fine-grained, moderate to well sorted, immature to submature (textural), unconsolidated, calcareous, reddish brown to tan, clays, silts, and sands. Thin to moderately thin layers of caliche material were interbedded throughout much of the samples collected. The sands were comprised of angular to subangular grains with varying amounts of silts, clays, and calcium carbonate (caliche) material. This description of lithology (Figure 7-2) is simliar to the description of soils given by the USDA Draft Soil Survey, 1993. The thickness of this particular unit remains unknown, due to the fact that boring levels did not exceed twenty feet. The total thickness of the Ogallala Formation beneath the aircraft drain system is not presently known, but regional information based on Curry County reports have suggested thicknesses of approximately 320-400 feet. No groundwater was encountered while drilling at these four borehole locations. The minimum depth of the High Plains aquifer is reported to be greater than 250 feet below ground surface.

7.4 Nature and Extent of Contamination

7.4.1 Volatile Organic Compounds

A series of HNU meter readings were taken in the well head and in the breathing zone for each borehole for worker safety purposes. Well head readings were positive for all boreholes, particularly boreholes 1 and 2, ranging from 0.2 - 480 ppm (Table 7-3). A single reading of 4.0 occurred in the breathing zone of borehole 1. Due to the high HNU readings for boreholes 1 and 2, modified level C personal protection was employed in the immediate area of boreholes 1 and 2.



LEGEND

- Asphalt
- Sand
- Clay
- Caliche

LRL Sciences, Inc.

SWMU #9
STRATIGRAPHIC COLUMN
CANNON AFB, NEW MEXICO

Project: Cannon AFB RFI	
Contract No: DACA47-93-C-009	
Prepared by: DR	Date: 3/2/94

Figure 7-2.

Table 7-3.
HNU Meter* Readings (PPM) in Borehole Headspace
SWMU No. 9 - Aircraft Washrack Drain System

DATE: 4/16/93							
TIME	BH1	TIME	BH2	TIME	BH3	TIME	BH4
0900	4.2	1036	40.0	1150	1.0	1440	9.0
0905	80.0	1039	30.0	1155	0.8	1445	10.0
0910	40.0	104.3	0.0	1210	0.0	1455	2.0
0930	22.0	1052	2.0	1220	0.0	1459	0.4
0945	1.0	1053	0.0	1255	0.0	1507	0.2
0958	1.6	1101	0.0			1529	3.0
1013	480.0						
* Model: 101, Type: OVA PID, Make: HNU							

Samples were collected from all four boreholes, at the surface and at 10 feet, and analyzed for Target Compound List Volatile Organic Compounds (TCL VOC). Following are the results of these analyses:

7.4.1.1 Borehole 1

In borehole 1, acetone and tetrachloroethene were detected in the surface sample (CAN009-AWD1-031A) at 28 μg/kg and 14 μg/kg respectively (Table 7-4). Xylene was also detected below the CRQL but rejected due to co-elution with unknown contaminants. TIC compounds were also detected.

Table 7-4.
Concentration (μg/kg) of Volatile Organic Compounds
SWMU No. 9 - Aircraft Washrack Drain System

Borehole Number	Cannon Number	Depth (ft.)	Chemical			
			Toluene	Acetone	Xylene	Tetrachloro ethene
1	CAN009-AWD1-031A	Surface	11U	28	R	14
	CAN009-AWD1-032D	10.0	12U	12U	12U	12U
2	CAN009-AWD2-031A	Surface	56U	56U	56U	56U
	CAN009-AWD2-032D	10.0	11U	16	11U	11U
	CAN009-AWD2-831D			11U (QCD)		
3	CAN009-AWD3-031A	Surface	58U	250	58U	58U
	CAN009-AWD3-032D	10.0	11U	R	11U	11U
4	CAN009-AWD4-031A	Surface	43J	170	52J	58U
	CAN009-AWD4-032D	10.0	11U	11U	11U	11U

Duplicate samples or laboratory repeat samples are presented only if they are different from the original sample and not rejected.

J = estimate
R = rejected

U = not detected at CRQL
UJ = estimated as non-detect at CRQL
QCD = duplicate analyzed at the same lab as the normal sample.

At 10 feet no target compounds were detected. TIC compounds were detected but rejected since there was no correlation between these data and the QA/QC duplicates also collected at this depth. The QC duplicate, which was analyzed at the same lab as the normal sample, contained no target compounds and no TIC compounds. The QA duplicate, which was analyzed at a different lab than the normal sample, contained acetone and methylene chloride. These two analytes appear in nearly all the samples from the QA lab and and have been rejected as laboratory contaminants. There were no TIC compounds detected.

7.4.1.2 Borehole 2

In borehole 2, no target compounds were detected in the surface sample but TIC compounds were present.

Acetone was detected at 16 μg/kg in the sample collected at 10 feet (CAN009-AWD2-032D) but did not appear in the QC duplicate. The QA duplicate contains both acetone and methylene chloride, however, due to the prevalence of these two compounds at the QA laboratory, they were considered laboratory contaminants. The 10 foot sample contained one TIC compound

which was rejected since no TIC compounds were detected in either the QC duplicate or the QA duplicate.

7.4.1.3 Borehole 3

In borehole 3, acetone was detected in the surface sample (CAN009-AWD3-031A) at 250 μg/kg. TIC compounds were also detected.

At 10 feet acetone was detected but rejected due to co-elution of some contaminant. No TIC compounds were detected.

7.4.1.4 Borehole 4

In borehole 4, acetone was detected at 170 μg/kg in the surface sample (CAN009-AWD4-031A). Toluene and xylene were also detected below the CRQL. TIC compounds were detected.

At 10 feet no target compounds or TIC compounds were detected.

7.4.2 BTEX

In each borehole two samples were collected for BTEX analysis. Samples were collected at 5, 15, and 20 feet of depth. No BTEX compounds were detected in any of the samples. QA/QC BTEX duplicates were not collected and therefore not analyzed.

7.4.3 Priority Metals

Total metals concentrations, using the RCRA SW-846 test methods for the analysis of metals in soils, were determined for the eight TCLP metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) plus nickel. These are the priority metals. Samples were collected for priority metals analysis at the surface, 5, 10, 15, and 20 feet.

In the following presentation of metals results, only metals concentrations in excess of background concentrations are presented. No background data was collected for this investigation, therefore, background concentrations were taken from Concentrations of Selected Naturally Occurring Chemical Constituents in Soil and Groundwater at Cannon Air Force Base Clovis, New Mexico, March 1993 prepared by Woodward-Clyde. For a discussion of Woodward-Clydes background data see Section 1.7.

7.4.3.1 Borehole 1

In the surface sample (CAN009-AWD1-021A), barium was detected at 840 mg/kg but was qualified as an estimate due to lack of agreement with the laboratory duplicate (Table 7-5). The chromium concentration was 19.5 mg/kg but was qualified as an estimate since the ICP Serial Dilution %D was outside control limits. Background concentrations for barium and chromium are 642 mg/kg and 12.5 mg/kg respectively.

The sample collected at 5 feet contained no metals in excess of the background concentrations.

The sample collected at 10 feet (CAN009-AWD1-023D) contained barium above background at 1380 mg/kg. This value was qualified as an estimate since it was not in agreement with the laboratory duplicate. The QC/QA field duplicate samples were also collected at this depth. The QC field duplicate concentration for barium did not exceed the background concentration but the QA field duplicate (CAN009-AWD1-721D) did at 1240 mg/kg. Background concentration for barium is 642 mg/kg.

The samples collected at 15 feet and 20 feet contained no metals in excess of the background concentrations.

7.4.3.2 Borehole 2

The surface sample (CAN009-AWD2-021A) contained chromium above background at 22.3 mg/kg. This value is an estimate because the ICP Serial Dilution %D exceeded control limits.

The samples collected at 5, 10, 15 and 20 feet contained no metals in excess of the background concentrations. The QC and the QA field duplicates, both taken at 10 feet, also contained no metals in excess of the background concentrations.

7.4.3.3 Borehole 3

The surface sample (CAN-009-AWD3-021A) contained nickel at 10.5 mg/kg and chromium at 17.7 mg/kg. The chromium concentration is an estimate because the ICP Serial Dilution %D exceeded the control limits. The background concentration for nickel is 9.0 mg/kg and for chromium, 12.5 mg/kg.

The samples collected at 5, 10, 15, and 20 feet contained no metals in excess of the background concentrations.

7.4.3.4 Borehole 4

The surface sample (CAN009-AWD4-021A) contained nickel at 10.0 mg/kg and chromium at 26.9 mg/kg. The chromium concentration is an estimate because the ICP Serial Dilution %D exceeded the control limits.

Table 7-5.
Concentration (mg/kg) of Priority Metals
SWMU No. 9 - Aircraft Wash Drain System

Borehole Number	Sample Number (CAN009-AWD)	Sample Depth (feet)	Barium		Chromium		Nickel
1	1-021A	0	**840**	J	**19.5**	J	5.9
	1-022C	5	161	J	8.1	J	7.3
	1-023D	10	**1380**	J	3.2	J	3.6
(QAD)	1-721D	10	**1240**		5		4.5
(QCD)	1-821D	10	181	J	5.8	J	5.1
	1-024E	15	100	J	7.3	J	6.8
	1-025F	20	97.7	J	4.3	J	3
2	2-021A	0	623	J	**22.3**	J	7.7
	2-022C	5	149	J	11.3	J	8.4
	2-023D	10	256	J	5.6	J	5.9
(QAD)	2-721D	10	207		7.5		5.8
(QCD)	2-821D	10	171	J	6.1	J	6.4
	2-024E	15	99.4	J	8	J	6.5
	2-025F	20	532	J	5.8	J	4.8
3	3-021A	0	603	J	**17.7**	J	**10.5**
	3-022C	5	220	J	5.1	J	6.1
	3-023D	10	274	J	5.3	J	5.7
	3-024E	15	184	J	7.2	J	6.7
	3-025F	20	253	J	5.9	J	4.3
4	4-021A	0	457	J	**26.9**	J	**10**
	4-022C	5	215	J	**13.1**	J	8.5
	4-023D	10	**820**	J	5.1	J	4.4
	4-024E	15	86.7	J	8	J	7.4
	4-025F	20	55.6	J	6.1		4.3
Background (95% UCL) (1)			642.00		12.50		9.00

NOTES:

Duplicate samples (QAD) or (QCD) samples are presented only if they are different from the original sample and not rejected.

U indicates that the compound was analyzed for, but not detected at or above the standard limit.
J indicates and estimated value.
UJ indicates the compound was analyzed for but not detected. The sample quantification limit or reported detection limit is an estimated quantity.
*R indicates that the data was rejected because of quality control measures.

Boldface indicates a detection above the 95% UCL background level.

Only data for metals detected above background is presented.

(1) Background data is described in Section 1.7.

The sample collected at 5 feet (CAN009-AWD4-022C), contained chromium at 13.1 mg/kg. This value is an estimate since the ICP Serial Dilution %D exceeded the control limits.

The sample collected at 10 feet (CAN009-AWD4-023D) contained barium above background at 820 mg/kg. This value is an estimate since it was not in agreement with the laboratory duplicate.

At 15 and 20 feet no priority metals were detected above background.

7.4.4 Summary of Data

Several VOCs and metals occur in one or more of the surface samples of all four boreholes (acetone, tetrachloroethane, toluene, xylene, chromium, nickel, and barium). Barium, chromium, and acetone occurred again at 5 to 10 feet. Below 10 feet, no metals were detected above background. VOCs were not tested for at 15 and 20 feet, however, BTEX analysis at these depths yielded no detects.

7.5 Recommendations

Concentrations of organics and metals found in soils around the drain are low and generally diminishing with depth. Groundwater level is deep at approximately 250 feet below ground surface. In addition, the risk assessment information associated with this SWMU indicates minimal or no risk to human health or the environment. Therefore, no further action is recommended.

8.0 OIL/WATER SEPARATOR (SWMU NO. 11/SITE NO. 170)

8.1 SWMU Description

8.1.1 Setting

SWMU No. 11 is a grease trap which has been previously misidentified as an oil/water separator. It is located on the west side of Building 170. The unit is a one-compartment underground unit, constructed of concrete. Access to the unit is through a six inch diameter opening which is used for sampling and pumping out the unit's contents. The opening to the separator is surrounded on all sides by asphalt. The depth of the unit is unknown. Borehole locations were selected, in part, to avoid underground utilities and the building. Figure 8-1 shows the SWMU setting and borehole locations. The driller was required to penetrate asphalt and restore the surface with concrete plugs.

8.1.2 History of Use

This grease trap has been active since 1943 and is still in use. Water from the hanger flows through the concrete chamber and discharges to the Sanitary Sewer Line (SWMU No. 98) which ultimately discharged into one of two sewage lagoons (SWMU Nos. 101 and 102). The unit receives wash water generated from aircraft maintenance operations, which contains petroleum, synthetic lubricating oils and dirt.

8.1.3 Past Investigations

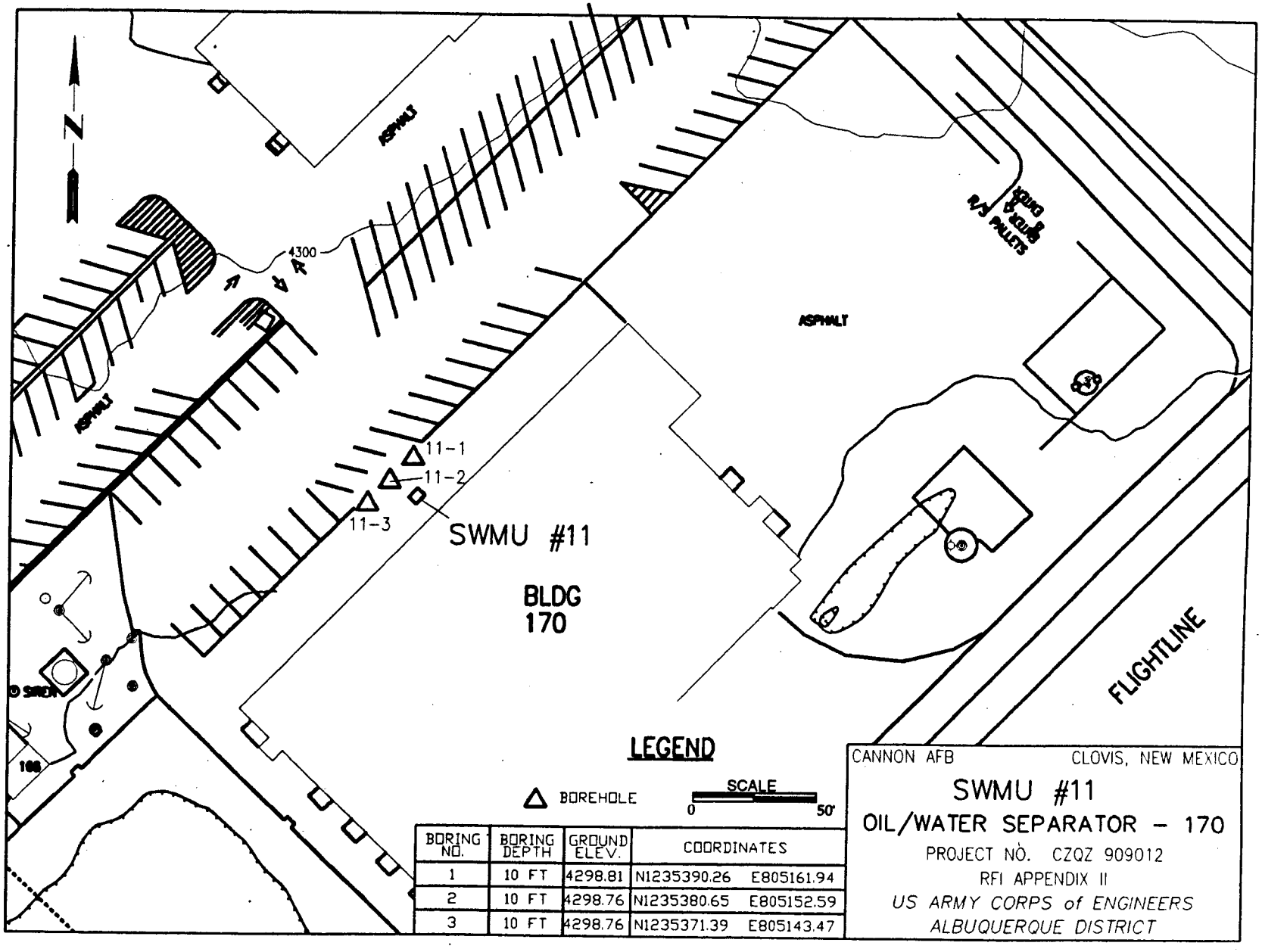
This unit was not included in a 1988 study conducted by the Tulsa District Corps of Engineers which sampled the influent and effluent of a number of oil/water separators at Cannon Air Force Base. Therefore no previous data is available.

8.1.4 Land Use and Demography

This SWMU is located in an area of the base which is commonly used by base personnel. However, the unit is under ground and the area is covered by asphalt.

8.2 Field Investigation

Drilling and sampling activities at this SWMU occurred April 12, 1993 at 0820. The activities at SWMU No. 11 as outlined in the FSP (LRL, 1993) consisted of drilling 3 boreholes, and collecting 6 surface samples, 18 subsurface samples, 4 QA/QC duplicate samples and 6 QA/QC water samples. Table 8-1 summarizes the drilling and sampling methods, along with sampling frequency conducted at SWMU 11. Table 8-2 summarizes the various samples collected and analyses performed.



BORING NO.	BORING DEPTH	GROUND ELEV.	COORDINATES	
1	10 FT	4298.81	N1235390.26	E805161.94
2	10 FT	4298.76	N1235380.65	E805152.59
3	10 FT	4298.76	N1235371.39	E805143.47

Figure 8-1.

Table 8-1.
Summary of Drilling and Sampling
SWMU No.11 - Oil/Water Separator No. 170

Borehole Number	Sampling Depth (ft.-BGS)	Drilling/ Sampling Methods	Drillrig Used	Borehole Diameter (in.)	Ground Elevation	Date Grouted
1	0	NA/SSS	NA	NA	4298.81	4/14/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
2	0	NA/SSS	NA	NA	4298.76	4/14/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		
3	0	NA/SSS	NA	NA	4298.76	4/14/93
	2.5	HSA/SBC	CME-75	8.0		
	5.0	HSA/SBC	CME-75	8.0		
	10.0	HSA/SBC	CME-75	8.0		

HSA = Hollow Stem Auger
HA = Hand Auger
SBC = Split Barrel Continuous Sampler
SS = Split Spoon
SSS = Stainless Steel Spoon

Table 8-2.
Summary of Sampling and Analyses
SWMU No. 11 - Oil/Water Separator No. 170

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
1	0	CAN011-1701-021A	N	SOIL	0940	PM	6010\7000S+
		CAN011-1701-031A	N	SOIL	0940	TCL VOC	8240
	2.5	CAN011-1701-011B	N	SOIL	0950	BTEX	8020
		CAN011-1701-022B	N	SOIL	0950	PM	6010\7000S
	5.0	CAN011-1701-012C	N	SOIL	1007	BTEX	8020
		CAN011-1701-023C	N	SOIL	1007	PM	6010\7000S
	10.0	CAN011-1701-024D	N	SOIL	1005	PM	6010\7000S
		CAN011-1701-032D	N	SOIL	1005	TCL VOC	8240
		CAN011-1701-821D	QCD	SOIL	1005	PM	6010\7000S
		CAN011-1701-831D	QCD	SOIL	1005	TCL VOC	8240
		CAN011-1701-721D	QAD	SOIL	1005	PM	6010\7000S
		CAN011-1701-731D	QAD	SOIL	1005	TCL VOC	8240
2	0	CAN011-1702-021A	N	SOIL	1025	PM	6010\7000S
		CAN011-1702-031A	N	SOIL	1025	TCL VOC	8240
	2.5	CAN011-1702-011B	N	SOIL	1035	BTEX	8020
		CAN011-1702-022B	N	SOIL	1035	PM	6010\7000S
	5.0	CAN011-1702-012D	N	SOIL	1045	BTEX	8020
		CAN011-1702-023D	N	SOIL	1045	PM	6010\7000S
	10.0	CAN011-1702-024D	N	SOIL	1047	PM	6010\7000S
		CAN011-1702-032D	N	SOIL	1047	TCL VOC	8240

Table 8-2. (Concluded)
Summary of Sampling and Analyses
SWMU No. 11 - Oil/Water Separator No. 170

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
3	0	CAN011-1703-021A	N	SOIL	1105	PM	6010\7000S
		CAN011-1703-031A	N	SOIL	1105	TCL VOC	8240
	2.5	CAN011-1703-011B	N	SOIL	1115	BTEX	8020
		CAN011-1703-022B	N	SOIL	1115	PM	6010/7000S
	5.0	CAN011-1703-012D	N	SOIL	1020	BTEX	8020
		CAN011-1703-023D	N	SOIL	1025	PM	6010\7000S
	10.0	CAN011-1703-024D	N	SOIL	1027	PM	6010\7000S
		CAN011-1703-032D	N	SOIL	1023	TCL VOC	8240
		CAN011-1700-431Z	QC	WATER	1015	TCL VOC	8240
		CAN011-1700-321Z	QC	WATER	1150	PM	6010\7000S
		CAN011-1700-331Z	QC	WATER	1145	TCL VOC	8240
		CAN011-1700-231Z	QC	WATER	1147	TCL VOC	8240
		CAN011-1700-621Z	QC	WATER	1150	PM	6010\7000S
		CAN011-1700-631Z	QC	WATER	1150	TCL VOC	8240

BTEX = Benzene, Toluene, Ethyl Benzene, Xylene
ft-BGS = feet below ground surface
N = Normal soil sample
PM = Priority metals = 8 TCLP metals + Ni
TCL VOC = Target Compound List Volatile Organic Compounds
+ = Metals analyzed using the 7000 Series include: mercury, selenium, and arsenic.

QAD = Duplicate soil sample (analyzed at different laboratory from normal samples).
QCD = Duplicate soil sample analyzed at same laboratory as normal samples.
QC = Quality control water sample (ambient blank, trip blank, etc.)
TAL Metals = Target analyte list metals

8.2.1 Sampling Objectives

Borehole locations, sampling depth, and parameters for analysis were selected, to the greatest extent possible, to determine if a release from the oil/water separator has occurred. Borehole locations were changed from the original FSP locations in order to avoid the sewer line and the building. Figure 8-1 shows the borehole locations.

8.2.2 Surface and Subsurface Soil Investigation

Three boreholes were drilled at this SWMU. Borehole 1 was drilled to the north of the unit. Borehole 2 was drilled to the northwest of the unit. Borehole 3 was drilled to the west of the unit. Drilling was advanced to a depth of 10 feet. Samples were collected at the surface, 2.5, 5 and 10 feet in depth. Surface samples were collected with a stainless steel trowel. Subsurface samples were collected using a split barrel continuous sampler. Samples were collected at discrete depths and locations. No composite samples were taken. Samples were analyzed for BTEX, priority metals and TCL VOC. Duplicates, rinsate blanks, ambient blanks and decontamination water samples were also submitted to the laboratory for this SWMU site.

8.3 Physical Characteristics

This section provides a discussion of the surface water drainage, groundwater, soils and geology at the No. 170 grease trap based on a review of information from previous investigations at Cannon AFB and from the lithologic descriptions from a split barrel continuous sampler.

8.3.1 Surface Water Drainage

A topographic/surface drainage map in addition to text found in Installation Restoration Program Records Search, August 1983 prepared by CH_2M Hill indicates that surface water drainage in the vicinity of SWMU No. 11 is directed topographically and through a series of ditches to Stormwater Collection Point (SWMU No. 85). SWMU No. 85 is an ephemeral lake basin (playa) located in the southwest corner of the base.

8.3.2 Groundwater

Depth to groundwater at Cannon AFB is approximately 250 feet or greater. Groundwater recharge rates for the High Plains Region are typically low. Localized recharge rates for Curry County range from 0.75 - 12.22 mm/yr (Stone, 1985). EPA, 1987 DRASTIC reports recharge rates of 1 in/yr. Section 1.4.3.5 of this report includes a discussion of groundwater hydrology for Cannon AFB.

8.3.3 Soils and Geology

The near surface (upper ten feet) stratigraphy in the area surrounding this SWMU consist of Tertiary Miocene to Pliocene fluvial deposits of the Ogallala Formation. The soils have been described as a fine sandy loam (Ab) of the Amarillo soil group (USDA draft "Soil Survey" 1993). Interpretations and correlation on the fluvial deposits for this area are based on split

spoon samples collected during the drilling process. The soils consist of very fine to fine-grained, moderate to well sorted, submature to mature (textural), unconsolidated, calcareous, red to dark red, clays, silts, and sand. Thin to moderately thin layers and nodules of caliche material were interbedded throughout much of the samples collected. The sands were comprised of angular to subangular grains with varying amounts of silts, clays, and calcium carbonate (caliche) material. This description of lithology (Figure 8-2) is simuliar to the description of soils given by the USDA Draft Soil Survey, 1993. The thickness of this particular unit remains unknown, due to the fact that boring levels did not exceed ten feet. The total thickness of the Ogallala Formation beneath this SWMU is not presently known, but regional information based on Curry County reports have suggested thicknesses of approximately 320-400 feet. No groundwater was encountered while drilling at these three borehole locations. The minimum depth of the High Plains aquifer is reported to be greater than 250 feet below ground surface.

8.4 Nature and Extent of Contamination

8.4.1 Volatile Organic Compounds

A series of HNU meter readings were taken in the well head and in the breathing zone of each borehole for worker safety purposes. In all three boreholes there were some positive readings in the wellhead ranging from 0.0 to 6.0 ppm (Table 8-3). All readings from the breathing zone were 0.0.

Table 8-3.
HNU Meter* Readings (PPM) in Borehole Headspace
SWMU No. 11 - Oil/Water Separator No. 170

DATE: 4/12/93					
TIME	BH1	TIME	BH2	TIME	BH3
0943	5.0	1026	5.0	1105	6.0
0948	0.0	1035	6.0	1109	1.0
1003	0.5	1041	2.0	1117	0.0
1008	1.5	1053	2.0		

* Model: 101, Type: OVA PID, Make: HNU

Samples were collected from all three boreholes, at the surface and at 10 feet, and analyzed for Target Compound List Volatile Organic Compounds (TCL VOC). Following are the results of these analyses.

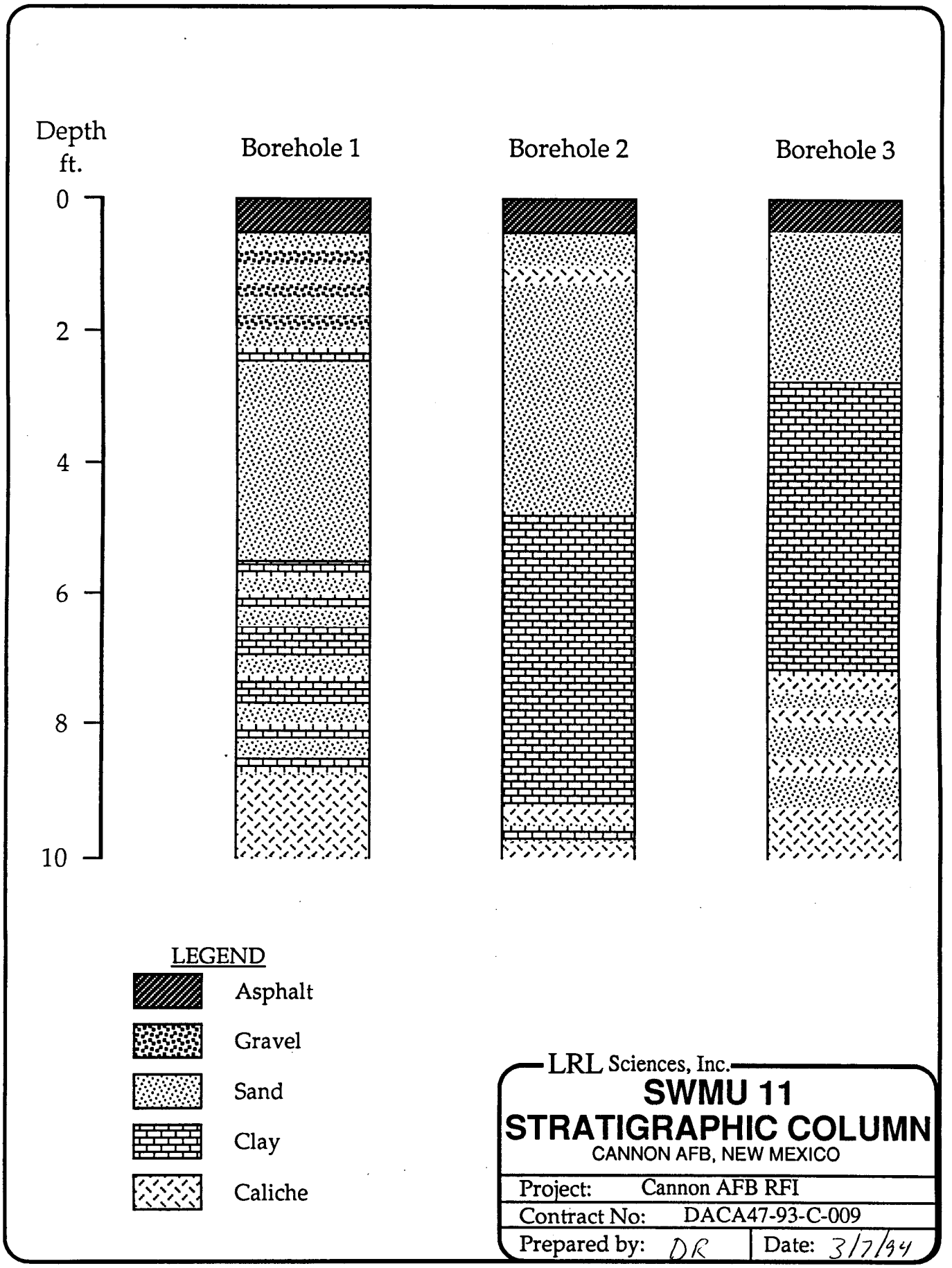

Depth
ft.
0
2
4
6
8
10
Borehole 1
Borehole 2
Borehole 3
LEGEND
Asphalt
Gravel
Sand
Clay
Caliche
LRL Sciences, Inc.
SWMU 11
STRATIGRAPHIC COLUMN
CANNON AFB, NEW MEXICO
Project: Cannon AFB RFI
Contract No: DACA47-93-C-009
Prepared by: DR
Date: 3/7/94

Figure 8-2.

8.4.1.1 Borehole 1

In borehole 1, the surface sample and a laboratory repeat analysis of the surface sample yielded no target compounds. However, both samples contained TIC compounds.

At 10 feet, no target compounds or TIC compounds were detected. QA and QC duplicate samples were taken in association with this sample. The QC duplicate, which was analyzed at the same lab did not contain target or TIC compounds. The QA sample, analyzed at another lab, contained acetone, methylene chloride and 2-butanone. The prevalence of methylene chloride and acetone in nearly all the QA lab samples suggests that they are laboratory contaminants. Therefore, they have been rejected. 2-butanone was also rejected since it is a common laboratory contaminant and since there were no detections of this compound at the QC lab.

8.4.1.2 Borehole 2

In borehole 2, methylene chloride was detected in the surface sample (CAN011-1702-031A) but was qualified as an estimate since the value was below the CRQL (Table 8-4). Acetone was detected but qualified as a non-detect since it also appeared in the method blank. TIC compounds were detected.

At 10 feet (CAN011-1702-032D), methylene chloride was detected below the CRQL. No TIC compounds were detected.

Table 8-4.
Concentration (μg/kg) of Volatile Organic Compounds
SWMU No. 11 - Oil/Water Separator No. 170

BOREHOLE NUMBER	CANNON NUMBER	DEPTH (ft.)	CHEMICAL	
			TOLUENE	METHYLENE CHLORIDE
1	CAN011-1701-031A	Surface	58U	58U
	CAN011-1701-032D	10.0	11U	11U
2	CAN011-1702-031A	Surface	11U	6J
	CAN011-1702-032D	10.0	10U	6J
3	CAN011-1703-031A	Surface	13	11U
	CAN011-1703-032D	10.0	11U	11U

Duplicate samples or laboratory repeat samples are presented only if they are different from the original sample and not rejected.

J = estimate
R = rejected
U = not detected at CRQL
UJ = estimated as non-detect at CRQL

8.4.1.3 Borehole 3

In borehole 3, the surface sample (CAN011-1703-031A) contained toluene at 13 μg/kg. This sample also contained TIC compounds.

At 10 feet, no target or TIC compounds were detected.

8.4.2 BTEX

In each borehole, 2 samples were collected for BTEX analysis at 2.5 and 10 feet of depth. No BTEX compounds were detected in any of the samples. QA/QC duplicate samples were not collected and therefore QA/QC BTEX analyses were not performed.

8.4.3 Priority Metals

Total metals concentrations, using the RCRA SW-846 test methods for the analysis of metals in soils, were determined for the eight TCLP metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) plus nickel. These are the priority metals. Samples were collected for priority metals analysis at the surface, 2.5, 5, and 10 feet.

In the following presentation of metals results, only metals concentrations in excess of background concentrations are presented. No background data was collected for this investigation, therefore, background concentrations were taken from Concentrations of Selected Naturally Occurring Chemical Constituents in Soil and Groundwater at Cannon Air Force Base Clovis, New Mexico, March 1993 prepared by Woodward-Clyde. For a discussion of Woodward-Clydes background data see Section 1.7.

8.4.3.1 Borehole 1

No metals were detected above background in the surface sample.

At 2.5 feet (CAN011-1701-022B) nickel was detected at 9.6 mg/kg (Table 8-5). The background value for nickel is 9.0 mg/kg.

At 5 and 10 feet no metals were detected above the background level. The QA and QC duplicates were collected at 10 feet. The QA duplicate (CAN011-1701-721D), which was analyzed at a different lab from the normal sample, contained mercury above background at 0.26 mg/kg.

Table 8-5.
Concentration (mg/kg) of Priority Metals
SWMU No. 11 - Oil/Water Separator No. 170

Borehole Number	Sample Number (CAN011-170)	Sample Depth (feet)	Chromium		Mercury		Nickel	
1	1-021A	0	**14.3**	UJ	0.02	U	4.9	J
	1-022B	2.5	11.1	UJ	0.02	U	**9.6**	
	1-023C	5	5.3	UJ	0.02	U	4.5	J
	1-024D	10	6.7	UJ	0.1	U	4.6	J
(QAD)	1-721D	10	5.3		**0.26**		4.7	
(QCD)	1-821D	10	5.1	UJ	0.01	U	4.2	J
2	2-021A	0	9.2	UJ	0.03	U	5.2	J
	2-022B	2.5	8.4	UJ	0.02	U	**9.6**	J
	2-023C	5	5.6	UJ	0.02	U	3.6	J
	2-024D	10	3.7	UJ	0.03	U	3.2	
3	3-021A	0	**15.1**	UJ+	0.02	U	7.3	J
	3-022B	2.5	8	UJ	0.1	U	**10.6**	J
	3-023C	5	3.1	UJ	0.01	U	5.1	J
	3-024D	10	1.1	UJ	0.01	U	3.8	J
Background (95% UCL) (1)			12.50		0.13		9.00	

NOTES:

Duplicate samples (QAD) or (QCD) samples are presented only if they are different from the original sample and not rejected.

U indicates that the compound was analyzed for, but not detected at or above the standard limit.
J indicates and estimated value.
UJ indicates the compound was analyzed for but not detected. The sample quantification limit or reported detection limit is an estimated quantity.
*R indicates that the data was rejected because of quality control measures.

Boldface indicates a detection above the 95% UCL background level.

Only data for metals detected above background is presented.

(1) Background data is described in Section 1.7.

8.4.3.2 Borehole 2

No metals were detected above background levels in the surface sample.

At 2.5 feet (CAN011-1702-022B), nickel was detected at 9.6 mg/kg.

At 5 and 10 feet, no metals were detected above the background level.

8.4.3.3 Borehole 3

No metals were detected above background levels in the surface sample.

At 2.5 feet (CAN011-1703-022B), nickel was detected at 10.6 mg/kg. This value is an estimate since the matrix spike recovery was was not within control limits.

At 5 and 10 feet, no metals were detected above background levels.

8.4.4 Summary of Data

Low concentrations of VOCs and TIC compounds were detected in the surface samples of this SWMU. While no metals were detected above background in the surface samples, nickel was detected marginally above background in all the boreholes at 2.5 feet. At 10 feet, mercury was detected by the QA lab only in borehole 1 and methylene chloride was detected below the CRQL in borehole 2.

8.5 Recommendations

Concentrations of organics and metals found in soils around this SWMU are low and generally diminishing with depth. In addition, groundwater level is deep at approximately 250 feet below ground surface. The oil/water separator should be tested for structural integrity to determine that the unit contains no cracks or leaks. If none are found, based on the risk assessment information associated with this SWMU indicating minimal or no risk to human health or the environment, no further action is recommended. If the integrity test fails, however, it is recommended that the unit be removed and soils below the separator be analyzed. Further action would depend upon the results of these analyses.

9.0 OIL/WATER SEPARATOR (SWMU NO. 16/SITE NO. 680)

9.1 SWMU Description

9.1.1 Setting

The oil/water separator No. 680 was located on the southeast corner of building 680. The separator was a three compartment underground unit, with a skimmer, a 584 gallon main compartment and a 140 gallon oil compartment. The unit was constructed of concrete. The separator was excavated in 1991 during building renovations and the area is now inside a garage covered by concrete. A new unit sits approximately 15 feet to the east of this SWMU. The bottom of the separator, when in place, is estimated to have been between 7½ and 12 feet deep. Outside to the southeast of the corner of the building, a hand auger was used for drilling and sample collection due to a concentration of underground and overhead utility lines. Although the original locations of the boreholes, as planned in the FSP, included a borehole inside the garage, information provided by Cannon AFB engineers indicated that this SWMU was originally either under the rear wall of the building or ouside of it. Therefore, all boreholes were drilled outside. Figure 9-1 shows the setting and borehole locations.

9.1.2 History of Use

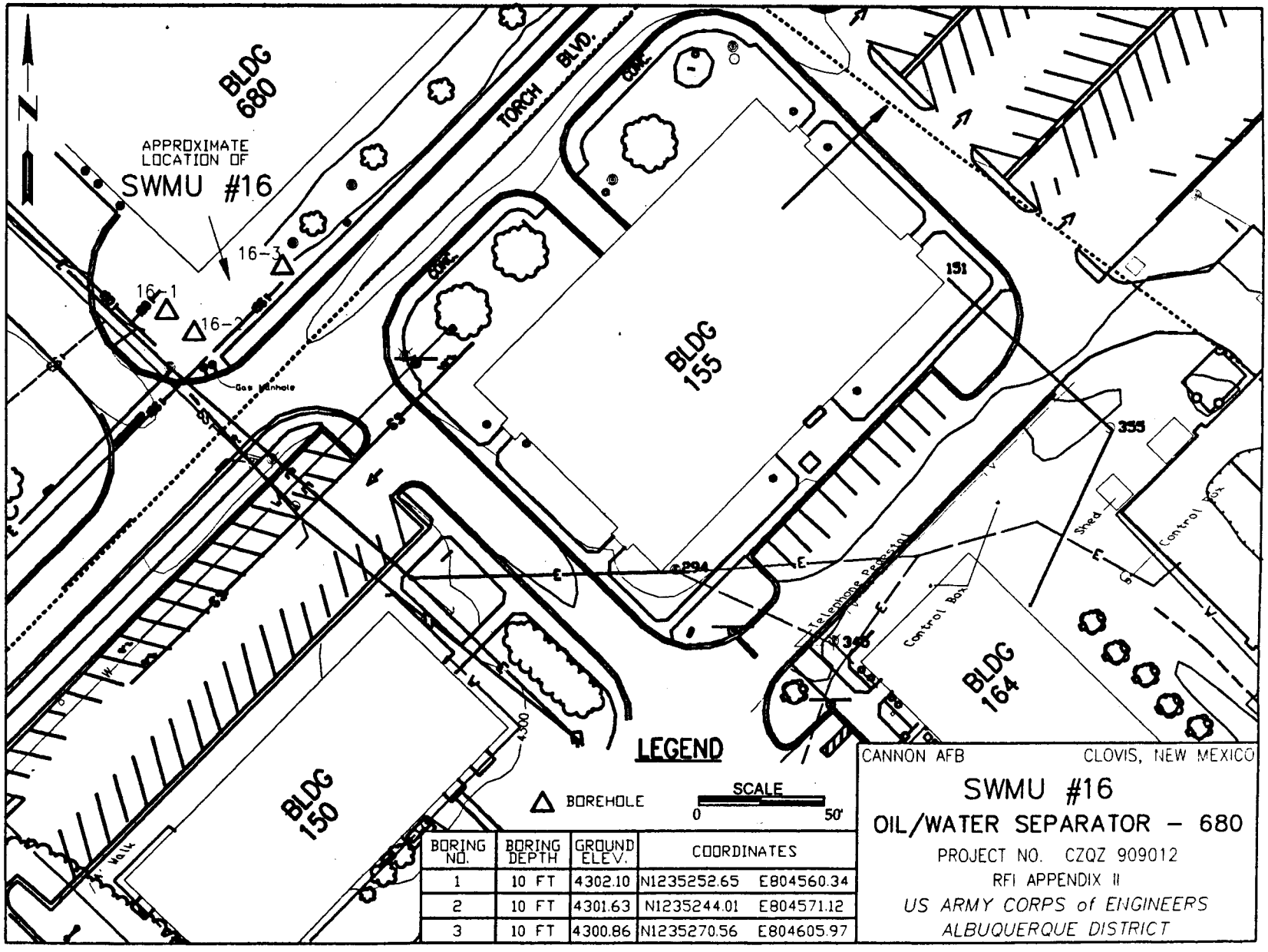
Oil/water separator No. 680 was active from 1965 to 1991 and was excavated in April 1991. While in use, the recovered oils were directed to the 140 gallon holding tank and the waste water was discharged to the Sanitary Sewer Line (SWMU No. 98). Historically, the facility discharging into the separator was used for washing aircraft and maintenance operations. Aircraft fuels and fluids were disposed in accordance with the base waste generation reporting procedures.

9.1.3 Past Investigations

In 1987-1988 the Tulsa District Corps of Engineers conducted a study of a number of oil/water separators on the base. The results of analyses performed on the influent and effluent from this separator are found in Cannon Air Force Base Oil/Water Separators Sampling and Analytical Report, June 1988. The following compounds were present in the influent and/or effluent of this separator: 4-methyl-2-pentanone, naphthalene, 2-methylnaphthalene, xylene, lead, nickel bis(2-ethylhexyl)phthalate, 1,4-dichlorobenzene, 4-methylphenol.

9.1.4 Land Use and Demography

This SWMU is in an area of the base commonly used by base personnel. This separator has been removed and the area is covered partially by a wall of the building and partially by grass.



BORING NO.	BORING DEPTH	GROUND ELEV.	COORDINATES	
1	10 FT	4302.10	N1235252.65	E804560.34
2	10 FT	4301.63	N1235244.01	E804571.12
3	10 FT	4300.86	N1235270.56	E804605.97

Figure 9-1.

9.2 Field Investigation

Activities at SWMU No. 16 began April 10, 1993 beginning at 0805. Due to the density of buried utilities and overhead wires, a hand auger was employed for drilling. The activities at this SWMU consisted of hand augering 3 boreholes and collecting 6 surface samples, 18 normal subsurface samples, 4 QA/QC duplicate samples and 6 QA/QC water samples. Table 9-1 summarizes the field sampling program at SWMU 16. Table 9-2 summarizes the various samples collected and analyses performed.

9.2.1 Sampling Objectives

Borehole locations, sampling depth, and parameters for analysis were selected, to the greatest extent possible, to determine if a release from the oil/water separator has occurred. Boreholes 1 and 2 were moved from the original FSP locations in order to accomodate the location, as recalled by base engineers, of the former oil/water separator. Borehole locations are shown in Figure 9-1.

9.2.2 Surface and Subsurface Soil Investigation

Borehole 1 was augered to the west of the former separator. Borehole 2 was augered to the southwest of the former separator and borehole 3 was augered to the northeast of the former separator. Augering was advanced to a depth of 10 feet. Samples were collected at the surface, 2.5, 5 and 10 feet in depth. Surface samples were collected using a stainless steel spoon and subsurface samples were collected from the hand auger. Samples were collected at discrete depths and locations. No composite samples were taken. Samples were analyzed for BTEX, priority metals and TCL VOCs. Duplicates, rinsate blanks, ambient blanks, decontamination water, and trip blanks were also submitted to the laboratory for this SWMU. The trip blanks and ambient blanks were inadvertently opened at SWMU No. 1 but were still included for analysis.

9.3 Physical Characteristics

This section provides a discussion of the surface water drainage, groundwater, soils and geology at the No. 680 oil/water separator based on a review of information from previous investigations at Cannon AFB and from the lithologic descriptions of the soil samples taken from the hand auger.

9.3.1 Surface Water Drainage

A topographic/surface drainage map in addition to text found in Installation Restoration Program Records Search, August 1983 prepared by CH_2M Hill indicates that surface water drainage in the vicinity of SWMU No. 16 is directed topographically and through a series of ditches to Stormwater Collection Point (SWMU No. 85). SWMU No. 85 is an ephemeral lake basin (playa) located in the southwest corner of the base.

Table 9-1.
Summary of Drilling and Sampling
SWMU No.16 - Oil/Water Separator No. 680

Borehole Number	Sampling Depth (ft.-BGS)	Drilling/ Sampling Methods	Drillrig Used	Borehole Diameter (in.)	Ground Elevation	Date Grouted
1	0	NA/SS	NA	NA	4298.81	4/10/93
	2.5	HA/SBC	NA	8.0		
	5.0	HA/SBC	NA	8.0		
	10.0	HA/SBC	NA	8.0		
2	0	NA/SS	NA	NA	4298.76	4/10/93
	2.5	HA/SBC	NA	8.0		
	5.0	HA/SBC	NA	8.0		
	10.0	HA/SBC	NA	8.0		
3	0	NA/SS	NA	NA	4300.86	4/10/93
	2.5	HA/SBC	NA	8.0		
	5.0	HA/SBC	NA	8.0		
	10.0	HA/SBC	NA	8.0		

HSA = Hollow Stem Auger
HA = Hand Auger
SBC = Split Barrel Continuous Sampler
SS = Split Spoon
SSS = Stainless Steel Spoon

Table 9-2.
Summary of Sampling and Analyses
SWMU No. 16 - Oil/Water Separator No. 680

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
1	0	CAN016-6801-021A	N	SOIL	0830	PM	6010\7000S+
		CAN016-6801-031A	N	SOIL	0830	TCL VOC	8240
	2.5	CAN016-6801-022B	N	SOIL	0840	PM	6010\7000S
		CAN016-6801-032B	N	SOIL	0840	TCL VOC	8240
	5.0	CAN016-6801-011C	N	SOIL	0905	BTEX	8020
		CAN016-6801-023C	N	SOIL	0905	PM	6010\7000S
	10.0	CAN016-6801-012D	N	SOIL	0920	BTEX	8020
		CAN016-6801-024D	N	SOIL	0920	PM	6010\7000S
2	0	CAN016-6802-021A	N	SOIL	0930	PM	6010\7000S
		CAN016-6802-031A	N	SOIL	0930	TCL VOC	8240
	2.5	CAN016-6802-022B	N	SOIL	0938	PM	6010\7000S
		CAN016-6802-032B	N	SOIL	0938	TCL VOC	8240
	5.0	CAN016-6802-011C	N	SOIL	0945	BTEX	8020
		CAN016-6802-023C	N	SOIL	0945	PM	6010\7000S
	10.0	CAN016-6802-012D	N	SOIL	1000	BTEX	8020
		CAN016-6802-024D	N	SOIL	1000	PM	6010\7000S

Table 9-2. (Continued)
Summary of Sampling and Analyses
SWMU No. 16 - Oil/Water Separator No. 680

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
3	0	CAN016-6803-021A	N	SOIL	1005	PM	6010\7000S
		CAN016-6803-031A	N	SOIL	1005	TCL VOC	8240
	2.5	CAN016-6803-022B	N	SOIL	1022	PM	6010\7000S
		CAN016-6803-032B	N	SOIL	1020	TCL VOC	8240
		CAN016-6803-821B	QCD	SOIL	1022	PM	6010\7000S
		CAN016-6803-831B	QCD	SOIL	1020	TCL VOC	8240
		CAN016-6803-721B	QAD	SOIL	1022	PM	6010\7000S
		CAN016-6803-731B	QAD	SOIL	1020	TCL VOC	8240
	5.0	CAN016-6803-011C	N	SOIL	1025	BTEX	8020
		CAN016-6803-023C	N	SOIL	1025	PM	6010\7000S
	10.0	CAN016-6803-012D	N	SOIL	1040	BTEX	8020
		CAN016-6803-024D	N	SOIL	1040	PM	6010\7000S

Table 9-2. (Concluded)
Summary of Sampling and Analyses
SWMU No. 16 - Oil/Water Separator No. 680

Borehole Number	Sampling Depth (ft.-BGS)	Sample ID Number	Sample Type	Sample Matrix	Sample Time	Analytical Parameter	Test Method
		CAN016-6800-431Z	QC	WATER	1100	TCL VOC	8240
		CAN016-6800-321Z	QC	WATER	1105	PM	6010\7000S
		CAN016-6800-331Z	QC	WATER	1110	TCL VOC	8240
		CAN016-6800-231Z	QC	WATER	1110	TCL VOC	8240
		CAN016-6800-621Z	QC	WATER	1105	PM	6010\7000S
		CAN016-6800-631Z	QC	WATER	1110	TCL VOC	8240

BTEX = Benzene, Toluene, Ethyl Benzene, Xylene
ft-BGS = feet below ground surface
N = Normal soil sample
PM = Priority metals = 8 TCLP metals + Ni
TCL VOC = Target Compound List Volatile Organic Compound
+ = Metals analyzed using the 7000 Series include: mercury, selenium, and arsenic.

QAD = Duplicate soil sample (analyzed at different laboratory from normal samples).
QCD = Duplicate soil sample analyzed at same laboratory as normal samples.
QC = Quality control water sample (ambient blank, trip blank, etc.)
TAL Metals = Target analyte list metals

9.3.2 Groundwater

Depth to groundwater at Cannon AFB is approximately 250 feet or greater. Groundwater recharge rates for the High Plains Region are typically low. Localized recharge rates for Curry County range from 0.75 - 12.22 mm/yr (Stone, 1985). EPA, 1987 DRASTIC reports recharge rates of 1 in/yr. Section 1.4.3.5 of this report includes a discussion of groundwater hydrology for Cannon AFB.

9.3.3 Soils and Geology

The near surface (upper ten feet) stratigraphy in the area surrounding this SWMU consist of Tertiary Miocene to Pliocene fluvial deposits of the Ogallala Formation. The soils have been described as a fine sandy loam (Ab) of the Amarillo soil group (USDA draft "Soil Survey" 1993). Interpretations and correlation on the fluvial deposits for this area are based on split spoon samples collected during the drilling process. The soils are heavily bioturbated within the first foot of section and thereafter consist of very fine to fine-grained, moderate to well sorted, submature to mature (textural), unconsolidated, calcareous, reddish brown, clays, silts, and sands. Thin to moderately thin layers of caliche material were interbedded throughout much of the samples collected. The sands were comprised of angular to subangular grains with varying amounts of silts, clays, and calcium carbonate (caliche) material. This description of lithology (Figure 9-2) is similiar to the description of soils given by the USDA Draft Soil Survey, of 1993. The thickness of this particular unit remains unknown, due to the fact that boring levels did not exceed ten feet. The total thickness of the Ogallala Formation beneath this SWMU is not presently known, but regional information based on Curry County reports have suggested thicknesses of approximately 320-400 feet. No groundwater was encountered while drilling at these three borehole locations. The minimum depth of the High Plains aquifer is reported to be greater than 250 feet below ground surface.

9.4 Nature and Extent of Contamination

9.4.1 Volatile Organic Compounds

A series of HNU meter readings were collected in the well head and in the breathing zone for each borehole for the purpose of worker safety. No positive readings occurred.

Samples were collected from three boreholes at the surface and at 2.5 feet and analyzed for Target List Compound Volatile Organic Compounds (TCL VOC). Following are the results of these analyses.

9.4.1.1 Borehole 1

In borehole 1, no target compounds or TIC compounds were detected in the surface sample or at 2.5 feet.

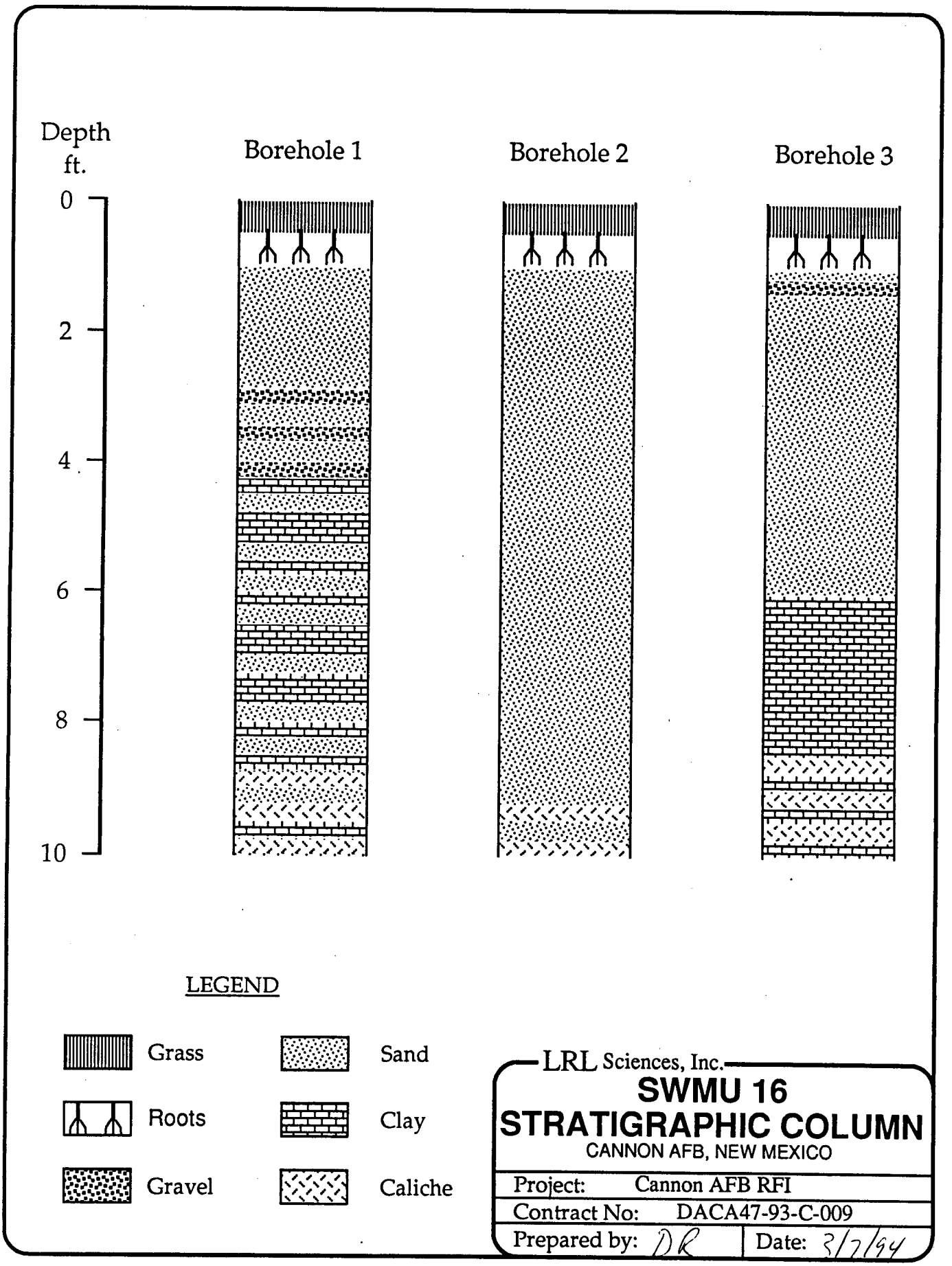

Depth
ft.
0
2
4
6
8
10
Borehole 1
Borehole 2
Borehole 3
LEGEND
Grass
Roots
Gravel
Sand
Clay
Caliche
LRL Sciences, Inc.
SWMU 16
STRATIGRAPHIC COLUMN
CANNON AFB, NEW MEXICO
Project: Cannon AFB RFI
Contract No: DACA47-93-C-009
Prepared by: DR
Date: 3/7/94

Figure 9-2.

9.4.1.2 Borehole 2

In borehole 2, no target compounds or TIC compounds were detected in the surface sample or at 2.5 feet.

9.4.1.3 Borehole 3

In borehole 3, no target compounds or TIC compounds were detected in the surface sample.

No target compounds or TIC compounds were detected at 2.5 feet. Two duplicate samples were collected with the 2.5 foot sample from borehole 3. The QC duplicate, analyzed at the same laboratory as the normal sample, contained no target compounds or TIC compounds. The QA duplicate which was analyzed at a different laboratory from the normal sample contained acetone and methylene chloride. These values have been rejected as contaminants due to their prevalence in nearly all of the QA lab samples.

9.4.2 BTEX

In each borehole, 2 samples were collected for BTEX analysis at 5 and 10 feet of depth. No BTEX compounds were detected in any of the samples. QA/QC duplicate samples for BTEX were not collected and therefore analyses were not performed.

9.4.3 Priority Metals

Total metal concentrations, using the RCRA SW-846 test methods for the analysis of metals in soils, were determined for the eight TCLP metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver) plus nickel. These are the priority metals. Samples were collected for priority metals analysis at the surface, 2.5, 5, and 10 feet.

In the following presentation of metals results, only metals concentrations in excess of background concentrations are presented (). No background data was collected for this investigation, therefore, background concentrations were taken from Concentrations of Selected Naturally Occurring Chemical Constituents in Soil and Groundwater at Cannon Air Force Base Clovis, New Mexico, March 1993 prepared by Woodward-Clyde. For a discussion of Woodward-Clydes background data see Section 1.7.

Table 9-3.
Concentration (mg/kg) of Priority Metals
SWMU No. 16 - Oil/Water Separator No. 680

Borehole Number	Sample Number (CAN016-680)	Sample Depth (feet)	Lead		Mercury		Nickel
1	1-021A	0	20.5		0.03	U	8.1
	1-022B	2.5	10.1		0.03	U	6.9
	1-023C	5	9.2		0.02	U	**9.3**
	1-024D	10	4.3		0.01	U	7
2	2-021A	0	21.5		0.1	U	7
	2-022B	2.5	16.3		0.05	U	7.9
	2-023C	5	7		0.1	U	**9.3**
	2-024D	10	8		0.01	U	3.7
3	3-021A	0	**41.3**		0.02	U	6.2
	3-022B	2.5	14.9	J	0.02	U	6.7
(QAD)	3-721B	2.5	17.7		**0.24**		5.9
(QCD)	3-821B	2.5	13.7		0.02	U	5.5
	3-023C	5	8.3		0.1	U	**9.6**
	3-024D	10	12		0.01	U	6
Background (95% UCL) (1)			25.80		0.13		9.00

NOTES:

Duplicate samples (QAD) or (QCD) samples are presented only if they are different from the original sample and not rejected.

U indicates that the compound was analyzed for, but not detected at or above the standard limit.
J indicates and estimated value.
UJ indicates the compound was analyzed for but not detected. The sample quantification limit or reported detection limit is an estimated quantity.
*R indicates that the data was rejected because of quality control measures.

Boldface indicates a detection above the 95% UCL background level.

Only data for metals detected above background is presented.

(1) Background data is described in Section 1.7.

9.4.3.1 Borehole 1

No metals were detected above the background values in the samples collected at the surface or at 2.5 feet.

In the sample collected at 5 feet (CAN016-6801-023C), nickel was detected at 9.3 mg/kg. The background value is 9.0 mg/kg.

No metals were detected above the background values in the samples collected at 10 feet.

9.4.3.2 Borehole 2

No metals were detected above the background values in the samples collected at the surface or at 2.5 feet.

In the sample collected at 5 feet (CAN016-6802-023C), nickel was detected at 9.3 mg/kg.

No metals were detected above the background values in the samples collected at 10 feet.

9.4.3.3 Borehole 3

The surface sample (CAN016-6803-021A), lead was detected at 41.3 mg/kg. The background value is 25.8 mg/kg.

No priority metals were detected above background in the sample collected at 2.5 feet or in the QC duplicate collected at this depth. The QA duplicate (CAN016-6803-721B), which was analyzed at a different laboratory from the normal sample, contained mercury at 0.24 mg/kg. The background value for mercury is 0.13 mg/kg.

At 5 feet (CAN016-6803-023C), nickel was detected at 9.6 mg/kg.

No priority metals were detected in the sample collected at 10 feet.

9.4.4 Summary of Data

No organic compounds were detected in any of the boreholes, while nickel was detected marginally above background at 5 feet in all three boreholes. Lead and mercury were detected in borehole 3 at the surface and at 2.5 feet, respectively. All concentrations were low. No metals or BTEX compounds were detected at 10 feet.

9.5 Recommendations

Concentrations of organics and metals found in soils around the former location of the SWMU are low and generally diminishing with depth. Groundwater level is deep at approximately 250 feet below ground surface. In addition, the risk assessment information associated with this SWMU indicates minimal or no risk to human health or the environment. Therefore, no further action is recommended.

10.0 OIL WATER SEPARATOR (SWMU NO. 32A/SITE NO. 186, #1-East)

10.1 SWMU Description

10.1.1 Setting

SWMU No. 32A is an oil/water separator located on the east side of Building 186, on the flightline side and adjacent to a washrack. This SWMU is identified as SWMU No. 32A in this report, however, the actual SWMU designation is SWMU No. 32. Since all of the sample identifiers for this report were labeled with the prefix CAN32A, the designation of SWMU 32A will be retained for this report to avoid confusion when referencing sample numbers. The separator is a 2-compartment underground unit, with a 300 gallon main compartment and a 300 gallon oil compartment. The unit is constructed of concrete. The opening to the separator is covered on all sides by asphalt. The depth of the bottom of the unit is unknown. A 5,000 gallon JP-4 underground storage tank is located approximately 25 feet northeast of the separator and a pair of 2,000 gallon underground storage tanks are located approximately 40 feet to the southwest. One of the 2,000 gallon tanks contains diesel and one contains gasoline. All three of these tanks are scheduled for replacement with above ground tanks. Borehole locations were selected, in part, to avoid underground utilities, product supply pipes and the gasoline pump island adjacent to the separator. In addition, the boreholes were moved in closer to the separator than specified in the FSP. The driller was required to penetrate the asphalt and restore the surface with a concrete plug. Figure 10-1 shows the setting and borehole locations.

10.1.2 History of Use

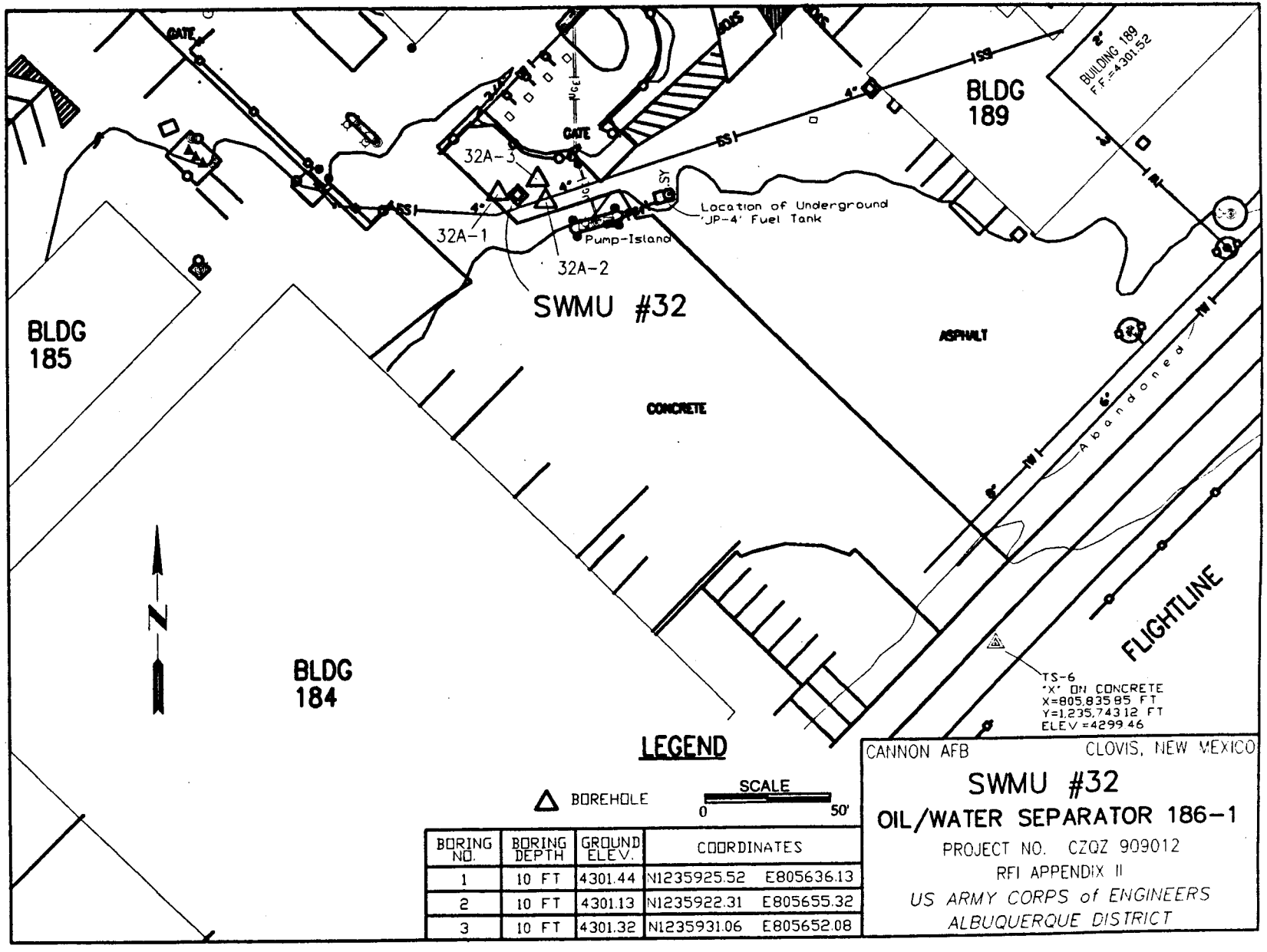
The oil/water separator No. 186 east, has been active since 1971 and is still in use, receiving wastewater from the cleaning of aircraft ground-support equipment at the washrack. The recovered oils are directed to the 300 gallon holding tank and the wastewater is discharged to the Sanitary Sewer Line (SWMU No. 98). Historically, the separator served the washrack outside of the Aerospace Ground Equipment (AGE) compound to the east of the facility. The unit received washwater generated from the cleaning of aircraft support equipment at the washrack, which contained petroleum and synthetic lubricating oils and dirt.

10.1.3 Past Investigations

In 1988 the Tulsa Corps of Engineers conducted a study of the influent and effluent from a number of oil/water separators on base. The results are reported in Cannon Air Force Base Oil/Water Separators Sampling and Analytical Report, June 1988. For Separator No. 186 the following compounds, among others, were found: benzene, toluene, xylene, naphthalene, 2-methylnaphthalene, bis(2-ethylhexyl)phthalate and lead.

10.1.4 Land Use and Demography

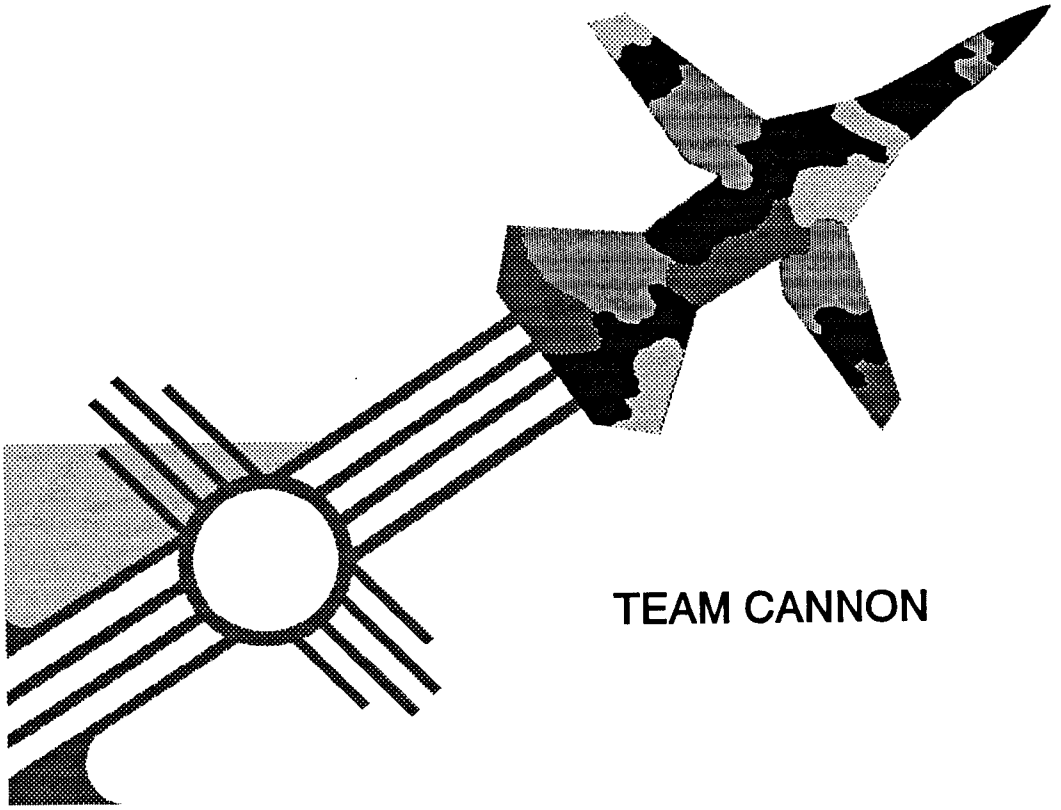
This SWMU is located in an area of the base which is commonly used by base personnel. However, this SWMU is underground and presently covered by asphalt.



BORING NO.	BORING DEPTH	GROUND ELEV.	COORDINATES	
1	10 FT	4301.44	N1235925.52	E805636.13
2	10 FT	4301.13	N1235922.31	E805655.32
3	10 FT	4301.32	N1235931.06	E805652.08

Figure 10-1.

DRAFT
27th FIGHTER WING



APPENDIX II
RCRA FACILITY INVESTIGATION

RISK ASSESSMENT
VOLUME 2

Project No. CZQZ 909012

CANNON AFB, NEW MEXICO

LRL sciences inc.

UNITED STATES ARMY
CORPS OF ENGINEERS
ALBUQUERQUE DISTRICT

OGDEN ENVIRONMENTAL AND ENERGY SERVICES

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19.0 HUMAN HEALTH RISK ASSESSMENT

19.1 Introduction

This section presents the results of a human health risk assessment (HRA) performed using the site investigation data obtained for 16 Solid Waste Management Units (SWMUs) at Cannon AFB as part of this RFI program. Surficial and subsurface soil samples were collected from the 16 SWMUs, the locations of which are shown in Figure 1-2. The analytical results of these samples, and the data validation qualifiers of the analytical results, were presented in previous sections of this report. This HRA report section presents the HRA results obtained using this previously presented data. The remainder of this introductory section to the HRA discusses the objectives, technical approach, and presentation format of the HRA.

19.1.1 Objectives

The objectives of the HRA included assessing the carcinogenic risk and noncarcinogenic hazard posed by contaminated soil at the various SWMUs to potential human receptors. The HRA discussed herein is intended to be used in the decision-making process for the 16 SWMUs and to help determine whether further investigative and/or remedial actions are necessary.

19.1.1.1 Approach

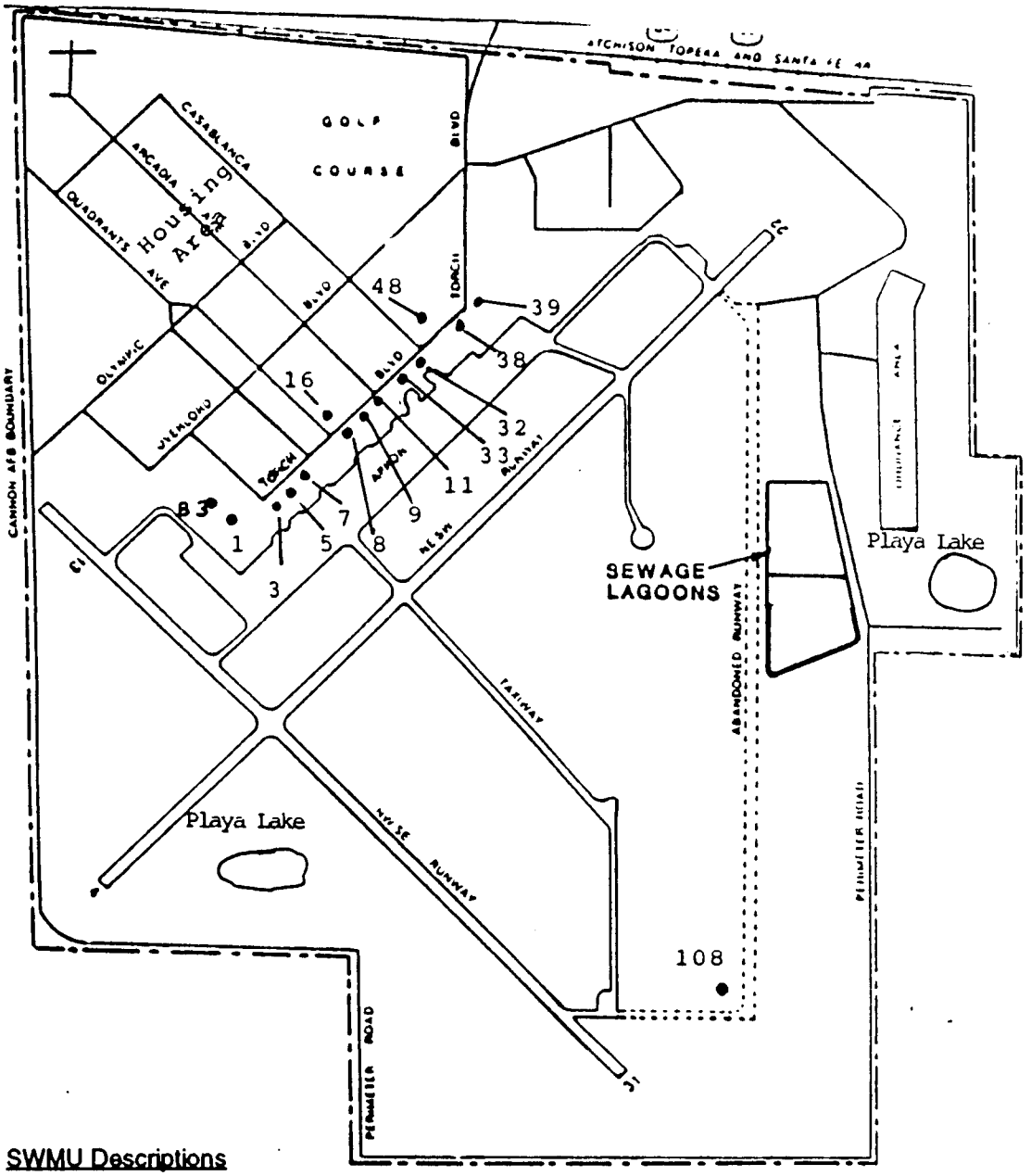
This HRA was conducted using the standard principles and approaches identified in *Risk Assessment Guidance for Superfund: Volume I: Human Health Evaluation Manual, Part A* (RAGS), (EPA 1989a). RAGS, which is the Superfund guidance document for human health risk assessment, was used instead of RFI guidance for human health risk assessment due to its more comprehensive nature. The quantitative evaluation of risk arising from chronic lead exposure was conducted using the United States Environmental Protection Agency's (USEPA's) Uptake Biokinetic (UBK) Model. Assumptions made throughout this risk assessment were generally conservative, and therefore tend to overestimate risk. For instance, exposure to contaminants in the soil was estimated as if the surface soils were entirely bare. However, most of the SWMUs investigated are covered with asphalt.

19.1.2 Presentation Format

The HRA is organized in the following manner. The rationale for the selection of the chemicals of concern (COCs) assessed in this HRA is discussed in Section 19.2. Also presented are the grouping of various SWMUs into Risk Assessment Areas (RAAs) and summaries of soil characterization results for each RAA. An exposure assessment, which identifies receptors, assesses exposure pathways, and calculates chronic daily intakes for each receptor, is presented in Section 19.3. As part of the exposure assessment, transport of the COCs is modeled, and the corresponding modeling results are also presented in Section 19.3. A toxicity assessment for each COC is described in Section 19.4. The exposure assessment results are then combined with the toxicity assessment results to estimate a cancer risk and noncancer hazard index for each receptor based on reasonable maximum exposures. The technical approach to and results of this risk characterization are presented in Section 19.5 for a baseline exposure scenario, and in

Section 19.6 for a construction scenario. Because the process of assessing human health risks requires the use of professional judgment and the application of exposure assumptions, a summary of uncertainties and limitations is included for each of the sections of the HRA.

Three appendices exist for the HRA: a summary of all soil contaminant concentration data used by the HRA, summary tables which calculate 95% Upper Confidence Levels (UCLs) for the soil contaminant data, and toxicological profiles of the compounds evaluated as part of this HRA.



SWMU Descriptions

1. Oil/Water Separator - bldg. 119
3. Oil/Water Separator - bldg. 108
5. Oil/Water Separator - bldg. 121
7. Oil/Water Separator - bldg. 129
8. Oil/Water Separator - bldg. 165
9. Aircraft Washrack Drain System - bldg. 165
11. Oil/Water Separator - bldg. 170
16. Oil/Water Separator - bldg. 680
32. Oil/Water Separator - bldg. 186-1
33. Oil/Water Separator - bldg. 186-2
38. Oil/Water Separator - bldg. 194
39. Oil/Water Separator - bldg. 195
48. A-Underground Waste Oil Tank
    B - Above ground overflow Capacity Tank
83. Sump
108. Explosive Ordinance Disposal Activities Area

LRL Sciences, Inc.

SWMU LOCATION MAP

CANNON AFB, NEW MEXICO

Project: Cannon AFB RFI	
Contract No: DACA47-93-C-009	
Prepared by: RLH	Date: 11-5-93

Fig. 1-2

19.2 Data Evaluation

This section summarizes the soil contaminant concentrations on which this HRA was based, and presents the methodology used to identify COCs and to group various SWMUs into RAAs. A discussion of a previous study on the background concentration of metals in soils at Cannon AFB is presented in Section 19.2.1. The selection of COCs for this HRA is summarized in Section 19.2.2. The rationale for the grouping of the 15 SWMUs into four RAAs is presented in Section 19.2.3. Complete soil characterization results and the determination of soil exposure concentrations are presented in Section 19.2.4. Finally, a discussion of the uncertainties and limitations regarding the data evaluation process is presented in Section 19.2.5.

19.2.1 Background Concentrations of Metals

Metals are naturally occurring elements in soils. To determine whether the detected metal concentrations were related to site activities, background metal concentrations in soils were used as a basis for comparison. The background metal concentrations, presented in Table 19-1, were taken from a report which compiled background soils data collected from three previous soil investigations at Cannon AFB (Woodward-Clyde Consultants, 1993).

19.2.2 Identification of Chemicals of Concern (COCs)

COCs for each SWMU were selected from the chemicals for which analyses were performed. For each SWMU, soil characterization results are summarized in Appendix E in the following order:

- Benzene, toluene, ethylbenzene, total xylenes (BTEX) results determined using EPA Method 8020 (all SWMUs except for SWMUs #83 and #108);
- Target Contaminant List Volatile Organic Compounds (TCL VOCs) results determined using CLP (Contract Laboratory Program) Methodology for VOCs (all SWMUs except for SWMU #108);
- Metals results determined using CLP Methodology for Inorganics (all SWMUs);
- For SWMUs #48B and #83, cyanide results determined using CLP Methodology;
- For SWMU #83, total petroleum hydrocarbons (TPH) results using EPA Method 418.1; and,
- For SWMU #108, Wet Chemistry (reactives, cyanide, and sulfide) results determined using EPA Methods 9010/9030.

Soil samples collected from SWMU #108 were analyzed for metals and wet chemistry analytes, but not for BTEX or TCL VOCs, because only metals and wet chemistry analytes were suspected contaminants. Soil samples collected from SWMU #83 were analyzed for TPH in lieu of BTEX.

Table 19-1

BACKGROUND METAL CONCENTRATIONS AT CANNON AIR FORCE BASE

Metal	Background Concentration (1) (mg/kg)
Aluminum	10540
Antimony	12.2
Arsenic	15.5
Barium	642
Beryllium	0.73
Cadmium	2.9
Calcium	186400
Chromium	12.5
Cobalt	4.5
Copper	13.0
Iron	8720
Lead	25.8
Magnesium	11790
Manganese	164
Mercury	0.13
Nickel	9.0
Potassium	2572
Selenium	56.6
Silver	2.2
Sodium	1042
Thallium	1.2
Vanadium	25.3
Zinc	21.9

Notes:
(1) Background concentrations presented represent the upper end of the background concentration range presented in Table 2-5 of "Concentrations of Selected Naturally Occurring Chemical Constituents in Soil and Groundwater at Cannon Air Force Base, Clovis, New Mexico" (Woodward-Clyde Consultants, March 1993).

Data evaluation consisted of assessing detection frequencies, data certainty, data comparability, and concentrations. Each SWMU data set was subjected to a set of criteria for identifying COCs. All data that were rejected (qualified R) during data validation were not considered. The selection criteria are as follows:

BTEX

- Any chemical not detected in any sample was excluded.

TCL VOCs

- Any chemical not detected in any sample was excluded.

Metals

- Any metal not detected in any sample was excluded.
- Any metal in which the maximum detected concentration was less than its background concentration in soil at Cannon AFB (as discussed in Section 19.2.1) was excluded.
- Any metal with no EPA-verified toxicity data was excluded. EPA-verified toxicity data refers to EPA's Integrated Risk Information System (IRIS) database or Health Effects Assessment Summary Tables (HEAST). Metals that were detected but have no toxicity values include aluminum, calcium, cobalt, copper, iron, magnesium, and potassium. Some of these metals are essential nutritional elements, and are typically used as food contact surfaces or in medicine (Woodward-Clyde, 1992). As a result, these were excluded as COCs. Although lead has no EPA-verified toxicity values, it was evaluated for its potential human health and environmental risks by comparing detected lead concentrations with EPA guidelines, criteria, and standards.

Cyanide was not detected in any sample for SWMUs #48B or #83; therefore, this chemical was not considered a COC for these SWMUs.

TPH results for SWMU #83 were excluded from consideration in favor of the more chemical-specific results provided by the TCL VOC analysis.

Wet chemistry analytes for SWMU #108 were excluded from becoming COCs; reactives and cyanide data were rejected during data validation, and sulfide was not detected in any sample.

The COCs selected for each SWMU as a result of this screening process are presented in Table 19-2. The results include:

BTEX

- Benzene was not detected at any of the SWMUs, therefore it is not a COC for this HRA.
- Toluene was identified as a COC for eight SWMUs (#1, 3, 7, 9, 11, 38, 39, and 48A).
- Ethylbenzene was identified as a COC for one SWMU (#48A).
- Xylenes were identified as a COC for five SWMUs (#7, 8, 9, 33B, and 48A-B).

Non-BTEX TCL VOCs

- 1,1,1-Trichloroethane (TCA) was identified as a COC for one SWMU (#7).
- Acetone was identified as a COC for eight SWMUs (#1, 5, 7, 9, 33B, 38, 39, and 48B). Acetone is known to be a common laboratory contaminant. However, data validation was inconclusive in positively identifying this chemical as a laboratory contaminant. As a result, acetone was not excluded as a COC.
- Methylene Chloride was identified as a COC for two SWMUs (#11 and #48B). Methylene chloride is also known to be a common laboratory contaminant. However, data validation was inconclusive in positively identifying the chemical as a laboratory contaminant. As a result, methylene chloride was not excluded as a COC.
- Tetrachloroethene was identified as a COC for one SWMU (#9).

Metals

- Arsenic was identified as a COC for two SWMUs (#7, 33B).
- Barium was identified as a COC for eight SWMUs (#3, 8, 9, 32A, 33B, 39, 48A-B and 83). The prevalence of barium suggests that the background concentration of barium used for comparison purposes (Table 19-1) may not have been representative of the actual background barium concentrations at the SWMUs investigated as part of this effort.
- Beryllium was identified as a COC for one SWMU (#83).
- Chromium was identified as a COC for six SWMUs (#1, 3, 7, 8, 9, 33B).
- Lead was identified as a COC for three SWMUs (#16, 39, 83).
- Manganese was identified as a COC for one SWMU (#83).

- Nickel was identified as a COC for all fifteen SWMUs. The prevalence of nickel suggests that the background concentration of nickel used for comparison purposes (Table 19-1) may not have been representative of the actual background nickel concentrations at the SWMUs investigated as part of this effort.

- Silver was identified as a COC for two SWMUs (#1, 83).

- Vanadium was identified as a COC for one SWMU (#48A).

- Zinc was identified as a COC for one SWMU (#83).

19.2.3 Risk Assessment Areas (RAAs)

A Risk Assessment Area (RAA) is a group of SWMUs that are geographically close and have similar chemical release sources. Grouping the SWMUs into RAAs allows the identification of chemicals and pathways which result in significant contributions to risk, and the assessment of whether potential human health impacts are related to a particular RAA or contamination source. The physical setting and soil characterization data from each RAA are used in the fate and transport modeling and exposure assessment portions of this HRA. SWMUs were grouped using the following criteria:

- Physical setting: This criterium considers the physical characteristics such as the site-specific geology, hydrogeology, hydrology, and meterology. SWMUs in close proximity share these characteristics, and are more likely to have the same risk impacts than those farther away.

- Function: SWMUs that serve similar functions at Cannon AFB are more likely to have similar chemical release sources.

- Chemical release sources: SWMUs with common or similar chemical release sources are more likely to have the same COCs.

For example, SWMUs that serve the same function (i.e., oil water separators) and that are close together would be grouped into a RAA. However, if the oil/water separators were far apart from each other (i.e., on the other side of the base), they would not likely be grouped into a RAA because the risk impacts of each of the SWMUs could be different, even though their COCs may be identical.

SWMUs 1, 3, 5, 7, 8, 11, 16, 32A, 33B, 38, and 39 all lie in a rectangular area bounded by the flight apron and South Torch Boulevard (southwest-northeast direction), as shown in Figure 2-1. They also all function as oil/water separators. These oil/water separators share similar sources of contamination, receiving wash water generated from aircraft maintenance operations, which contain petroleum and synthetic lubricating oils and dirt. SWMU #9, the aircraft washrack drain system, which discharges into SWMU #8, also has similar sources of contamination. COCs identified include toluene, xylenes, four non-BTEX VOCs, and six metals. As a result, SWMUs 1, 3, 5, 7, 8, 9, 11, 16, 32A, 33B, 38, and 39 were grouped into RAA #1. COCs for RAA #1 include: toluene, xylenes, 1,1,1-trichloroethane (TCA), acetone, methylene chloride, tetrachloroethene, arsenic, barium, chromium, lead, nickel, and silver.

SWMU #48A and #48B are adjacent locations of removed storage tanks and are considered to constitute a single SWMU. SWMU #48B served as an aboveground overflow tank for the underground waste oil tank, SWMU #48A. Since the removed tanks were physically connected, they most likely stored similar chemicals. COCs identified include toluene, ethylbenzene, xylenes, two non-BTEX VOCs, and three metals. As a result, SWMUs #48A and #48B were grouped into RAA #2. COCs for RAA #2 include: toluene, ethylbenzene, xylenes, acetone, methylene chloride, barium, nickel, and vanadium.

SWMU #83 is located near RAA #1, but it functions as a sump as opposed to an oil/water separator, collecting rain water, wash water, fuel products, and dilute waste oil generated from flight line operations. Moreover, metals were the only identified COCs. As a result, SWMU #83 alone comprises RAA #3. COCs for RAA #3 include: barium, beryllium, lead, manganese, nickel, silver, and zinc.

SWMU #108, the explosive ordnance disposal activities training area, is not located in close proximity with the other SWMUs. The area is used for training and the source of contamination includes detonated explosives. As a result, SWMU #108 alone comprises RAA #4. The only identified COC in RAA #4 is nickel.

The grouping of the 15 SWMUs into four RAAs is summarized in Table 19-3. COCs have also been identified according to RAA and are summarized in Table 19-4.

19.2.4 Reasonable Maximum Soil Exposure Concentrations

The first step in quantifying the potential human health risk posed by the RAAs is to calculate the exposure point concentrations for each media sampled. For this report, only soil samples were collected, as per the field sampling plan approved prior to the commencement of field sampling. No groundwater or surface water samples were collected since the groundwater and surface water exposure pathways were determined to be incomplete (see Section 19.3.1.3 for discussion of potential exposure pathways). Therefore, the objective of this section is to calculate the exposure point concentrations for onsite soils for each COC identified for each RAA (Table 19-4).

An HRA is based on an estimate of the reasonable maximum exposure (RME) expected to occur under current and future land use conditions (EPA, 1989a). The RME is defined as the highest exposure that can reasonably be expected to occur at a site. The EPA recommends that the 95% upper confidence limit (UCL) be used as the representative RME concentration for risk assessments (EPA, 1989a; EPA, 1992a).

Before calculating 95% UCL concentrations for each COC, the statistical distribution of data and the depth interval over which to base the calculations were determined. Evaluation of both the organics and inorganics data proved inconclusive in determining whether the data were normally or lognormally distributed. As a result, both the organic and inorganic compound data sets were assumed to be normally distributed. This assumption of normal distribution is consistent with the assumptions incorporated into a previous baseline risk assessment performed for other SWMUs at Cannon AFB (Woodward-Clyde, 1992).

Almost all soil borings reached a maximum depth of 10 feet below ground surface. This depth also corresponds to the greatest depth of soil that could possibly be excavated and contribute to receptor exposures. Thus, the depth interval chosen was 10 feet, which incorporates almost all of the soil data collected for this HRA.

For the finite number of sample results, which were assumed to be distributed normally, the 95% UCL for each COC in each RAA was calculated using the following equation (EPA, 1992a):

$$95\%\ \text{UCL} = X + t\,s / [n]^{1/2} \qquad (19\text{-}1)$$

where

$$X = (\Sigma\, x_i) / n \qquad (19\text{-}2)$$

$$s = \{ [n\Sigma(x_i^2) - (\Sigma x_i)^2] / [n(n-1)] \}^{1/2} \qquad (19\text{-}3)$$

and

X = Average of sample results from the finite data set;
x_i = Sample result from the finite data set;
n = Number of samples within the finite data set;
s = Standard deviation of sample results from the finite data set; and,
t = Tabulated t value for a 95% confidence level, given n-1 degrees of freedom.

A set of criteria was established to determine the numerical values to be used for qualified data:

Data Validation Qualifier	Example of Result	Numerical Value Used in 95% UCL Calculations
J	1.5 J	1.5
U	1.5 U	If the reported detection limit (RDL) (e.g., 1.5) is greater than the maximum detected concentration, exclude from calculations. Otherwise, use half the RDL (e.g., 1.5/2 = 0.75) in calculations.
UJ	1.5 UJ	Same as "U" qualified data.

The analytical results used and the corresponding 95% UCL calculations for all COCs for each RAA are presented in Appendix F. All COC data for a particular RAA were considered, which thus in some instances included COC data from SWMUs without any valid detections. Such an inclusion resulted in 95% UCLs that were representative of an entire RAA. The results are summarized in Tables 19-5 through 19-8, with the 95% UCLs presented in the third column.

Although the number of samples taken was constant within a chemical group (i.e., BTEX, TCL VOCs, and metals) for a particular RAA, the number of results, or the total number of data points used in calculating the 95% UCL, varied with COC. The number of results, presented in the first column, depended on the amount and type of qualified data for a particular COC. For instance, most of the sample data for 1,1,1-trichloroethane (TCA) and methylene chloride in RAA #1 were nondetects with RDLs greater than the maximum detected concentration (see Note (4) in Tables 19-5 and 19-6). Therefore, these nondetects were not included in the calculations of 95% UCLs. Consequently, the number of results is low (e.g., only two results for methylene chloride in RAA #1). The low number of results provides an insufficient data set for calculating a meaningful 95% UCL (EPA, 1992a).

For some COCs, 90% or more of the sample data were nondetects with RDLs less than the maximum detected concentration. These COCs included: toluene, ethylbenzene, xylenes, acetone, tetrachloroethene, methylene chloride, and silver (see Note (3) in Tables 19-5 thru 19-7). The nondetects for these COCs were included in the calculations of 95% UCLs. However, the high percentage of non-detects compared with the total number of results precludes a clear representation of the RME values by the calculated 95% UCLs.

RME concentrations are presented in the last column of Tables 19-5 through 19-8. In the cases discussed above where 95% UCLs were not necessarily representative of the RME concentrations, the maximum detected COC concentrations were selected to conservatively represent the RME values. A summary of the RME soil concentrations for the four RAAs which were carried forward into the exposure assessment portion of this HRA are presented in Table 19-9.

19.2.5 Uncertainties and Limitations

This section discusses the uncertainties and limitations associated with the evaluation of the data. The greatest source of uncertainty involves reported detection limits (RDLs) that were greater than the contract-required detection limits (CRDLs). A second uncertainty involves the numerical assumptions which were used to handle two data types: estimated data ("J" qualified) and nondetect ("U" and "UJ" qualified) data. Another source of uncertainty is the degree to which the RME value is representative of the entire RAA. A final source of uncertainty involves the identification of known laboratory contaminants as COCs for this HRA.

Elevated RDLs

Before determining risk assessment areas, each SWMU data set was individually evaluated for the identification of COCs. Analytes that were not detected in any sample were excluded from becoming COCs. However, the RDLs associated with the nondetect data of some analytes were greater than the CRDLs. Had the CRDLs been met, detections might have resulted, and the analyte would have been identified a COC for this HRA. Moreover, most of these excluded chemicals were identified as COCs in a previous baseline risk assessment report (Woodward-Clyde, 1992). For instance, carbon disulfide has a CRDL of 5 ppb, and was identified a COC in the previous risk assessment. From soil sample data taken for this report, carbon disulfide was not detected in any sample in SWMU #7, but had an RDL of 10 ppb. Evaluation of the uncertainty involving this nondetect data, whose RDLs are greater than the CRDLs, is not quantifiable.

Estimated Data

Assessment of data qualified as estimated (i.e., qualified **J**) is a qualitative evaluation; the potential uncertainty is not quantifiable. Therefore, to evaluate as complete a data set as possible, estimated data have been treated as unqualified data in statistical calculations, following the recommendation in RAGS (EPA, 1989a).

Nondetect Data

Nondetect data were treated as instances of detection at one-half the RDL. A nondetect is simply an indication that an analyte was not identified above the RDL; an analyte could have been present at concentrations anywhere between the RDL and zero. There was no reason to believe the nondetected concentrations were closer to the RDLs than to one-half the RDLs; therefore, one-half of the RDL was used as a proxy concentration, as recommended in RAGS (EPA, 1989a).

Applicability of RME Concentrations to RAAs

RME values determined for this HRA are either the 95% UCL or the maximum detected concentration, depending on the amount and type of qualified data. These values are assumed to represent the reasonable maximum exposure expected anywhere within the RAA. Calculations included all data from all SWMUs composing the particular RAA. However, some

or most of this data were nondetects; therefore, the 95% UCL could underestimate the risk at individual "hot spot" locations within the RAA that have high concentrations of COCs. On the other hand, the 95% UCLs could overestimate the risk at locations within the RAA that have no or low detections of COCs. Maximum detected concentrations were also used as the RME concentrations, especially for organics. These RME values are assumed to represent the reasonable maximum exposure expected anywhere within the RAA. However, using the maximum detected concentrations as RME concentrations clearly overestimates the risk at all locations within the RAA, except near the point of maximum detection.

Laboratory Contaminants as COCs

Acetone and methylene chloride are common laboratory contaminants. However, since the data validation process for this investigation did not conclusively identify the instances of acetone and methylene chloride detections as being due to laboratory contamination, acetone and methylene chloride were included as COCs in this HRA. As a result, the inclusion of these two common lab contaminants in the exposure and dose calculations probably leads to an unquantifiable overestimation of risk.

Table 19-2

CHEMICALS OF CONCERN
(BY SWMU)

		Chemicals of Concern															
		BTEX (1)			Non-BTEX TCL VOCs (2)				Metals (3)								
SWMU	Unit	Toluene	Ethyl-benzene	Xylenes	1,1,1-Trichloro-ethane (TCA)	Acetone	Methylene Chloride	Tetrachloro-ethene	As	Ba	Be	Cr	Pb	Mn	Ni	Ag	Vn	Zn
1	Oil/Water Separator	√				√						√			√	√		
3	Oil/Water Separator	√								√		√			√			
5	Oil/Water Separator					√									√			
7	Oil/Water Separator	√		√	√	√			√			√			√			
8	Oil/Water Separator			√						√		√			√			
9	Aircraft Washrack Drain System	√		√		√		√		√		√			√			
11	Oil/Water Separator	√					√								√			
16	Oil/Water Separator												√		√			
32A	Oil/Water Separator									√					√			
33B	Oil/Water Separator			√		√			√	√		√			√			
38	Oil/Water Separator	√				√									√			
39	Oil/Water Separator	√				√				√			√		√			
48A	Underground Waste Oil Tank	√	√	√						√					√		√	
48B	Aboveground Overflow Capacity Tank			√		√	√			√								
83	Sump									√	√		√	√	√	√		√
108	Explosive Ordnance Disposal Activities Area														√			

Notes:
(1) "BTEX" represents the chemicals Benzene, Toluene, Ethylbenzene, and Xylenes, which were analyzed using both EPA Method 8020 and CLP Methodology for Volatile Organics.
(2) Non-BTEX TCL VOCs represent Target Contaminant List Volatile Organic Compounds, not including BTEX, and were analyzed using CLP Methodology for Volatile Organics.
(3) Metals analyses were performed using CLP Methodology for Inorganics; individual metal analytes are represented by their two-letter chemical abbreviations.

Table 19-3

ASSIGNMENT OF SWMUs INTO RISK ASSESSMENT AREAS

SWMU	Unit	Risk Assessment Area
1	Oil/Water Separator	1
3	Oil/Water Separator	1
5	Oil/Water Separator	1
7	Oil/Water Separator	1
8	Oil/Water Separator	1
9	Aircraft Washrack Drain System	1
11	Oil/Water Separator	1
16	Oil/Water Separator	1
32A	Oil/Water Separator	1
33B	Oil/Water Separator	1
38	Oil/Water Separator	1
39	Oil/Water Separator	1
48A	Underground Waste Oil Tank	2
48B	Aboveground Overflow Capacity Tank	2
83	Sump	3
108	Explosive Ordnance Disposal Activities Area	4

Table 19-4

CHEMICALS OF CONCERN
(BY RISK ASSESSMENT AREA)

Risk Assessment Area (RAA)	1	2	3	4
SWMUs	1, 3, 5, 7, 8, 9, 11, 16, 32A, 33B, 38, 39	48A, 48B	83	108
Chemical of Concern				
BTEX				
Toluene	Yes	Yes	No	No
Ethylbenzene	No	Yes	No	No
Xylenes	Yes	Yes	No	No
Non-BTEX TCL VOCs				
1,1,1-Trichloroethane	Yes	No	No	No
Acetone	Yes	Yes	No	No
Methylene Chloride	Yes	Yes	No	No
Tetrachloroethene	Yes	No	No	No
Metals				
Arsenic	Yes	No	No	No
Barium	Yes	Yes	Yes	No
Beryllium	No	No	Yes	No
Chromium	Yes	No	No	No
Lead	Yes	No	Yes	No
Manganese	No	No	Yes	No
Nickel	Yes	Yes	Yes	Yes
Silver	Yes	No	Yes	No
Vanadium	No	Yes	No	No
Zinc	No	No	Yes	No

TABLE 19-5

REASONABLE MAXIMUM SOIL EXPOSURE CONCENTRATIONS

RAA #1

Chemical of Concern	Number of Results (1)	Number of Detections	95% Upper Confidence Level (2) (mg/kg)	Maximum Detected Concentration (mg/kg)	RME Concentration (mg/kg)
BTEX					
Toluene (3)	143	12	5.0E-03	4.3E-02	4.3E-02
Xylenes (3)	142	5	5.0E-03	5.2E-02	5.2E-02
Non-BTEX TCL VOCs					
1,1,1-Trichloroethane (4)	3	3	9.0E-03	8.0E-03	8.0E-03
Acetone (3)	72	19	2.2E-02	2.5E-01	2.5E-01
Methylene Chloride (4)	2	2	6.0E-03	6.0E-03	6.0E-03
Tetrachloroethene (3)	73	1	6.0E-03	1.4E-02	1.4E-02
Metals					
Arsenic	144	144	4.1E+00	3.2E+01	4.1E+00
Barium	144	144	3.1E+02	2.2E+03	3.1E+02
Chromium	144	102	8.9E+00	5.4E+01	8.9E+00
Lead	133	126	1.1E+01	1.6E+02	1.1E+01
Nickel	144	140	7.5E+00	3.2E+01	7.5E+00
Silver (3)	133	7	5.3E-01	5.8E+00	5.8E+00

Notes:

(1) Number of Results is the total number of data points used in calculating the 95% UCL (i.e., all unqualified data; "J" (estimated) data; and "U" and "UJ" (nondetect) data with reported detection limits (RDLs) below the maximum detected concentration).

(2) For each chemical of concern, a 95% UCL was calculated for a depth interval of 10.0 feet.

(3) For these chemicals, the 95% UCLs were determined not representative of the RME because of the high percentage of nondetects, and were not used. Thus, the maximum detected concentration represents the RME value.

(4) For these chemicals, the number of results is low because most of the data are nondetects with RDLs above the maximum detected concentration. Therefore, these nondetects were not included in the calculation of 95% UCLs. The 95% UCLs were considered questionable because of the limited data set. Thus, the maximum detected concentration represents the RME value.

TABLE 19-6

REASONABLE MAXIMUM SOIL EXPOSURE CONCENTRATIONS

RAA #2

Chemical of Concern	Number of Results (1)	Number of Detections	95% Upper Confidence Level (2) (mg/kg)	Maximum Detected Concentration (mg/kg)	RME Concentration (mg/kg)
BTEX					
Toluene (3)	13	1	2.6E-01	1.2E+00	1.2E+00
Ethylbenzene (3)	13	2	9.1E-01	4.2E+00	4.2E+00
Xylenes (3)	13	3	6.9E+00	3.2E+01	3.2E+01
Non-BTEX TCL VOCs					
Acetone (3)	8	2	4.8E-02	1.1E-01	1.1E-01
Methylene Chloride (3)	9	3	5.8E-02	1.5E-01	1.5E-01
Metals					
Barium	15	15	7.7E+02	1.8E+03	7.7E+02
Nickel	15	15	7.9E+00	9.5E+00	7.9E+00
Vanadium	15	15	1.5E+01	2.9E+01	1.5E+01

Notes:

(1) Number of Results is the total number of data points used in calculating the 95% UCL (i.e., all unqualified data; "J" (estimated) data; and "U" and "UJ" (nondetect) data with reported detection limits (RDLs) below the maximum detected concentration).

(2) For each chemical of concern, a 95% UCL was calculated for a depth interval of 10.0 feet.

(3) For these chemicals, the 95% UCLs were determined not representative of the RME because of the high percentage of nondetects, and were not used. Thus, the maximum detected concentration represents the RME value.

TABLE 19-7

REASONABLE MAXIMUM SOIL EXPOSURE CONCENTRATIONS

RAA #3

Chemical of Concern	Number of Results (1)	Number of Detections	95% Upper Confidence Level (2) (mg/kg)	Maximum Detected Concentration (mg/kg)	RME Concentration (mg/kg)
Metals					
Barium	12	12	7.5E+02	2.2E+03	7.5E+02
Beryllium	12	12	6.1E-01	8.1E-01	6.1E-01
Lead	12	12	1.4E+01	3.7E+01	1.4E+01
Manganese	12	11	1.5E+02	2.7E+02	1.5E+02
Nickel	12	12	9.2E+00	1.1E+01	9.2E+00
Silver (3)	12	1	1.1E+00	3.4E+00	3.4E+00
Zinc	6	6	1.4E+02	2.3E+02	1.4E+02

Notes:

(1) Number of Results is the total number of data points used in calculating the 95% UCL (i.e., all unqualified data; "J" (estimated) data; and "U" and "UJ" (nondetect) data with reported detection limits (RDLs) below the maximum detected concentration).

(2) For each chemical of concern, a 95% UCL was calculated for a depth interval of 10.0 feet.

(3) For these chemicals, the 95% UCLs were determined not representative of the RME because of the high percentage of nondetects, and were not used. Thus, the maximum detected concentration represents the RME value.

TABLE 19-8

REASONABLE MAXIMUM SOIL EXPOSURE CONCENTRATIONS

RAA #4

Chemical of Concern	Number of Results (1)	Number of Detections	95% Upper Confidence Level (2) (mg/kg)	Maximum Detected Concentration (mg/kg)	RME Concentration (mg/kg)
Metals					
Nickel	20	20	7.6E+00	1.1E+01	7.6E+00

Notes:
(1) Number of Results is the total number of data points used in calculating the 95% UCL (i.e., all unqualified data; "J" (estimated) data; and "U" and "UJ" (nondetect) data with reported detection limits (RDLs) below the maximum detected concentration).
(2) For each chemical of concern, a 95% UCL was calculated for a depth interval of 10.0 feet.

TABLE 19-9

SUMMARY OF
REASONABLE MAXIMUM SOIL EXPOSURE CONCENTRATIONS

Chemical of Concern	Reasonable Maximum Soil Exposure Concentration (mg/kg) (1)			
	RAA #1	RAA #2	RAA #3	RAA #4
BTEX				
Toluene	4.3E-02	1.2E+00	NA	NA
Ethylbenzene	NA	4.2E+00	NA	NA
Xylenes	5.2E-02	3.2E+01	NA	NA
Non-BTEX TCL VOCs				
1,1,1-Trichloroethane	8.0E-03	NA	NA	NA
Acetone	2.5E-01	1.1E-01	NA	NA
Methylene Chloride	6.0E-03	1.5E-01	NA	NA
Tetrachloroethene	1.4E-02	NA	NA	NA
Metals				
Arsenic	4.1E+00	NA	NA	NA
Barium	3.1E+02	7.7E+02	7.5E+02	NA
Beryllium	NA	NA	6.1E-01	NA
Chromium	8.9E+00	NA	NA	NA
Lead	1.1E+01	NA	1.4E+01	NA
Manganese	NA	NA	1.5E+02	NA
Nickel	7.5E+00	7.9E+00	9.2E+00	7.6E+00
Silver	5.8E+00	NA	3.4E+00	NA
Vanadium	NA	1.5E+01	NA	NA
Zinc	NA	NA	1.4E+02	NA

Notes:
(1) RME Values obtained from Tables 19-5 through 19-8.
(2) "NA" means not applicable. This chemical was not considered a chemical of concern for this RAA.

19.3 Exposure Assessment

The objective of this section is to estimate, for each COC, the extent of exposure to an individual (herein referred to as a receptor) based on onsite soil concentrations and fate and transport modeling results. Exposure is expressed as a chronic daily intake (or dose) for each exposure pathway of concern and each receptor of concern. Results of the exposure assessment are then combined with toxicity data for each COC to determine the probability of an exposed receptor developing cancer and noncancer adverse health effects.

The identification of complete exposure pathways is discussed in Section 19.3.1. The first of two exposure scenarios, the baseline scenario, is evaluated in Section 19.3.2, which combines the RME soil concentrations presented in Section 19.2.4 with fate and transport modeling results to determine exposure point concentrations for the baseline scenario. These exposure point concentrations, with corresponding exposure assumptions, are then used to estimate exposure doses. The second of two exposure scenarios, the construction scenario, is evaluated in the same manner in Section 19.3.3.

19.3.1 Exposure Pathway Analysis

The objective of this section is to assess and evaluate the manner by which site contaminants may potentially lead to human exposures. An exposure pathway describes the course a COC takes from the source to the receptor. Only complete exposure pathways need to be assessed in an HRA (EPA, 1989a). A complete exposure pathway consists of the following four elements:

- A source and mechanism of chemical release;
- A retention or transport medium;
- A point of potential human contact with the contaminated medium (referred to as the exposure point or receptor); and,
- An exposure route (e.g., ingestion) at the contact point.

Before identifying complete exposure pathways, the 15 SWMUs investigated at Cannon AFB were characterized with respect to current and future land use. Current and future site conditions were identified under which exposure may occur. Analyses of the four elements described above follows, resulting in the determination of complete exposure pathways for this HRA.

19.3.1.1 Identification of Exposure Scenarios

Exposure scenarios for this HRA describe the most likely site conditions under which exposure may occur. Activities associated with current and future land use were investigated. For each of the RAAs, a discussion on the current and future land use follows.

- RAA #1 is bordered by the flight apron and South Torch Boulevard (NE-SW direction), and extends from Building 119 to Building 195. The current land use of this RAA is industrial, containing buildings that support flight operations and maintenance. It is anticipated that the land use of RAA #1 will not change to residential, recreational, or private commercial use.

- RAA #2 is the previous location of removed hydrocarbon storage tanks. This RAA is currently paved for use as a parking lot for use by maintenance personnel who occupy the aircraft hangers nearby. It is anticipated that the land use of RAA #2 will not change to residential, recreational, or private commercial use.

- RAA #3 is a sump located approximately 120 feet west of Building 120 on the western edge of the flightline. Nearby buildings support flight operations and maintenance. It is anticipated that the land use of RAA #3 will not change to residential, recreational, or private commercial use.

- RAA #4 is the explosive ordnance disposal training area, located on the southeast corner of the base. The area is used for explosive ordnance disposal practice. It is anticipated that the land use of RAA #4 will not change to residential, recreational, or private commercial use.

In conclusion, the current and future land use of the RAAs is industrial. As a military installation, the use of Cannon AFB is highly specialized and there is low probability that the RAAs will support residential use in the future.

The residential area of Cannon AFB is located in the corner of the base northwest of the NE-SW runway. The area is bordered by Olympic Boulevard (NE-SW direction), approximately one-half mile from the nearest RAA, RAA #1. There are 761 residential buildings on base. As of July 1989, 830 military personnel lived in on-base dormitories and 1,011 lived in base family housing, not including spouses and other dependents (Woodward-Clyde, 1992). The nearest sensitive receptors, or those more sensitive to chemical exposures, are children living in the residential area. Child day-care centers are also located in the residential area. There are no schools located on base.

Based on the current and anticipated future land use of the RAAs, two exposure scenarios were defined. The first exposure scenario is that of "baseline" conditions, which incorporate the following assumptions:

- The land use of the RAAs will not change. The RAAs will remain industrial, and will never support residential use;
- The site characterization data available are representative of site conditions in the future; and,
- Short-term activities such as construction will not occur. No further remedial action will be implemented to reduce the exposure to COCs.

Since the RAAs have an industrial/commercial setting, it is anticipated that some level of construction might occur at the RAAs in the future. Therefore, the second exposure scenario is that of "construction" conditions, which incorporate the following assumptions:

- Trenching activities will take place at each RAA;
- One utility trench will be constructed along the length of each RAA. The trench will be straight, four feet wide, and 10 feet deep;
- Construction activities will occur over a 30-day period; days will be 8-hour days, for a total exposure duration for the construction scenario of 240 hours; and,
- Onsite construction workers will be potentially exposed as a result of construction activities, and mitigation measures (i.e., dust control, personal protective equipment) will not exist;
- The site characterization data available are representative of site conditions during construction activities.

19.3.1.2 Source of Contamination

For each RAA, the source of chemical release is assumed to be the surface and subsurface soil contamination detected at the RAA. COCs were identified in the soil, and the corresponding RME concentrations were calculated. No groundwater, surface water, or air monitoring samples were taken for this HRA; therefore, it cannot be determined if these media are current sources of chemical releases at the RAAs.

19.3.1.3 Identification of Transport Mechanisms

For an exposure pathway to be considered complete, it must be possible for a COC to be transported from the source by an environmental transport medium to an exposure point. The following three transport mechanisms were qualitatively evaluated to assess the viability of transport to receptors: air transport, vadose or unsaturated zone transport, and surface water transport.

Air

COCs in onsite soils can be released into environmental media, including air. Air transport of COCs occurs via either vapor phase or airborne particulate (dust) mechanisms. For the purposes of this HRA, vapor-phase transport was assumed to occur for volatile organic COCs, while particulate transport was assumed to occur for inorganic COCs. Although many of the RAAs are paved, both vapor-phase and particulate transport of COCs were conservatively assumed to be viable transport mechanisms. Modeling of both vapor-phase and particulate transport was performed to estimate the environmental concentrations of COCs in ambient air at each RAA and at offsite receptor locations.

Unsaturated Zone

The unsaturated zone (or vadose zone) is a layer of unsaturated soils between the atmosphere above and the saturated zone below. At each of the RAAs, COCs were identified in soils in the unsaturated zone. Transport of chemicals through the unsaturated zone can occur as a result of vapor-phase, dissolved-phase, and/or pure phase-migration. Volatile COCs in the vapor phase can migrate through the unsaturated zone and subsequently be released to the atmosphere and/or the saturated zone.

Both volatile and non-volatile COCs in the dissolved-phase can migrate through the unsaturated zone and subsequently be released into the first saturated zone (groundwater). Unsaturated zone dissolved-phase transport of solutes occurs through vertical unsaturated flow of soil moisture. This flow and associated solute transport results from gravity-driven infiltration of precipitation and surface water runoff. Pure-phase transport, primarily of organic solvents, can also occur in the unsaturated zone. Unsaturated zone transport through dissolved-phase or pure-phase transport mechanisms to the saturated zone was assumed to be unviable for this HRA for the following reasons:

- The depth to groundwater is approximately 240 feet at Cannon AFB (Woodward Clyde, 1992). Additionally, site lithologies in the vadose zone, including clays and Caliche (calcium carbonate) layers, would tend to impede dissolved-phase and pure-phase transport mechanisms.

- A prior baseline risk assessment, performed for a greater number of SWMUs encompassing a wider variety of contaminant sources in similar physical settings, reported that all chemicals detected in ground-water monitoring wells were below Maximum Contaminant Levels (MCLs) under the Safe Drinking Water Act and that historic ground-water data have never exceeded the MCLs (Woodward Clyde, 1992).

- Organic COCs, which are much more likely to be transported by dissolved-phase and pure-phase mechanisms than inorganic COCs, were only identified as being present at RAAs #1 and #2. Generally, the samples collected from the greatest depth (10, 20, or 30 feet) at the SWMUs constituting these RAAs had non-detectable concentrations of organics. The only exceptions to this generalization were instances of acetone detection at the greatest depth of samples collected for RAA #1 and instances of TEX detection at the greatest depth of samples collected from RAA #2 (in particular, SWMU #48A).

As a result, unsaturated zone transport was assumed not to be a significant transport mechanism, and therefore potential risks and hazards associated with groundwater use and ingestion were not evaluated in this HRA.

Surface Water

Surface water transport of chemicals occurs through either dissolved-phase or sediment loading mechanisms. Surface water transport of COCs via surface drainage and runoff is possible at the site if soil or dust particulates are entrained. However, this transport mechanism is not likely to be significant, because of the subsurface nature of the contamination and the intermittent nature of surface water runoff. Moreover, no streams exist on or near Cannon AFB, and the playa lakes persist for only a few weeks at most without recharge (Woodward-Clyde 1992). As a result, surface water was assumed to not be a viable transport mechanism.

19.3.1.4 Identification of Receptors

The objective of this section is to identify those receptors that may have the greatest potential for exposure, both under baseline and construction scenarios. Human receptors are adults and children who are potentially exposed to COCs directly at the site or following offsite transport of COCs via the transport mechanisms discussed above.

People working at the RAAs are potentially exposed, and are defined as "onsite" receptors. Under the baseline scenario, general-duty or maintenance workers are onsite receptors. Onsite receptors are assumed to be located at a point of hypothetical maximum onsite exposure within the RAA. Since it was assumed the RAAs will remain industrial, no onsite residential receptors were identified. Under the construction scenario, the general-duty or maintenance workers are assumed to remain onsite as receptors. In addition, onsite construction workers at the RAAs are potentially exposed under the construction scenario, located at a point of hypothetical maximum onsite exposure within the utility trench construction area.

People working or living away from the RAAs are also potentially exposed, and are defined as "offsite" receptors. Potential receptors that work offsite are assumed to have less exposure than those working onsite; therefore, these offsite workers were not evaluated. However, resident adults and children living offsite may potentially be exposed for longer periods of time than the onsite workers. Under the baseline scenario, resident adults and children are potentially exposed to COCs transported offsite. Therefore, resident adults and children are offsite receptors. These offsite receptors are assumed to be located directly downwind of the RAAs at the point of hypothetical maximum offsite exposure. In other words, assumed receptor locations for resident adults and children are along Olympic Boulevard, which borders the residential area closest to the RAAs. Under the construction scenario, these same two receptors are assumed to remain at these locations. Therefore, resident adults and children are offsite receptors under the construction scenario.

As a result, receptor populations selected for evaluation under the baseline scenario at each of the RAAs are onsite general-duty workers, offsite resident adults, and offsite resident children. Under the construction scenario, the same receptors are evaluated, with the addition of an onsite construction worker at each of the RAAs. Exposure to offsite receptors will be evaluated for each of the RAAs.

19.3.1.5 Identification of Routes of Exposure

With viable transport mechanisms to the potential receptors identified, routes of exposure must be identified to complete the exposure pathway analyses. An exposure route is the way a chemical comes in contact with the human receptor (EPA, 1989a). Possible exposure routes include ingestion of soil onsite or of deposited particulates offsite (onsite airborne particulates transported offsite), absorption through dermal contact with soil, inhalation of vapors, and inhalation of airborne particulates. The potential exposure routes for each group of receptors are discussed below.

Onsite receptors are susceptible to dermal absorption of COCs from direct contact of bare skin (i.e., arms, hands) with impacted soil. All of the RAAs, except RAA #4, are located adjacent to buildings where workers are employed. These workers may also be exposed to COCs through inhalation of vapor, inhalation of particulates, and ingestion of soil. Based on their locations and work habits, onsite construction and general-duty workers may therefore be exposed to COCs through ingestion of soil, dermal absorption of soil, inhalation of vapor, and inhalation of airborne particulates.

The offsite residential receptors will be exposed to COCs transported through the air pathway. Exposure routes include: ingestion of deposited particulates, dermal absorption of deposited particulates, inhalation of vapor, and inhalation of airborne particulates.

Offsite sensitive receptors consist of children who may be exposed to COCs through the same pathways as the offsite residential receptors. Children are assumed to spend a greater portion of their time outside and in close contact with soil in their play areas. Ingestion and dermal absorption of deposited particulates, and inhalation of vapor and airborne particulates are viable pathways of exposure for children.

19.3.1.6 Identification of Complete Exposure Pathways

The complete exposure pathways for both exposure scenarios are summarized in Table 19-10, based on the information presented above. For the onsite construction and general-duty workers, ingestion and dermal absorption of onsite soils are complete exposure pathways. Offsite receptors are not expected to come in direct contact with site soils. Vapor and airborne dust inhalation are also complete exposure pathways for the onsite workers as well as for the offsite receptors. In addition, ingestion and dermal absorption of COCs present in particulate matter following air transport are complete exposure pathways for the offsite receptors.

For those exposure pathways judged to be complete, the chemical intakes or doses are estimated and the risks to human health are characterized in terms of carcinogenic risk and noncarcinogenic hazards.

19.3.1.7 Uncertainties and Limitations

This section discusses the uncertainties and limitations associated with the exposure pathway analysis. A source of uncertainty involves the assumption that surface soils are bare, when most of the RAAs investigated are covered with asphalt. A second source of uncertainty involves the evaluation potential vadose zone transport mechanisms.

This HRA assumes that surface soils are entirely bare, when most of the RAAs investigated are covered with asphalt. RAA #1 consists of 11 oil/water separators and the aircraft washrack drain system, all underground units constructed of concrete. The openings to all separators, except SWMU #8, are surrounded on all sides by asphalt. RAA #2, the previous location of two chemical storage tanks, was recently paved for use as a parking lot. RAA #3 consists of an inactive sump constructed in a concrete slab. RAA #4 is the only area investigated at which surface soils are completely exposed. The explosive ordnance disposal area is graded to remove any debris from explosives and vegetation. As a result, the assumption that surface soils are bare at all RAAs overestimates exposure.

This HRA assumed that vadose zone transport mechanisms are not viable enough to transport surface and near-surface soil contamination to the water table. Generally, the soil data supports the conclusion that VOCs in the vadose zone have not migrated beyond the soil depths investigated as part of this RFI. However, certain exceptions to this generalization do exist. For SWMU #48A in RAA #2, VOCs (TEX) were detected at the maximum depth of samples

taken, 10 feet. However, no data were collected at greater depths or at the groundwater to determine the extent of possible further VOC migration. The limitation involving this data gap is unquantifiable. A similar limitation exists for the acetone data for several of the SWMUs which constitute RAA #1, although this limitation is confounded by the possibility of some instances of acetone detection arising due to lab contamination.

19.3.2 Baseline Scenario

This section summarizes the exposure assessment process used to estimate exposure doses under baseline conditions at each of the RAAs. The RME soil concentrations presented in Section 19.2.4 are used in fate and transport modeling to determine exposure point concentrations. These exposure point concentrations, with corresponding exposure assumptions, are then used to estimate exposure doses for each receptor.

19.3.2.1 Air Pathway Fate and Transport Modeling

Based on the exposure pathway analysis presented in Section 19.3.1, fate and transport modeling was performed only for air transport mechanisms. Air transport of COCs can occur through vapor-phase and/or particulate-phase mechanisms. Exposures associated with air transport are considered in this HRA for both onsite and offsite receptors. Exposure for onsite receptors consists of the inhalation of onsite vapor-phase emissions and the inhalation of COCs present in airborne particulates generated from onsite soils. Exposure for offsite receptors consists of the inhalation of COCs present in airborne particulates generated from onsite soils that have been transported offsite, and the ingestion or dermal absorption of COCs present in deposited airborne particulates that have been transported from the RAAs to offsite receptor locations.

Vapor concentrations for VOCs are used to calculate doses for the vapor inhalation pathway. Ambient PM_{10} concentrations (particulates less than 10 microns in diameter, considered the inhalable fraction), are used to calculate doses for the dust inhalation pathway. Total suspended particulate (TSP) deposition rates are used to calculate doses for the soil ingestion and dermal absorption pathways for offsite receptors. This subsection presents the transport assumptions, modeling approaches, and results.

19.3.2.1.1 *Vapor Phase*. A vapor-phase migration model suited to the site conditions is the Thibodeaux-Hwang Land Treatment Model. This model is used to obtain a flux at the ground surface (in units of mass per unit time per unit area) for VOCs. The calculated flux can then be used to estimate the concentrations of VOCs in ambient air using a box-modeling approach. The box model assumes that VOCs migrating up from the soil accumulate into a hypothetical "box" above the ground surface. Both models conservatively assume bare soil is present over each RAA. In reality, all RAAs except RAA #4 are covered with asphalt. The Thibodeaux-Hwang Land Treatment Model and the box model used, their accompanying assumptions, and the modeling results for VOCs are discussed below.

Thibodeaux-Hwang Land Treatment Model

The Thibodeaux-Hwang Land Treatment Model is recommended by the USEPA for use in estimating volatile emissions for land treatment operations (EPA, 1988a) In this model, the emission rate is controlled by the diffusion of vapor through air-filled pores. The model predicts an emission flux at a specified period of time after application of the contaminants to the soil. The maximum rate of air emissions would theoretically occur immediately after application.

The effective flux (q_i), or rate at which the volatile compound is transported to the atmosphere per unit surface area, can be calculated using the following equation (Thibodeaux and Hwang, 1982):

$$q_i = \frac{D_{ei} \times C_{ig} \times 10^7}{[\,(2 \times D_{ei} \times T \times A \times H_p \times C_{ig}) / M_{io}]^{1/2}} \qquad (19\text{-}4)$$

where

$$D_{ei} = D_{ai} \times [(T_2 + 273)^{1.5}/(T_1 + 273)^{1.5}] \times (E^{10/3}/S_t^2) \qquad (19\text{-}5a)$$

$$E = S_t\text{-}m \qquad (19\text{-}5b)$$

$$S_t = 1\text{-}(BD/SD) \qquad (19\text{-}5c)$$

$$C_{ig} = C_{il} \times H_c' \qquad (19\text{-}6a)$$

$$C_{il} = PPM_i \times (1/m) \times BD \times 10^{-6} \qquad (19\text{-}6b)$$

$$H_c' = H_c/K_{sw} \qquad (19\text{-}6c)$$

$$K_s = 10^{[(\log Kow-b)/a]} \qquad (19\text{-}6d)$$

$$H_c = H \times C_g \times (1/P) \times 10^6 \qquad (19\text{-}6e)$$

$$M_{io} = PPM_i \times 10^{-6} \times A \times H_p \times BD \qquad (19\text{-}7)$$

and

q_i = Flux emission rate (mg/m^2-s);
D_{ai} = Molecular diffusivity in air (cm^2/s);
T_1 = Temperature of diffusion coefficient (25 deg C);
T_2 = Temperature of calculations (25 deg C);
BD = Soil bulk density (1.78 g/cm^3);
SD = Soil particle density (2.65 g/cm^3);
m = Moisture content (by volume) = Moisture content (by weight) x BD x [1/Density of water (1g/cm^3)];
H = Henry's Law constant (atm-m^3/g-mole);
K_{ow} = Octanol/water partition coefficient (unitless);
a = Solvent regression equation coefficient (0.894);
b = Solvent regression equation coefficient (0.29);
PPM_i = COC concentration in soil (mg/kg);
A = Surface area of Risk Assessment Area (cm^2);
H_p = Depth of contaminated soil (304.8 cm);
T = Time at which emissions are determined (3600 sec);
S_t = Total soil porosity (unitless);

E = Soil air filled porosity (unitless);
D_{ei} = Effective diffusivity of COC in air-filled soil pore spaces (cm^2/s);
H_c = Henry's Law constant in concentration (cm^3 water/cm^3 air);
P = Total pressure (1 atm);
C_g = Molar density of vapor (4.1×10^{-5} g-mol/cm^3);
K_{sw} = Solvent/water partition coefficient (unitless);
H_c' = Effective Henry's Law constant (cm^3 water/cm^3 air);
C_{il} = COC concentration in soil water (g/cm^3 water);
C_{ig} = COC concentration in pore spaces (g/cm^3 air);
M_{io} = Initial mass of COC (g);
10^7 = Conversion factor (cm^2-mg/m^2-g);
10^{-6} = Conversion factor (kg/mg); and,
10^6 = Conversion factor (cm^3/m^3).

The effective flux (q_i) is dependent on an effective diffusivity (D_{ei}) and the concentration of the COC in the pore spaces. The effective diffusivity, D_{ei}, can be calculated according to Equation 19-5a. D_{ei} represents the rate at which the chemical can migrate through soil. D_{ei} is a function of the chemical-specific air diffusivities (D_{ai}) and soil porosity (total and air-filled). The chemical-specific physical properties were obtained from *Air/Superfund National Technical Guidance Study Series, Volume II, Estimation of Baseline Air Emissions at Superfund Sites* (EPA, 1989b). Effective diffusivities are always less than their corresponding air diffusivities because of the tortuous path that diffusing molecules must follow in the subsurface.

Air-filled porosity is based on the total porosity and moisture content (by volume). The volumetric moisture content is calculated from the gravimetric moisture content, bulk density of the soil, and density of water.

The concentration of the COC in the pore spaces (C_{ig}) is calculated by multiplying the concentration of the COC in the liquid phase (C_{il}) by the effective Henry's Law constant (H_c'). C_{il} was calculated assuming that the COC in soil had totally partitioned into the pore water. The COC then further partitions from the pore water into the air-filled pore space. Once in the air-filled pore space, the COC migrates to the surface through a tortuous path of interconnected pores in the soil.

Retardation processes considered are the phase portioning from pore water to air-filled pore space and the migration through tortuous, interconnected pores within the soil. These retardation processes are incorporated into the calculation of the effective diffusivity and the effective Henry's Law constant.

The input parameters for the model for RAA #1 and RAA #2, the only RAAs with VOCs as COCs, are presented in Tables 19-11 and 19-12, respectively. RME soil concentrations, presented in Section 19.2.4, were used as the concentration of the COC in soil (PPM_i). The resulting flux emission rates are presented in Table 19-13.

Box Model

Ambient vapor concentrations of VOCs that would arise due to the fluxes calculated using the Thibodeaux-Hwang Model are dependent on land use. For instance, if the site were exposed to outside air (i.e., there were no building or surface enclosures in which the vapors could accumulate), wind currents and atmosphere mixing would almost immediately reduce the vapor concentrations. In keeping with the conservative nature of this HRA, the box model assumes that vertically diffusing vapors enter an enclosed space and accumulate. The elevated vapor concentrations in this enclosed space can be calculated. The ambient vapor concentrations are conservatively assumed equivalent to the vapor concentrations in this enclosed space.

An estimate of VOC concentrations in ambient air can be made using Equation 19-8:

$$C_{air} = q_i / N \qquad (19\text{-}8)$$

where

C_{air} = Ambient air concentration (mg/m^3);
q_i = Effective flux as calculated from Thibodeaux-Hwang Model (mg/m^2-s);

and

N = Outdoor ventilation rate (m^3 air/s-m^2 area).

Assumptions used in the box model include the following: the asphalt covering most of the RAAs is considered to be completely permeable to VOC vapors and the outdoor ventilation rate recommended by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. could be achieved. The outdoor ventilation rate was obtained from *Ventilation for Acceptable Indoor Quality* for a spectator area (ASHRAE, 1989). With an estimated maximum occupancy of 150 persons per 1000 square feet and an outdoor air requirement of 15 cubic feet of air per minute per person, the outdoor ventilation rate (N) equals 2.25 cubic feet of air per minute per square foot, or 0.12 cubic meters of air per second per square meter.

For each volatile COC in RAAs #1 and #2, the onsite ambient vapor concentrations were calculated (using Equation 19-8 and the fluxes presented in Table 19-13) and are presented in Table 19-13. The maximum VOC concentration, 8×10^{-2} mg/m^3 (80 ug/m^3), was for xylenes in RAA #2. The ambient air VOC concentration estimates are very conservative, especially since most of the RAAs are paved and the maximum detected concentrations were used as RME soil concentrations. Since wind currents and atmospheric effects would instantaneously reduce vapor concentrations, an estimate of ambient air concentrations of VOCs offsite was assumed to not be necessary.

19.3.2.1.2 *Airborne Particulate Phase*. Air transport modeling of particulates consisted of three operations: estimation of the onsite fugitive particulate emission factors, modeling the onsite ambient particulate concentration, and modeling the offsite transport and deposition of these particulates. The analysis for particulates was conducted in four steps. First, the particulate erosion emission factor at each RAA was calculated using the methodology given in the *Air/Superfund National Technical Guidance Study Series, Volume III, Estimation of Air Emissions from Cleanup Activities at Superfund Sites* (EPA, 1989c). Second, onsite ambient air

particulate concentrations at each RAA were estimated using the Fugitive Dust Model (FDM) (EPA, 1991a). Third, ambient particulate concentrations and deposition rates at offsite receptor locations were estimated using the FDM. Finally, the RME soil concentrations presented in Section 19.2.4 for the inorganics (metals) were combined with the FDM results to obtain RAA-specific airborne and deposited particulate concentrations of COCs at each exposure point. Each of these four steps is discussed separately below.

Estimation of Particulate Emission Factors

The Air/Superfund soils handling methodology was used to compute the total suspended particulate (TSP) and PM_{10} emission factors for the baseline scenario (EPA, 1989c). PM_{10} refers to the inhalable fraction of the TSP load that is less than 10 microns in diameter, and is used in estimating inhalation exposure. The generation of onsite airborne particulates results primarily from fugitive particulate emissions due to wind erosion.

The equation used to estimate particulate emission factors from wind erosion is:

$$E = k \times 1.9 \times (s/1.5) \times [(365-p)/235] \times (f/15) \times CF \qquad (19\text{-}9)$$

where

E	=	Particulate emission factor for wind erosion/storage (g/m^2-s);
k	=	Particle size multiplier;
s	=	Silt content (%);
p	=	Number of days per year with precipitation of 0.01 inches or more;
f	=	Annual occurrence of unimpeded winds exceeding 12 miles per hour (%); and,
CF	=	Conversion factor [1.1574×10^{-6}(hectare-g-day)/(m^2-kg-sec)]

This equation applies to both TSP and PM_{10}. The particle size multiplier (k), which represents the PM_{10} fraction of the TSP load, is 1.0 for TSP, and 0.35 for PM_{10}. Required input parameters for estimating emission factors using the Air/Superfund soils handling methodology were the onsite silt content, the number of days per year with precipitation of 0.01 inches or more, and the annual occurrence of unimpeded winds exceeding 12 miles per hour. These parameters were obtained from the previous Cannon AFB baseline risk assessment report (Woodward-Clyde, 1992). Silt content percentages for each RAA were obtained from RAAs investigated during the Woodward-Clyde assessment which are located immediately adjacent to the RAAs investigated during this effort. At Cannon AFB, the precipitation exceeds 0.01 or more inches approximately 60 days out of the year (Climactic Atlas of the Unites States, 1973). Data from the closest available meteorology station reveal that approximately 49% of the time the wind speed exceeds 12 miles per hour (NWS, 1992).

The TSP and PM_{10} particulate emission factors for each RAA were calculated and are presented in Table 19-14. These results were used as input parameters for dispersion modeling.

Air Dispersion Modeling

The particulate emission factors calculated above were used as input to the Fugitive Dust Model (FDM) to estimate the impacts at each receptor location. FDM is an air dispersion model specifically designed for computing concentrations and deposition impacts from fugitive dust sources (EPA, 1991a). FDM was used to obtain airborne particulate concentrations and particulate deposition rates at specified receptor locations, assuming worst-case meteorological conditions for ground level, non-buoyant sources.

In addition to the particulate emission factors, FDM requires the following input: modeling time; surface roughness height; particulate density; particle size distribution; receptor locations; source type, dimension, and spatial orientation; and meteorological data. Assumed values for these inputs are presented in Table 19-15. Emissions over a period of one year were modeled, and FDM calculated the long term average concentration at each receptor location. A roughness height was estimated from physical site conditions in conjunction with information in the FDM Model Users Guide (EPA, 1991a). FDM uses the roughness height to model the influence wind has on the movement of fugitive particulates at ground surface. The roughness height input values correspond to the predominant ground surface cover between the emitting source (i.e., the RAAs) and the receptor location. A roughness height of 11.4 cm, corresponding to tall grass, was selected for onsite calculations, and a value of 370 cm, corresponding to residential development, was selected for offsite calculations. These values were obtained from the FDM Model Users Guide (EPA, 1991a). Two separate particle size distributions were used for TSP and PM_{10} dispersion modeling. These distributions were obtained from the Support Center for Regulatory Air Models--Bulletin Board System (EPA, 1992b), an online electronic bulletin board serving users of air quality models.

Receptor locations were specified as part of the FDM particulate modeling input. Various onsite receptor locations were placed within and just outside the RAAs, to determine the precise location of maximum onsite exposure. Fifteen offsite receptor locations were placed along Olympic Boulevard at 100 meter intervals, also to determine the precise location of maximum offsite exposure.

The dimensions of the RAAs were determined by the surface area over which soil samples were taken. For RAAs composed of two or more SWMUs, the modeled area was defined by the sum of the individual SWMUs. For example, RAA #1 was modeled as a large rectangular area bounded by the flight apron and South Torch Boulevard (NE-SW direction), extending from Building 119 to Building 195. RAAs #2, 3, and 4 were modeled as area sources. RAA #1 was modeled as a line source because its length was greater than five times the width, as recommended by the FDM Model Users Guide (EPA, 1991a). As a result, the particulate emission factors (g/m^2-s) for RAA #1 were converted to units of g/m-s by multiplying by the width of the RAA.

The assumed worst-case meteorological conditions included the following: wind speed of 2.5 m/sec and a direction directly towards offsite receptors, atmospheric stability class F (maximum stability), and a mixing height of 100 meters.

Particulate Modeling Results

The FDM model was used to calculate onsite PM_{10} ambient concentrations (ug/m^3), offsite TSP deposition rates (ug/m^2/s), and offsite PM_{10} ambient concentrations (ug/m^3) for each RAA. These results are presented in Table 19-15. The highest concentrations and deposition rates were conservatively selected from the receptor locations modeled. For onsite receptors, the highest impacts were seen at the receptor located 1 meter downwind of the RAA boundary.

The COC particulate concentrations were calculated assuming that the concentration of COCs on the airborne particulates (mg COC/kg of soil) was the same as that in onsite soils (RME soil concentration). The following expression was used to calculate the airborne dust concentration of each COC for onsite receptors:

$$\text{Onsite COC Dust Concentration (mg/m}^3\text{)} = \text{FDM } PM_{10} \text{ concentration (ug/m}^3\text{)} \times \text{Onsite RME soil concentration (mg/kg)} \times 10^{-9} \text{ kg/ug} \quad (19\text{-}10)$$

Onsite dust concentrations for each COC are presented in Tables 19-16 through 19-19. These results represent the PM_{10} concentration of each COC present in ambient air at the receptors, and are used in dose calculations for the dust inhalation exposure pathway for onsite receptors.

Offsite receptors were assumed to be exposed to soils deposited from airborne dusts generated onsite. Deposition of airborne particulates transported offsite was assumed to occur continuously. The offsite deposited soil concentration for each particulate-bound COC was calculated using the following equation (Clement, 1988):

$$\text{COC Deposited Soil Concentration (mg/kg)} = \frac{\text{TSPDR} \times \text{RME} \times \text{AT} \times 10^{-9}}{\text{SD} \times \text{BD}} \quad (19\text{-}11)$$

where:

TSPDR	=	Total Suspended Particulate (TSP) deposition rate from FDM (ug/m^2/s);
RME	=	Onsite RME soil concentration;
AT	=	Accumulation time (70 years, or 2.21 x 10^{-9} sec)
10^{-9}	=	Conversion factor (kg/ug);
SD	=	Soil mixing depth (0.01 m); and,
BD	=	Bulk density of soil (1780 kg/m^3).

The accumulation time represents the total time during which deposited airborne particulates are estimated to accumulate at receptor locations. Accumulation time is assumed to be 70 years, the amount of time a receptor is expected to be exposed over a lifetime (EPA, 1989a). The soil mixing depth represents the depth to which deposited airborne particulates are assumed to be mixed after deposition on exposed soils at receptor locations offsite. The bulk density of the soil is the dry density of the soil as determined by the previous baseline risk assessment (Woodward-Clyde 1992). The equation, however, neglects all mechanisms of loss, including

photodegradation, biodegradation, volatilization, runoff, resuspension of particulate matter, removal of soil, mixing to greater depths, and dilution with other deposited particulates.

The deposited particulate soil concentrations of COCs for all of the RAAs are presented in Tables 19-16 through 19-19. These offsite soil concentrations represent the deposition of total airborne particulates occurring over a total deposition period of 70 years. The results are used in dose calculations for the soil ingestion and dermal absorption exposure pathways for the offsite receptors.

Offsite receptors are also assumed to be exposed to ambient dust containing COCs that have been transported offsite. Ambient dust concentrations of COCs were assumed to be directly proportional to the onsite RME soil concentrations and the airborne PM_{10} concentrations determined by FDM for offsite receptors. The following expression was used to calculate the airborne dust concentration of each COC for offsite receptors:

$$\text{Offsite COC Dust Concentration (mg/m}^3\text{)} = \text{FDM } PM_{10} \text{ concentration (ug/m}^3\text{)} \times \text{Onsite RME soil concentration (mg/kg)} \times 10^{-9} \text{ kg/ug} \quad (19\text{-}12)$$

Offsite dust concentrations for each COC are presented in Tables 19-16 through 19-19. These results represent the PM_{10} concentration of each COC present in ambient air at the receptors, and are used in dose calculations for the dust inhalation exposure pathway for offsite receptors.

19.3.2.1.3 *Uncertainties and Limitations.* This section discusses the uncertainties and limitations associated with fate and transport modeling. For vapor-phase modeling, uncertainties involving the use of a conservative box model with other conservative assumptions are discussed. For particulate-phase modeling, uncertainties involving the chemical composition of airborne particulates, particle size distribution, and the modeled area of RAA #1 are discussed.

VOC Emissions

For airborne exposure to VOCs, a conservative box model was used to estimate airborne concentrations. The model overestimates potential exposure point concentrations since dispersion and deposition were not considered for the emitted gases, and the gases were assumed to be nonreactive. Furthermore, no surface barrier to diffusion from soil to ambient air (like pavement, building foundations, or ponded water) was assumed to exist. Finally, the source of VOC emissions was assumed constant over time. As a result, the risk due to inhalation of vapors is likely overestimated.

Particulate Emissions

In estimating particulate concentrations, all chemicals present in the soil were assumed to be attached to the particulates. Furthermore, the particulates (dust) were assumed to be the PM_{10} fraction, and all such particulates were assumed inhalable. As a result, the risk due to inhalation of dust onsite and offsite, soil ingestion offsite, and dermal absorption offsite is overestimated.

The results of FDM modeling are sensitive to the input parameters, which include: surface roughness height; particulate density; particle size distribution; receptor locations; source type, dimension, and spatial orientation; and meteorological data. Input values for each of these terms were taken from site-specific data and worst-case meteorological conditions, with the exception of the airborne particle size distribution. Airborne particle size distribution measurements for TSP and PM10 were not performed at the site. Therefore, airborne particle size distributions were obtained from a test case of typical airborne particle size distributions in the EPA SCRAM Air Quality Model electronic clearing house. The test case was documented by Kirk D. Winges of TRC Environmental Consultants, Inc. (the EPA contractor that developed FDM).

The degree to which these distributions are indicative of the actual airborne particle size distributions at Cannon AFB is an unquantifiable uncertainty. Furthermore, the area modeled for RAA #1 is significantly greater than the sum of the areas of the individual SWMUs composing this RAA. As a result, the risk due to inhalation of dust onsite and offsite, soil ingestion offsite, and dermal absorption offsite due to COCs at RAA #1 is overestimated.

19.3.2.2 Exposure Point Concentrations

Fate and transport modeling was used to estimate exposure point concentrations resulting from soil contaminants present at the RAAs. This section summarizes the exposure point concentrations used in the estimation of dose for each receptor. For each RAA, the exposure point concentrations for onsite and offsite receptors, per exposure pathway, per COC, are presented in Tables 19-20 through 19-23.

Onsite receptors were assumed to be in direct contact with the soil itself. Thus, exposure point concentrations for the onsite worker for onsite soils were assumed equivalent to the RME soil concentrations calculated in Section 19.2.4, and are presented in the first column of Tables 19-20 through 19-23. The estimated onsite ambient vapor concentrations are presented in the second column of the tables. These vapor concentrations are based on the fate and transport modeling of vapor-phase migration of VOCs, as described in Section 19.3.2.1.1. The onsite airborne dust concentrations are presented in the third column of the tables; these concentrations were calculated in Section 19.3.2.1.2.

Offsite receptors such as residential adults and children were assumed to be exposed to deposited soils and airborne dusts. The offsite deposited soil concentrations are presented in the fourth column of the tables; these concentrations were calculated in Section 19.3.2.1.2. Because offsite vapor concentrations were assumed negligible due to wind dispersion, it was assumed that offsite receptors were not exposed to ambient vapor concentrations. The offsite airborne dust concentrations are presented in the fifth column of the tables; these concentrations were calculated in Section 19.3.2.1.2.

19.3.2.3 Exposure Assumptions

Exposure concentrations for all applicable environmental media were discussed in the previous section. This section presents the receptor-specific and chemical-specific exposure assumptions used to calculate exposure doses for all receptors, under baseline conditions.

19.3.2.3.1 *Receptor-Specific.* Exposure assumptions for each receptor quantitatively evaluated in this HRA are presented in Table 19-24. Values of all parameters listed in the table were obtained from RAGS or supplemental RAGS documents. Sources for each exposure assumption are noted in the table.

The onsite worker was assumed to spend 8 hours a day, 250 days a year for 25 years at a hypothetical onsite location of maximum exposure. The offsite residential receptor was assumed to spend 24 hours a day, 350 days a year for 30 years outdoors at the point of hypothetical maximum offsite exposure. The offsite sensitive receptor (child) was assumed to spend 24 hours a day, 350 days a year for 6 years outdoors at the point of hypothetical maximum offsite exposure. To differentiate children from adults, the soil ingestion rate was increased to 200 mg/day, the surface area of exposed skin was decreased to 2295 cm^2, and the body weight was decreased to 15 kg.

Averaging time is defined as the period over which exposure is averaged. Carcinogenic averaging time assumes exposure over 70 years for 365 days per year, while noncarcinogenic averaging time is equal to the exposure duration (years) times 365 days per year. Different averaging times are used for carcinogens and noncarcinogens because it is thought that their effects occur through different mechanisms. In essence, exposure to low doses of a carcinogen over an extended duration (7 years or more) is assumed to be cumulative. The approach for carcinogens is based on the current scientific opinion that a high dose received over a short period of time (as conducted in chronic studies in experimental animals) is equivalent in the dose-response rate to a corresponding low dose spread over a lifetime. Therefore, the intake of a carcinogen, for whatever duration, is averaged over a 70-year lifetime (Woodward-Clyde 1992).

19.3.2.3.2 *Chemical-Specific.* Chemical-specific exposure assumptions describe the interaction of each COC with the human body. The interaction of a compound with the human body is influenced by the chemical characteristics of the compound and the route of exposure. Merely coming into contact with a certain concentration or amount of compound does not mean total absorption into the human body. Some compounds are very poorly absorbed by the body via a particular exposure pathway and thus pose a negligible risk if exposure occurs via that pathway.

The ability of the human body to absorb different compounds to which it is exposed can be quantified according to the route of exposure. Bioavailability is the fraction of a compound actually absorbed into the body through all exposure pathways. The inhalation retention factor is the fraction of an inhaled compound retained in the body. The skin absorption rate (ABS) is the fraction of a compound absorbed through the skin due to dermal contact.

Bioavailability, inhalation retention factors, and absorption factors are chemical-specific. In keeping with the conservative nature of this HRA, the bioavailability and inhalation retention factors for all COCs were assumed to be 100%. Skin absorption factors were assumed to be 10% for organics and 1 percent for inorganics. A summary of the bioavailability, inhalation retention factor, and skin absorption factor associated with each COC is presented in Table 19-25.

19.3.2.4 Exposure Dose Estimation

In the previous section, receptor-specific and chemical-specific exposure assumptions were presented. This section discusses the methodology used to calculate exposure doses for each exposure pathway and presents the resulting dose estimations for each receptor. Calculated doses are expressed in units of milligrams of chemical per kilogram of body weight per day (mg/kg/day).

19.3.2.4.1 *Soil Ingestion Pathway.* Calculation of the dose via soil ingestion pathway requires an estimation of the rate of transfer of materials from surface soils to hands and then from hands to mouth. This rate is defined as the ingestion rate and is measured in units of mg of soil per day. It is assumed that children have a higher probability of contact with soil and therefore ingest a greater mass of soil each day than adults. Other important variables involved in calculating the dose via soil ingestion are the bioavailability of compounds adsorbed to soils and the fraction ingested (FI). As discussed in Section 19.3.2.3.2, the bioavailability factor of compounds ingested is assumed to be 100%. The fraction ingested is the fraction of soil ingested that is from the contaminated source. This value is also assumed to be 100%. Other assumptions made in the calculation of the dose for the soil ingestion pathway include uniform mixing of compounds in soil and no leaching or washing away of compounds from soil.

Onsite receptors were assumed to be exposed to onsite surface soils containing COCs at concentrations equal to the RME values. Offsite adult and sensitive receptors were assumed to be exposed to soils deposited from airborne dusts generated onsite. Exposure point concentrations for all receptors for all RAAs are presented in Tables 19-20 through 19-23; soil exposure point concentrations for onsite receptors are presented in the first column of the tables, and for offsite receptors in the fourth column of the tables.

Carcinogenic and noncarcinogenic dose via the soil ingestion pathway was calculated according to the following expression (EPA, 1989a).

$$Dose_{soil} = \frac{CS \times IR \times CF \times FI \times EF \times ED}{BW \times AT} \qquad (19\text{-}13)$$

where,

$Dose_{soil}$	=	Daily dose due to ingestion of soil (mg/kg/day);
CS	=	Concentration of COC in onsite surface soils or deposited soils (mg/kg);
IR	=	Soil ingestion rate (mg/day);
CF	=	Conversion factor (10^{-6} kg/mg);
FI	=	Fraction ingested from the contaminated source (unitless);
EF	=	Exposure frequency (days/year);
ED	=	Exposure duration (years);
BW	=	Average body weight (kg); and,
AT	=	Averaging time or period over which exposure is averaged (days).

Dose estimates for the soil ingestion pathway for the onsite, offsite, and offsite sensitive (child) receptors for all RAAs are presented in Tables 19-26 through 19-37. A review of the soil ingestion pathway doses estimated indicates the onsite receptor receives the largest dose. These results follow from the assumption that the onsite receptor is exposed to onsite surface soils while the offsite receptors are exposed to deposited soils. Furthermore, onsite receptors are exposed to VOCs in the soil.

19.3.2.4.2 *Dermal Absorption Pathway*. The amount of exposure via dermal absorption is determined by such variables as the frequency and duration of soil contact, the concentrations of COCs in the soil, the skin surface area available for contact with the soil, the adhesion of soil to the skin, and the ability of the chemicals to penetrate the skin. Exposure assumptions relating to these parameters are presented and referenced in Table 19-24.

For onsite workers, exposure due to dermal absorption is based on the concentrations of COCs in onsite surface soils (equivalent to the RME values). For the offsite adult and sensitive receptors, exposure to dermal absorption is based on the concentrations of COCs in deposited soil. Exposure point concentrations for all receptors for all RAAs are presented in Tables 19-20 through 19-23.

Carcinogenic and noncarcinogenic dose via the dermal absorption pathway was calculated according to the following expression (EPA, 1989a).

$$Dose_{dermal} = \frac{CS \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT} \qquad (19\text{-}14)$$

where,

$Dose_{dermal}$	=	Daily dose due to dermal absorption (mg/kg/day);
CS	=	Concentration of COCs in onsite surface soils or deposited soils (mg/kg);
CF	=	Conversion factor (10^{-6} kg/mg);
SA	=	Surface area of exposed skin (cm^2/event);
AF	=	Soil to skin adherence factor (mg/cm^2);
ABS	=	Fraction of soil absorbed across skin (unitless);
EF	=	Exposure frequency (events/year);
ED	=	Exposure duration (years);
BW	=	Average body weight (kg); and,
AT	=	Averaging time or period over which exposure is averaged (days).

Dose estimates for the dermal absorption pathway for the onsite, offsite, and offsite sensitive (child) receptors for all RAAs are presented in Tables 19-26 through 19-37. A review of the dermal absorption pathway doses estimated indicates the onsite receptor receives the largest dose. These results follow from the assumption that the onsite receptor is exposed to onsite surface soils while the offsite receptors are exposed to deposited soils, which have a much lower concentration of the COCs. Furthermore, onsite receptors are exposed to VOCs in the soil.

19.3.2.4.3 *Inhalation of Vapor Pathway.* Ambient vapor concentrations due to the upward vapor-phase migration of VOCs from onsite soils are presented in Tables 19-20 through 19-23. These vapor concentrations are used in the calculation of dose due to inhalation of vapors. Vapor concentrations of VOCs are assumed to be negligible at offsite receptor locations due to air dispersion and the low vapor concentrations calculated for the onsite receptor. Vapor concentrations of metals are assumed to be negligble at both onsite and offsite receptor locations due to the low volatility of metals.

Carcinogenic and noncarcinogenic dose via the inhalation of vapors pathway was calculated according to the following expression (EPA, 1989a).

$$Dose_{inh/v} = \frac{CA \times IR \times ET \times EF \times ED}{BW \times AT} \qquad (19\text{-}15)$$

where,

$Dose_{inh/v}$	=	Daily dose due to inhalation of vapor (mg/kg/day);
CA	=	Concentration of COCs in air (mg/m^3);
IR	=	Inhalation rate (m^3/hour);
ET	=	Exposure time (hours/day);
EF	=	Exposure frequency (days/year);
ED	=	Exposure duration (years);
BW	=	Average body weight (kg); and,
AT	=	Averaging time or period over which exposure is averaged (days).

For each volatile COC, dose estimates for the inhalation of vapors pathway are presented in Tables 19-26 through 19-37. Dose estimates for the inhalation of vapors pathway were not calculated for the offsite residential sensitive receptors because vapor concentrations were assumed to be negligible due to air dispersion. Dose estimates for the inhalation of vapors pathway were not calculated for metal COCs for the onsite receptors due to the negligible volatility of the metal COCs.

19.3.2.4.4 *Inhalation of Airborne Dust Pathway.* Particles of dust and soil to which COCs are adsorbed can be resuspended into the atmosphere and become airborne. The mechanisms for resuspension are primarily wind erosion and/or dust generation by soil disturbances such as landscaping, gardening, digging by children, walking, running, or the movement of vehicles. All receptors considered in this HRA may potentially be exposed to the compounds detected in site soils by inhalation of this airborne dust (or airborne particulates).

Airborne dust concentrations of each COC are summarized in Tables 19-20 through 19-23. Calculation of the exposure dose via the inhalation of airborne dust was based upon these airborne dust concentrations. It was assumed that 100% of the inhalation dose is absorbed by the body. For the onsite worker the inhalation rate was assumed to equal 20 m^3/day over an 8 hour per day period. For all other receptors, the inhalation rate equaled 20 m^3/day over a 24 hour per day period.

Carcinogenic and noncarcinogenic dose via the inhalation of airborne dust pathway was calculated according to the following expression (EPA, 1989a).

$$Dose_{inh/d} = \frac{CA \times IR \times ET \times EF \times ED}{BW \times AT} \quad (19\text{-}16)$$

where,

$Dose_{inh/d}$	=	Daily dose due to inhalation of airborne dust (mg/kg/day);
CA	=	Concentration of COC as airborne dust in air (mg/m3);
IR	=	Inhalation rate (m3/hour);
ET	=	Exposure time (hours/day);
EF	=	Exposure frequency (days/year);
ED	=	Exposure duration (years);
BW	=	Average body weight (kg); and,
AT	=	Averaging time or period over which exposure is averaged (days).

For each nonvolatile (metal) COC, dose estimates for the inhalation of dust pathway are presented in Tables 19-26 through 19-28. A review of the estimated doses for the inhalation of dust pathway indicates that the onsite receptor receives the largest dose.

19.3.2.4.5 *Uncertainties and Limitations.* This section discusses the uncertainties and limitations associated with the exposure dose estimation. A source of uncertainty involves using the overestimated exposure point concentrations to calculate exposure dose. Another source of uncertainty involves the assumptions made to calculate exposure dose. The calculation of exposure doses relied on the estimation of exposure point concentrations. Exposure point concentrations were determined by the RME soil concentrations and fate and transport modeling. For VOCs, maximum detected concentrations represented the RME values, resulting in an overestimation of risk. Fate and transport modeling incorporated conservative assumptions, also resulting in an overestimation of risk. As a result, exposure point concentrations, and thus, exposure dose, are overestimated.

The receptor-specific assumptions applied to all RAAs. However, some of the RAAs are not likely to have onsite workers that are exposed to COCs for the exposure duration and frequency specified. For instance, it is not likely that a worker is present at RAA #4, the explosive ordnance disposal area, for 8 hours a day, 250 days a year, for 25 years. As a result, these receptor-specific assumptions overestimate risk. Nevertheless, the protection of receptors under all exposure durations and frequencies provides justification for using these conservative assumptions which tend to overestimate risk.

19.3.3 Construction Scenario

This section describes the exposure assessment methodologies used to estimate exposure doses resulting from excavation activities associated with a hypothetical construction scenario at each of the RAAs. Such construction activity could give rise to non-baseline exposures for the previously evaluated receptors and construction workers. The exposure assessment for the construction scenario was performed using the same basic methodology as for the baseline

scenario described in Section 19.3.2. The results are used to estimate the health risk due to construction. Significant differences between the construction and baseline scenarios include the addition of an onsite construction worker receptor, a reduction in surface area from that of the entire RAA to a four feet wide trench dug through the RAA, and the reduction of exposure time. Construction activities were assumed to require 30 8-hour days to complete, for a total of 240 hours.

19.3.3.1 Air Pathway Fate and Transport Modeling

Fate and transport modeling was performed for the air transport pathway to estimate concentrations of COCs that could be released to onsite and offsite construction scenario receptors. Modeling of air transport and subsequent deposition of particulates was required to estimate exposure doses for complete exposure pathways.

Air transport modeling for the construction scenario was conceptually identical to that reported for the baseline scenario.

19.3.3.1.1 *Vapor Phase.* The Thibodeaux-Hwang Land Treatment Model was used to estimate the emission flux at the ground surface for VOCs. The input parameters for RAA #1 and RAA #2, the only RAAs with volatile COCs, are presented in Table 19-38 and Table 19-39, respectively. Since the onsite RME soil concentrations are identical for both baseline and construction scenarios, the results, in units of mass per unit time per unit area, are equivalent to the values determined under baseline conditions. As a result, onsite ambient vapor concentrations for construction activities would also be equivalent to baseline conditions, assuming the same outdoor ventilation rate. For convenience, the results are presented in Table 19-40.

19.3.3.1.2 *Airborne Particulate Phase.* Air transport modeling for the construction scenario consisted of the same four steps performed for the baseline scenario: estimation of the onsite emission rates at each RAA for TSP and PM_{10} arising from construction activities, estimation of onsite ambient particulate concentrations at each RAA using FDM, estimation of offsite ambient particulate concentrations and deposition rates using FDM, and calculation of RAA-specific airborne and deposited particulate concentrations of COCs at each exposure point. The only exceptions to the methodology include the addition of excavation (bulldozing) and dumping activities to estimate fugitive emission rates and the reduction in time for accumulation of deposited particulates at the offsite receptor locations to the duration of the hypothetical construction activities (240 hours).

Estimation of Particulate Emissions Factors

The Air/Superfund soils handling methodology was used to compute the TSP and PM_{10} emission factors for the construction scenario (EPA, 1989c). Three construction activities, soils excavation, soils dumping, and storage/wind erosion from newly exposed soils, were assumed to be the most likely activities that would produce fugitive particulates.

The equation used to estimate particulate emission factors from excavation (bulldozer) is:

$$E_e = a \times s^b \times M^{-c} \times (1/A) \times CF \quad (19\text{-}17)$$

where,

E_e	=	Particulate emission factor for excavation (bulldozer) (g/m^2-s);
a	=	2.6 for TSP, 0.45 for PM_{10};
s	=	Silt content (%);
b	=	1.2 for TSP, 1.5 for PM_{10};
M	=	Moisture content (%);
c	=	1.3 for TSP, 1.4 for PM_{10}.
A	=	Surface area of excavation trench (m^2); and,
CF	=	Conversion factor (0.278 g-hr/kg-s);

The equation used to estimate particulate emission factors from dumping is:

$$E_d = k \times 0.0016 \times (U/2.2)^{1.3} \times (M/2)^{-1.4} \times M_{soil} \times (1/T) \times (1/A) \times CF \quad (19\text{-}18)$$

where,

E_d	=	Particulate emission factor for dumping (g/m^2-s);
k	=	Particle size multiplier;
U	=	Mean wind speed (m/s);
M	=	Moisture content (%);
M_{soil}	=	Moss of soil removed (g) = Volume of excavated soil (m^3) x soil bulk density ($1.78 g/cm^3$) x (10^6 cm^3/m^3);
T	=	Construction time (30 8-hour days, or 8.64×10^5 s);
A	=	Surface area of excavation trench (m^2); and,
CF	=	Conversion factor (10^{-3} Mg/kg).

The equation used to estimate particulate emission factors from wind erosion is:

$$E_s = k \times 1.9 \times (s/1.5) \times [(365-p)/235] \times (f/15) \times CF \quad (19\text{-}19)$$

where

E_s	=	Particulate emission factor for wind erosion/storage (g/m^2-s);
k	=	Particle size multiplier;
s	=	Silt content (%);
p	=	Number of days per year with precipitation of 0.01 inches or more;
f	=	Annual occurrence of unimpeded winds exceeding 12 miles per hour (%); and,
CF	=	Conversion factor [3.472×10^{-6} (hectare-g-8-hour day)/(m^2-kg-sec)].

The above three equations apply to both TSP and PM10. The particle size multiplier (k), which represents the PM_{10} fraction of the TSP load, is 1.0 for TSP, and 0.35 for PM_{10}. Other input parameters in addition to those already addressed in Section 19.3.2.1.2 include the onsite soil moisture content (M); the average wind speed at the site (U); the surface area of the emission source (A); and the mass of soil to be excavated (M_{soil}). The moisture content of the soil was

based on available soil moisture data for SWMU soil samples. The surface soil data indicated drier conditions than the subsurface soils. The surface to subsurface soils were assumed to be at surface soil moisture conditions. The maximum monthly average windspeed was chosen to provide a conservative emissions estimate indicative of the 30-day construction period. April was determined to have the highest average wind speed of any month of the year, with an average speed of 10 mph, or 4.47 m/s (AWS Climate Brief, 1986). The surface area for fugitive particulate emissions was assumed to be limited to the top surface area of the excavated utility trenches. All trenches were assumed to be 4 feet wide, 10 feet deep, and have a length equivalent to the particular RAA. From these dimensions, the volume of the excavated soil was calculated. The mass of the soil excavated is the volume of the excavated soil multiplied by the soil bulk density. A bulk density of 1.78 g/cm^3 was obtained from a previous baseline risk assessment report (Woodward-Clyde, 1992).

The TSP and PM_{10} particle emission factors for each RAA were calculated and are presented in Table 19-41. The emission factors for each construction activity were summed together to provide the total emission factor from each RAA. These results were used as input parameters for dispersion modeling.

Air Dispersion Modeling

FDM was used for the same purpose and in the same manner as in the baseline scenario. Construction worker receptors and general-duty worker receptors were modeled at the same locations onsite. All RAAs were modeled as line sources, since the excavation trenches are much longer (length of the RAA) than they are wide (4 feet).

Particulate Modeling Results

Airborne particulate modeling results are presented in Tables 19-42. The highest concentrations and deposition rates were conservatively selected from amongst the receptor locations. For onsite receptors, the highest impacts were seen at the receptor located 10 meters downwind of the hypothetical utility trench.

Subsequent calculations of the onsite ambient PM_{10} concentration, offsite deposited soil concentration, and offsite ambient PM_{10} concentration for each RAA are presented in Tables 19-43 through 19-46. Deposited soil concentrations of COCs at offsite receptor locations were calculated using an accumulation time for deposition of 240 hours, which is the duration of the hypothetical construction activities.

19.3.3.1.3 *Uncertainties and Limitations*. The discussion on uncertainty presented for the baseline scenario in Section 19.3.2.1.3 applies to the construction scenario. However, the addition of construction activities in the estimation of particulate emission factors introduces more uncertainty. Specifically, values for the silt content in Equation 19-17 and moisture content in Equation 19-18 were outside the ranges recommended by the EPA (EPA, 1989c). The recommended silt content range for Equation 19-17 is 4 to 15% (this HRA uses 28 and

29%) and the recommended moisture content range for Equation 19-18 is 0.25 to 4.8% (this HRA uses 7.4 to 10.5%). Site values should fall within these ranges, upon which the empirical equations are based. As a result, the confidence in the use of the two equations for the RAAs is decreased. However, using a higher silt content value results in a higher emission rate for excavation; therefore, the estimate is more conservative than using the range values. Using a higher moisture content value, however, results in a lower emission rate for dumping.

19.3.3.2 Exposure Point Concentrations

Fate and transport modeling estimated exposure point concentrations resultant from contaminant levels in the RAAs. This section summarizes the exposure point concentrations used in the estimation of dose for each receptor for the construction scenario. For each RAA, the input concentrations for onsite and offsite receptors, per exposure pathway, per COC, are presented in Tables 19-47 through 19-50.

Onsite receptors were assumed to be in direct contact with the soil itself. Thus, exposure point concentrations for the onsite worker were assumed equivalent to the RME soil concentrations calculated in Section 19.2.4 and are presented in the first column of the tables. The estimated onsite ambient vapor concentrations are presented in the second column. These vapor concentrations are based on the fate and transport modeling of vapor-phase migration of VOCs, described in Section 19.3.3.1.1. The onsite airborne dust concentrations are presented in the third column; its estimation was discussed in Section 19.3.3.1.2.

Offsite receptors such as residential adults and children were assumed to be exposed to deposited soils and airborne dusts arising from construction activities. The offsite deposited soil concentrations are presented in the fourth column, its estimation discussed in Section 19.3.3.1.2. Because offsite vapor concentrations were assumed to be negligible due to wind dispersion, it was assumed that offsite receptors were not exposed to ambient vapor concentrations. The offsite airborne dust concentrations are presented in the sixth column; its estimation was discussed in Section 19.3.3.1.2.

19.3.3.3 Exposure Assumptions

Exposure concentrations for all applicable environmental media were discussed in the previous section. This section presents the receptor-specific and chemical-specific exposure assumptions used to calculate exposure doses for all receptors, under construction conditions.

19.3.3.3.1 *Receptor-Specific.* Exposure assumptions for each receptor quantitatively evaluated as part of the construction scenario are presented in Table 19-51. Values of all parameters listed in the table were obtained from RAGS or supplemental RAGS documents or were assumed specifically for the construction scenario. Sources for each exposure assumption are noted in the table.

Averaging time is defined as the period over which exposure is averaged and is categorized as carcinogenic and noncarcinogenic. Carcinogenic averaging time assumes exposure over 70 years for 365 days per year, while noncarcinogenic averaging time is equal to the exposure duration (years) times 365 days per year. Different averaging times are used for carcinogens and noncarcinogens because it is thought that their effects occur through different mechanisms. In essence, exposure to low doses of a carcinogen over an extended duration (7 years or more) is assumed to be cumulative. The approach for carcinogens is based on the current scientific opinion that a high dose received over a short period of time (as conducted in chronic studies in experimental animals) is equivalent in the dose-response rate to a corresponding low dose spread over a lifetime. Therefore, the intake of a carcinogen, for whatever duration, is averaged over a 70-year lifetime (Woodward-Clyde, 1992).

For the vapor and dust inhalation pathways, the onsite and offsite receptors were assumed to be exposed to COCs generated from construction activities for 8 hours a day, 30 days a year for 1 year at a hypothetical location of maximum exposure. This exposure time is equivalent to the period of construction activity. For the soil ingestion and dermal absorption pathways, however, offsite receptors were assumed to be exposed to the deposited soils beyond the construction period. As a result, the residential adult receptor was assumed to spend 24 hours a day, 350 days a year for 30 years outdoors at the point of hypothetical maximum offsite exposure. The residential sensitive (child) receptor was assumed to spend 24 hours a day, 350 days a year for 6 years outdoors at the point of hypothetical maximum offsite exposure. For the soil ingestion and dermal absorption pathways, onsite receptors were assumed the same amount of exposure time as the vapor and dust inhalation pathways.

19.3.3.3.2 *Chemical-Specific.* The discussion on chemical-specific exposure assumptions presented for the baseline scenario in Section 19.3.2.3.2 applies to the construction scenario.

19.3.3.4 Exposure Dose Estimation

In the previous section, receptor-specific and chemical-specific exposure assumptions were presented. Exposure doses via the soil ingestion, dermal absorption, vapor inhalation, and dust inhalation pathways were calculated for the construction scenario according to the algorithms presented in Section 19.3.2.4. For the sake of brevity, those algorithms are not presented here. Calculated doses for each RAA for all pathways for all receptors for the construction scenario are presented in Tables 19-52 through 19-67. In addition, the uncertainties and limitations associated with the exposure assumptions used for the construction scenario are similar to the uncertainties and limitations associated with exposure assumptions used in the baseline scenario.

TABLE 19-10
SUMMARY OF EXPOSURE PATHWAYS

Exposure Scenario	Receptors	Routes of Exposure
Baseline	Onsite Adult Worker (Occupational Exposure)	Ingestion of Onsite Soils Dermal Contact with Onsite Soils Inhalation of Onsite Vapors Inhalation of Onsite Dusts
	Offsite Resident Adult	Ingestion of Deposited Soils Dermal Contact with Deposited Soils Inhalation of Offsite Vapors Inhalation of Offsite Dusts
	Offsite Sensitive Receptor (Resident Child)	Ingestion of Deposited Soils Dermal Contact with Deposited Soils Inhalation of Offsite Vapors Inhalation of Offsite Dusts
Construction	Onsite Construction Worker	Ingestion of Onsite Soils Dermal Contact with Onsite Soils Inhalation of Onsite Vapors Inhalation of Onsite Dusts
	Onsite Adult Worker (Occupational Exposure)	Ingestion of Onsite Soils Dermal Contact with Onsite Soils Inhalation of Onsite Vapors Inhalation of Onsite Dusts
	Offsite Resident Adult	Ingestion of Deposited Soils Dermal Contact with Deposited Soils Inhalation of Offsite Vapors Inhalation of Offsite Dusts
	Offsite Sensitive Receptor (Resident Child)	Ingestion of Deposited Soils Dermal Contact with Deposited Soils Inhalation of Offsite Vapors Inhalation of Offsite Dusts

Table 19-11

THIBODEAUX-HWANG LAND TREATMENT MODEL INPUT PARAMETERS

BASELINE SCENARIO
RAA #1

Parameter	Units	COC					
		Toluene	Xylenes	1,1,1-Trichloroethane	Acetone	Methylene Chloride	Tetrachloroethene
Dai (molecular diffusivity)	cm2/s	0.087	0.087	0.078	0.124	0.101	0.072
T1 (temperature of diffusion coefficient)	deg C	25	25	25	25	25	25
T2 (temperature of calculations)	deg C	25	25	25	25	25	25
BD (soil bulk density) (1)	g/cm3	1.78	1.78	1.78	1.78	1.78	1.78
SD (soil particle density)	g/cm3	2.65	2.65	2.65	2.65	2.65	2.65
m (moisture content) (2)	by volume	0.149	0.149	0.149	0.149	0.149	0.149
H (Henry's Law constant)	atm-m3/g-mole	0.00668	0.00526	0.0172	0.000025	0.00319	0.029
Kow (octanol/water partition coefficient)	unitless	537.03	588.84	316.23	0.58	17.78	398.11
a (solvent regression equation coefficient)	unitless	0.894	0.894	0.894	0.894	0.894	0.894
b (solvent regression equation coefficient)	unitless	0.29	0.29	0.29	0.29	0.29	0.29
PPMi (PPM of chemical in soil) (3)	mg/kg	0.043	0.052	0.008	0.25	0.006	0.014
A (surface area of Risk Assessment Area) (4)	cm2	2.14E+09	2.14E+09	2.14E+09	2.14E+09	2.14E+09	2.14E+09
Hp (depth of contaminated soil) (4)	cm	304.8	304.8	304.8	304.8	304.8	304.8
T (time at which emissions are determined)	sec	3600	3600	3600	3600	3600	3600

Notes:
Unless otherwise noted, values for parameters obtained from "Air/Superfund National Technical Guidance Study Series, Volume II, Estimation of Baseline Air Emissions at Superfund Sites" (USEPA, 1989).
(1) Value obtained from "Remedial Investigation Report for 18 Solid Waste Management Units, Cannon Air Force Base, Clovis, NM" (Woodward-Clyde Consultants, 1992).
(2) Value obtained from site-specific soil samples taken for this report.
(3) Onsite soil concentrations obtained from Table 19-9.
(4) Surface area is the approximate area encompassed by the sampling investigation. Depth of the contaminated soil is assumed to be equal to 10 feet.

Table 19-12

THIBODEAUX-HWANG LAND TREATMENT MODEL INPUT PARAMETERS

BASELINE SCENARIO
RAA #2

Parameter	Units	COC				
		Toluene	Ethylbenzene	Xylenes	Acetone	Methylene Chloride
Dai (molecular diffusivity)	cm2/s	0.087	0.075	0.087	0.124	0.101
T1 (temperature of diffusion coefficient)	deg C	25	25	25	25	25
T2 (temperature of diffusion coefficient)	deg C	25	25	25	25	25
BD (soil bulk density) (1)	g/cm3	1.78	1.78	1.78	1.78	1.78
SD (soil particle density)	g/cm3	2.65	2.65	2.65	2.65	2.65
m (moisture content) (2)	by volume	0.189	0.189	0.189	0.189	0.189
H (Henry's Law constant)	atm-m3/g-mole	0.00668	0.00644	0.00526	0.000025	0.00319
Kow (Octanol/water partition coefficient)	unitless	537.03	1412.54	588.84	0.58	17.78
a (solvent regression equation coefficient)	unitless	0.894	0.894	0.894	0.894	0.894
b (solvent regression equation coefficient)	unitless	0.29	0.29	0.29	0.29	0.29
PPMi (PPM of chemical in soil) (3)	mg/kg	1.2	4.2	32	0.11	0.15
A (surface area of Risk Assessment Area) (4)	cm2	5.81E+05	5.81E+05	5.81E+05	5.81E+05	5.81E+05
Hp (Depth of contaminated soil) (4)	cm	304.8	304.8	304.8	304.8	304.8
T (time at which emissions are determined)	sec	3600	3600	3600	3600	3600

Notes:

Unless otherwise noted, values for parameters obtained from "Air/Superfund National Technical Guidance Study Series, Volume II, Estimation of Baseline Air Emissions at Superfund Sites" (USEPA, 1989)

(1) Value obtained from "Remedial Investigation Report for 18 Solid Waste Management Units, Cannon Air Force Base, Clovis, NM" (Woodward-Clyde Consultants, 1992).

(2) Value obtained from site-specific soil samples taken for this report.

(3) Onsite soil concentrations obtained from Table 19-9.

(4) Surface area is the approximate area encompassed by the sampling investigation. Depth of the contaminated soil is assumed to be equivalent 10 feet.

Table 19-13

VOC EMISSIONS RESULTS

BASELINE SCENARIO

Chemical of Concern	RAA #1			RAA #2		
	Onsite Soil Concentration (1) (mg/kg)	Vapor Flux (2) (mg/m2/s)	Onsite Vapor Concentration (3) (mg/m3)	Onsite Soil Concentration (1) (mg/kg)	Vapor Flux (2) (mg/m2/s)	Onsite Vapor Concentration (3) (mg/m3)
BTEX						
Toluene	4.3E-02	2.69E-05	2.2E-04	1.2E+00	4.40E-04	3.6E-03
Ethylbenzene	NA	NA	NA	4.2E+00	8.18E-04	6.7E-03
Xylenes	5.2E-02	2.74E-05	2.2E-04	3.2E+01	9.89E-03	8.0E-02
Non-BTEX TCL VOCs						
1,1,1-Trichloroethane	8.0E-03	1.02E-05	8.3E-05	NA	NA	NA
Acetone	2.5E-01	5.21E-04	4.2E-03	1.1E-01	1.34E-04	1.1E-03
Methylene Chloride	6.0E-03	1.88E-05	1.5E-04	1.5E-01	2.75E-04	2.2E-03
Tetrachloroethene	1.4E-02	1.96E-05	1.6E-04	NA	NA	NA

Notes:

(1) Onsite soil concentrations are obtained from Table 19-9.

(2) Vapor fluxes were calculated using the Thibodeaux-Hwang Land Treatment Air-Emission Model (Equations 19-4 through 19-7).

(3) Onsite vapor concentrations were calculated from the vapor fluxes using Equation 19-8.

(4) "NA" means not applicable. This chemical was not considered a chemical of concern for this RAA.

Table 19-14

ESTIMATION OF PARTICULATE EMISSION FACTORS

BASELINE SCENARIO

	Units	RAA #1	RAA #2	RAA #3	RAA #4
Input Parameters					
k (Particle size multiplier) (1)	unitless	1.0/0.35	1.0/0.35	1.0/0.35	1.0/0.35
s (Silt content) (2)	%	29	29	29	28
p (Precipitation > 0.01 inches) (2)	days/year	60	60	60	60
f (Annual occurrence of winds > 12 mph) (2)	%	49	49	49	49
TSP Emission Factors					
Wind erosion/storage (3)	g/m2-s	1.80E-04	1.80E-04	1.80E-04	1.74E-04
	g/m-s	2.75E-02			
PM10 Emission Factors					
Wind erosion/storage (3)	g/m2-s	6.31E-05	6.31E-05	6.31E-05	6.09E-05
	g/m-s	9.62E-03			

Notes:

(1) Particle size multiplier represents the PM10 fraction of the TSP load. For TSP, k = 1.0. For PM10, k = 0.35.

(2) Values were obtained from "Remedial Investigation Report for 18 Solid Waste Management Units, Cannon AFB, Clovis, NM" (Woodward-Clyde Consultants, 1992).

(3) Emission factors calculated using Equation 19-9. RAA #1 emission factors were also converted to g/m-s, since RAA #1 was modeled as a line source in the Fugitive Dust Model, by multiplying by the approximate width of the RAA #1 (152.4 m).

Table 19-15

FUGITIVE DUST MODEL (FDM) INPUT PARAMETERS AND RESULTS

BASELINE SCENARIO

	Units	RAA #1	RAA #2	RAA #3	RAA #4
Particulate Emission Factors (1)					
TSP	g/m2-s	1.80E-04	1.80E-04	1.80E-04	1.74E-04
	g/m-s	2.75E-02			
PM10	g/m2-s	6.31E-05	6.31E-05	6.31E-05	6.09E-05
	g/m-s	9.62E-03			
Other Input Parameters					
Modeling Time (2)	minutes	525,600	525,600	525,600	525,600
Surface roughness height (3)	cm	11.4/370	11.4/370	11.4/370	11.4/370
Particulate density (4)	g/cm3	1.78	1.78	1.78	1.78
Source type (5)		line	area	area	area
Length (6)	m	1402	7.6	12.2	27.4
Width (6)	m	152.4	7.6	12.2	21.3
Surface area	m2	213677	58	149	585
Wind speed (7)	m/sec	2.5	2.5	2.5	2.5
Turner stability class (7)		F	F	F	F
Mixing height (7)	m	100	100	100	100
Ambient temperature	deg K	293	293	293	293
Results					
Onsite ambient PM10	ug/m3	1225.8	68.1	163.4	357.5
Offsite TSP deposition rate	ug/m2-s	1.66	0.0006	0.002	0.0003
Offsite ambient PM10	ug/m3	0.71	0.024	0.068	0.022

Notes:

(1) Particulate emission factors were obtained from Table 19-14.

(2) Modeling time was assumed equivalent to 1 year.

(3) Value of 11.4 used for modeling onsite, 370 for modeling offsite.

(4) Particulate density assumed equal to soil density. Soil density was obtained from "Remedial Investigation Report for 18 Solid Waste Management Units, Cannon AFB, Clovis, NM" (Woodward-Clyde Consultants, 1992).

(5) RAA #1 modeled as a line source since length is greater than 5 times the width.

(6) Lengths and widths of RAAs are those of the sampling areas of investigation. RAA #1 encompasses many SWMUs, therefore these dimensions are much greater than the sum of the areas of the individual SWMUs.

(7) Wind speed, stability class, and mixing height chosen to simulate worst-case conditions.

Table 19-16

PARTICULATE EMISSIONS RESULTS

BASELINE SCENARIO
RAA #1

Chemical of Concern	Onsite			Offsite			
	Soil Concentration (1) (mg/kg)	FDM PM10 Concentration (2) (ug/m3)	Airborne Dust Concentration (3) (mg/m3)	FDM TSP Deposition Rate (4) (ug/m2/s)	Soil Concentration (5) (mg/kg)	FDM PM10 Concentration (6) (ug/m3)	Airborne Dust Concentration (7) (mg/m3)
Metals							
Arsenic	4.1E+00	1.2E+03	5.0E-06	1.7E+00	8.4E-01	7.1E-01	2.9E-09
Barium	3.1E+02	1.2E+03	3.8E-04	1.7E+00	6.4E+01	7.1E-01	2.2E-07
Chromium	8.9E+00	1.2E+03	1.1E-05	1.7E+00	1.8E+00	7.1E-01	6.3E-09
Lead	1.1E+01	1.2E+03	1.4E-05	1.7E+00	2.3E+00	7.1E-01	8.0E-09
Nickel	7.5E+00	1.2E+03	9.2E-06	1.7E+00	1.5E+00	7.1E-01	5.3E-09
Silver	5.8E+00	1.2E+03	7.1E-06	1.7E+00	1.2E+00	7.1E-01	4.1E-09

Notes:
(1) Onsite soil concentrations were obtained from Table 19-9.
(2) Onsite ambient PM10 concentrations were calculated using the FDM at an assumed distance of one meter beyond the RAA boundary.
(3) Onsite airborne dust concentrations were calculated from the onsite soil concentrations using Equation 19-10.
(4) Offsite TSP deposition rates were calculated using the FDM; the receptor location giving rise to the greatest deposition rate was selected for purposes of conservatism.
(5) Offsite soil concentrations were calculated from the TSP deposition rate using Equation 19-11.
(6) Offsite PM10 concentrations were calculated using the FDM; the receptor location giving rise to the greatest PM10 concentration was selected for purposes of conservatism.
(7) Offsite airborne dust concentrations were calculated from the onsite soil exposure concentration using Equation 19-12.

Table 19-17

PARTICULATE EMISSIONS RESULTS

BASELINE SCENARIO
RAA #2

Chemical of Concern	Onsite			Offsite			
	Soil Concentration (1) (mg/kg)	FDM PM10 Concentration (2) (ug/m3)	Dust Concentration (3) (mg/m3)	FDM TSP Deposition Rate (4) (ug/m2/s)	Soil Concentration (5) (mg/kg)	FDM PM10 Concentration (6) (ug/m3)	Dust Concentration (7) (mg/m3)
Metals							
Barium	7.7E+02	6.8E+01	5.2E-05	6.0E-04	5.7E-02	2.4E-02	1.8E-08
Nickel	7.9E+00	6.8E+01	5.4E-07	6.0E-04	5.9E-04	2.4E-02	1.9E-10
Vanadium	1.5E+01	6.8E+01	9.9E-07	6.0E-04	1.1E-03	2.4E-02	3.5E-10

Notes:
(1) Onsite soil concentrations were obtained from Table 19-9.
(2) Onsite ambient PM10 concentrations were calculated using the FDM at an assumed distance of one meter beyond the RAA boundary.
(3) Onsite airborne dust concentrations were calculated from the onsite soil concentrations using Equation 19-10.
(4) Offsite TSP deposition rates were calculated using the FDM; the receptor location giving rise to the greatest deposition rate was selected for purposes of conservatism.
(5) Offsite soil concentrations were calculated from the TSP deposition rate using Equation 19-11.
(6) Offsite PM10 concentrations were calculated using the FDM; the receptor location giving rise to the greatest PM10 concentration was selected for purposes of conservatism.
(7) Offsite airborne dust concentrations were calculated from the onsite soil exposure concentration using Equation 19-12.

Table 19-18

PARTICULATE EMISSIONS RESULTS

BASELINE SCENARIO
RAA #3

Chemical of Concern	Onsite			Offsite			
	Soil Concentration (1) (mg/kg)	FDM PM10 Concentration (2) (ug/m3)	Dust Concentration (3) (mg/m3)	FDM TSP Deposition Rate (4) (ug/m2/s)	Soil Concentration (5) (mg/kg)	FDM PM10 Concentration (6) (ug/m3)	Dust Concentration (7) (mg/m3)
Metals							
Barium	7.5E+02	1.6E+02	1.2E-04	2.0E-03	1.8E-01	6.8E-02	5.1E-08
Beryllium	6.1E-01	1.6E+02	1.0E-07	2.0E-03	1.5E-04	6.8E-02	4.1E-11
Lead	1.4E+01	1.6E+02	2.4E-06	2.0E-03	3.6E-03	6.8E-02	9.8E-10
Manganese	1.5E+02	1.6E+02	2.4E-05	2.0E-03	3.7E-02	6.8E-02	1.0E-08
Nickel	9.2E+00	1.6E+02	1.5E-06	2.0E-03	2.3E-03	6.8E-02	6.3E-10
Silver	3.4E+00	1.6E+02	5.6E-07	2.0E-03	8.4E-04	6.8E-02	2.3E-10
Zinc	1.4E+02	1.6E+02	2.2E-05	2.0E-03	3.4E-02	6.8E-02	9.3E-09

Notes:
(1) Onsite soil concentrations were obtained from Table 19-9.
(2) Onsite ambient PM10 concentrations were calculated using the FDM at an assumed distance of one meter beyond the RAA boundary.
(3) Onsite airborne dust concentrations were calculated from the onsite soil concentrations using Equation 19-10.
(4) Offsite TSP deposition rates were calculated using the FDM; the receptor location giving rise to the greatest deposition rate was selected for purposes of conservatism.
(5) Offsite soil concentrations were calculated from the TSP deposition rate using Equation 19-11.
(6) Offsite PM10 concentrations were calculated using the FDM; the receptor location giving rise to the greatest PM10 concentration was selected for purposes of conservatism.
(7) Offsite airborne dust concentrations were calculated from the onsite soil exposure concentration using Equation 19-12.

Table 19-19

PARTICULATE EMISSIONS RESULTS

BASELINE SCENARIO
RAA #4

Chemical of Concern	Onsite			Offsite			
	Soil Concentration (1) (mg/kg)	FDM PM10 Concentration (2) (ug/m3)	Dust Concentration (3) (mg/m3)	FDM TSP Deposition Rate (4) (ug/m2/s)	Soil Concentration (5) (mg/kg)	FDM PM10 Concentration (6) (ug/m3)	Dust Concentration (7) (mg/m3)
Metals							
Nickel	7.6E+00	3.6E+02	2.7E-06	3.0E-04	2.8E-04	2.2E-02	1.7E-10

Notes:
(1) Onsite soil concentrations were obtained from Table 19-9.
(2) Onsite ambient PM10 concentrations were calculated using the FDM at an assumed distance of one meter beyond the RAA boundary.
(3) Onsite airborne dust concentrations were calculated from the onsite soil concentrations using Equation 19-10.
(4) Offsite TSP deposition rates were calculated using the FDM; the receptor location giving rise to the greatest deposition rate was selected for purposes of conservatism.
(5) Offsite soil concentrations were calculated from the TSP deposition rate using Equation 19-11.
(6) Offsite PM10 concentrations were calculated using the FDM; the receptor location giving rise to the greatest PM10 concentration was selected for purposes of conservatism.
(7) Offsite airborne dust concentrations were calculated from the onsite soil exposure concentration using Equation 19-12.

Table 19-20

EXPOSURE POINT CONCENTRATIONS

BASELINE SCENARIO
RAA #1

Chemical of Concern	Onsite Exposure			Offsite Exposure		
	Soil Concentration (1) (mg/kg)	Vapor Concentration (2) (mg/m3)	Dust Concentration (3) (mg/m3)	Soil Concentration (4) (mg/kg)	Vapor Concentration (mg/m3)	Dust Concentration (5) (mg/m3)
BTEX						
Toluene	4.3E-02	2.2E-04	ND (6)	ND	ND	ND
Xylenes	5.2E-02	2.2E-04	ND	ND	ND	ND
Non-BTEX TCL VOCs						
1,1,1-Trichloroethane	8.0E-03	8.3E-05	ND	ND	ND	ND
Acetone	2.5E-01	4.2E-03	ND	ND	ND	ND
Methylene Chloride	6.0E-03	1.5E-04	ND	ND	ND	ND
Tetrachloroethene	1.4E-02	1.6E-04	ND	ND	ND	ND
Metals						
Arsenic	4.1E+00	ND	5.0E-06	8.4E-01	ND	2.9E-09
Barium	3.1E+02	ND	3.8E-04	6.4E+01	ND	2.2E-07
Chromium	8.9E+00	ND	1.1E-05	1.8E+00	ND	6.3E-09
Lead	1.1E+01	ND	1.4E-05	2.3E+00	ND	8.0E-09
Nickel	7.5E+00	ND	9.2E-06	1.5E+00	ND	5.3E-09
Silver	5.8E+00	ND	7.1E-06	1.2E+00	ND	4.1E-09

Notes:
(1) Onsite soil concentrations are obtained from Table 19-9.
(2) Onsite ambient air vapor concentrations are obtained from Table 19-13.
(3) Onsite airborne dust concentrations are obtained from Table 19-16.
(4) Offsite soil concentrations are obtained from Table 19-16.
(5) Offsite airborne dust concentrations are obtained from Table 19-16.
(6) ND represents "not determined;" these concentrations were assumed to be negligible.

Table 19-21

EXPOSURE POINT CONCENTRATIONS

BASELINE SCENARIO
RAA #2

Chemical of Concern	Onsite Exposure			Offsite Exposure		
	Soil Concentration (1) (mg/kg)	Vapor Concentration (2) (mg/m3)	Dust Concentration (3) (mg/m3)	Soil Concentration (4) (mg/kg)	Vapor Concentration (mg/m3)	Dust Concentration (5) (mg/m3)
BTEX						
Toluene	1.2E+00	3.6E-03	ND (6)	ND	ND	ND
Ethylbenzene	4.2E+00	6.7E-03	ND	ND	ND	ND
Xylenes	3.2E+01	8.0E-02	ND	ND	ND	ND
Non-BTEX TCL VOCs						
Acetone	1.1E-01	1.1E-03	ND	ND	ND	ND
Methylene Chloride	1.5E-01	2.2E-03	ND	ND	ND	ND
Metals						
Barium	7.7E+02	ND	5.2E-05	5.7E-02	ND	1.8E-08
Nickel	7.9E+00	ND	5.4E-07	5.9E-04	ND	1.9E-10
Vanadium	1.5E+01	ND	9.9E-07	1.1E-03	ND	3.5E-10

Notes:
(1) Onsite soil concentrations are obtained from Table 19-9.
(2) Onsite ambient air vapor concentrations are obtained from Table 19-13.
(3) Onsite airborne dust concentrations are obtained from Table 19-17.
(4) Offsite soil concentrations are obtained from Table 19-17.
(5) Offsite airborne dust concentrations are obtained from Table 19-17.
(6) ND represents "not determined;" these concentrations were assumed to be negligible.

Table 19-22

EXPOSURE POINT CONCENTRATIONS

BASELINE SCENARIO
RAA #3

Chemical of Concern	Onsite Exposure			Offsite Exposure		
	Soil Concentration (1) (mg/kg)	Vapor Concentration (mg/m3)	Dust Concentration (2) (mg/m3)	Soil Concentration (3) (mg/kg)	Vapor Concentration (mg/m3)	Dust Concentration (4) (mg/m3)
Metals						
Barium	7.5E+02	ND (5)	1.2E-04	1.8E-01	ND	5.1E-08
Beryllium	6.1E-01	ND	1.0E-07	1.5E-04	ND	4.1E-11
Lead	1.4E+01	ND	2.4E-06	3.6E-03	ND	9.8E-10
Manganese	1.5E+02	ND	2.4E-05	3.7E-02	ND	1.0E-08
Nickel	9.2E+00	ND	1.5E-06	2.3E-03	ND	6.3E-10
Silver	3.4E+00	ND	5.6E-07	8.4E-04	ND	2.3E-10
Zinc	1.4E+02	ND	2.2E-05	3.4E-02	ND	9.3E-09

Notes:
(1) Onsite soil concentrations are obtained from Table 19-9.
(2) Onsite airborne dust concentrations are obtained from Table 19-18.
(3) Offsite soil concentrations are obtained from Table 19-18.
(4) Offsite airborne dust concentrations are obtained from Table 19-18.
(5) ND represents "not determined;" these concentrations were assumed to be negligible.

Table 19-23

EXPOSURE POINT CONCENTRATIONS

BASELINE SCENARIO
RAA #4

Chemical of Concern	Onsite Exposure			Offsite Exposure		
	Soil Concentration (1) (mg/kg)	Vapor Concentration (mg/m3)	Dust Concentration (2) (mg/m3)	Soil Concentration (3) (mg/kg)	Vapor Concentration (mg/m3)	Dust Concentration (4) (mg/m3)
Metals						
Nickel	7.6E+00	ND (5)	2.7E-06	2.8E-04	ND	1.7E-10

Notes:
(1) Onsite soil concentrations are obtained from Table 19-9.
(2) Onsite airborne dust concentrations are obtained from Table 19-19.
(3) Offsite soil concentrations are obtained from Table 19-19.
(4) Offsite airborne dust concentrations are obtained from Table 19-19.
(5) ND represents "not determined;" these concentrations were assumed to be negligible.

Table 19-24

EXPOSURE ASSUMPTIONS
BASELINE SCENARIO

Parameter (1)	Units	Receptors: Onsite Adult Worker	Receptors: Offsite Resident Adult	Receptors: Offsite Sensitive
Exposure Pathways		Soil Ingestion Dermal Absorption Inhalation of vapors Inhalation of dusts	Soil Ingestion Dermal Absorption Inhalation of dusts	Soil Ingestion Dermal Absorption Inhalation of dusts
Body weight	kg	70	70	15
Soil Ingestion Pathway				
Ingestion Rate	mg soil/day	50	100	200
Fraction Ingested (2)	unitless	1	1	1
Exposure Frequency	days/year	250	350	350
Exposure Duration	years	25	30	6
Averaging Time (3)				
Carcinogens	days	25550	25550	25550
Noncarcinogens	days	9125	10950	2190
Dermal Absorption Pathway				
Skin Surface Area Available (4)	cm2/event	5800	5800	2295
Soil to Skin Adherence Factor (5)	mg/cm2	0.6	0.6	0.6
Skin Absorption Factor (6)				
VOCs	unitless	0.1	0.1	0.1
Inorganics	unitless	0.01	0.01	0.01
Exposure Frequency (7)	events/year	250	350	350
Exposure Duration (7)	years	25	30	6
Averaging Time (3)				
Carcinogens	days	25550	25550	25550
Noncarcinogens	days	9125	10950	2190
Vapor Inhalation Pathway				
Inhalation Rate (8)	m3/hr	2.5	0.83	0.83 (9)
Exposure Time (8)	hours/day	8	24	24
Exposure Frequency	days/year	250	350	350
Exposure Duration	years	25	30	6
Averaging Time (3)				
Carcinogens	days	25550	25550	25550
Noncarcinogens	days	9125	10950	2190
Dust Inhalation Pathway				
Inhalation Rate (8)	m3/hr	2.5	0.83	0.83 (9)
Exposure Time (8)	hours/day	8	24	24
Exposure Frequency	days/year	250	350	350
Exposure Duration	years	25	30	6
Averaging Time (3)				
Carcinogens	days	25550	25550	25550
Noncarcinogens	days	9125	10950	2190

Notes:
(1) Unless otherwise noted, values for parameters obtained from "Risk Assessment Guidance for Superfund (RAGS), Volume 1: Human Health Evaluation Manual, Supplemental Guidance, Standard Default Exposure Factors" (USEPA, 1991)
(2) Values obtained from "RAGS, Volume 1: Human Health Evaluation Manual, Part A" (EPA, 1989d)
Value assumed applicable to both adults and children.
(3) According to "RAGS, Volume 1: Human Health Evaluation Manual, Part A" (USEPA, 1989d), Averaging Time (AT) is defined as the period over which exposure is averaged. For carcinogens, AT is 70 years x 365 days per year, representing a lifetime exposure. For noncarcinogens, AT is the exposure duration x 365 days per year.
(4) Values obtained from "Dermal Exposure Assessment: Principals and Applications, Interim Report" (USEPA, 1992).
(5) Values obtained from "Remedial Investigation Report for 18 Solid Waste Management Units, Cannon Air Force Base, Clovis, NM" (Woodward-Clyde Consultants, 1992).
(6) Values obtained from Table 19-25.
(7) Recommended values not located in sources. Values assumed equivalent to values for Soil Ingestion Pathway.
(8) Inhalation rates equivalent to 20m3 per 8-hour working day for onsite workers and 20m3 per 24-hour day for offsite receptors.
(9) Source from which value was obtained did not state whether value was applicable to adults only or adults and children. Therefore, value assumed applicable to adults and children.

Table 19-25

CHEMICAL-SPECIFIC EXPOSURE ASSUMPTIONS

Chemical of Concern	Bio-Availability	Inhalation Retention	Skin Absorption Factor (1)
BTEX	1.0	1.0	0.1
Non-BTEX TCL VOCs	1.0	1.0	0.1
Metals	1.0	1.0	0.01

Notes:
(1) Values obtained from "Dermal Exposure Assessment: Principals and Applications, Interim Report (EPA, 1992).

Table 19-26

CALCULATED DOSES FOR ALL PATHWAYS

BASELINE SCENARIO
RAA #1

ONSITE WORKER

Chemical of Concern	Soil Ingestion Pathway		Dermal Absorption Pathway		Vapor Inhalation Pathway		Dust Inhalation Pathway	
	Carcinogenic Dose (1) (mg/kg/day)	Noncarcinogenic Dose (1) (mg/kg/day)	Carcinogenic Dose (2) (mg/kg/day)	Noncarcinogenic Dose (2) (mg/kg/day)	Carcinogenic Dose (3) (mg/kg/day)	Noncarcinogenic Dose (3) (mg/kg/day)	Carcinogenic Dose (4) (mg/kg/day)	Noncarcinogenic Dose (4) (mg/kg/day)
BTEX								
Toluene	7.5E-09	2.1E-08	5.2E-08	1.5E-07	1.5E-05	4.3E-05	ND (5)	ND
Xylenes	9.1E-09	2.5E-08	6.3E-08	1.8E-07	1.6E-05	4.4E-05	ND	ND
Non-BTEX TCL VOCs								
1,1,1-Trichloroethane	1.4E-09	3.9E-09	9.7E-09	2.7E-08	5.8E-06	1.6E-05	ND	ND
Acetone	4.4E-08	1.2E-07	3.0E-07	8.5E-07	3.0E-04	8.3E-04	ND	ND
Methylene Chloride	1.0E-09	2.9E-09	7.3E-09	2.0E-08	1.1E-05	3.0E-05	ND	ND
Tetrachloroethene	2.4E-09	6.8E-09	1.7E-08	4.8E-08	1.1E-05	3.1E-05	ND	ND
Metals								
Arsenic	7.2E-07	2.0E-06	5.0E-07	1.4E-06	ND	ND	3.5E-07	9.8E-07
Barium	5.4E-05	1.5E-04	3.8E-05	1.1E-04	ND	ND	2.7E-05	7.5E-05
Chromium	1.6E-06	4.4E-06	1.1E-06	3.0E-06	ND	ND	7.6E-07	2.1E-06
Lead	2.0E-06	5.5E-06	1.4E-06	3.8E-06	ND	ND	9.7E-07	2.7E-06
Nickel	1.3E-06	3.7E-06	9.1E-07	2.6E-06	ND	ND	6.4E-07	1.8E-06
Silver	1.0E-06	2.8E-06	7.1E-07	2.0E-06	ND	ND	5.0E-07	1.4E-06

Notes:

(1) Dose calculated using Equation 19-13. Onsite soil concentrations were obtained from Table19-20. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-24 and 19-25, respectively.

(2) Dose calculated using Equation 19-14. Onsite soil concentrations were obtained from Table 19-20. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-24 and 19-25, respectively.

(3) Dose calculated using Equation 19-15. Onsite vapor concentrations were obtained from Table 19-20. Receptor-specific exposure assumptions were obtained from Table 19-24.

(4) Dose calculated using Equation 19-16. Onsite dust concentrations were obtained from Table 19-20. Receptor-specific exposure assumptions were obtained from Table 19-24.

(5) ND represents "not determined;" these doses were assumed to be negligible.

Table 19-27

CALCULATED DOSES FOR ALL PATHWAYS

BASELINE SCENARIO
RAA #1

OFFSITE RESIDENTIAL RECEPTOR

Chemical of Concern	Soil Ingestion Pathway		Dermal Absorption Pathway		Vapor Inhalation Pathway		Dust Inhalation Pathway	
	Carcinogenic Dose (1) (mg/kg/day)	Noncarcinogenic Dose (1) (mg/kg/day)	Carcinogenic Dose (2) (mg/kg/day)	Noncarcinogenic Dose (2) (mg/kg/day)	Carcinogenic Dose (3) (mg/kg/day)	Noncarcinogenic Dose (3) (mg/kg/day)	Carcinogenic Dose (4) (mg/kg/day)	Noncarcinogenic Dose (4) (mg/kg/day)
Metals								
Arsenic	4.9E-07	1.2E-06	1.7E-07	4.0E-07	ND (5)	ND	3.4E-10	7.9E-10
Barium	3.8E-05	8.8E-05	1.3E-05	3.0E-05	ND	ND	2.6E-08	6.0E-08
Chromium	1.1E-06	2.5E-06	3.7E-07	8.7E-07	ND	ND	7.4E-10	1.7E-09
Lead	1.4E-06	3.2E-06	4.7E-07	1.1E-06	ND	ND	9.4E-10	2.2E-09
Nickel	9.0E-07	2.1E-06	3.1E-07	7.3E-07	ND	ND	6.2E-10	1.5E-09
Silver	7.0E-07	1.6E-06	2.4E-07	5.7E-07	ND	ND	4.8E-10	1.1E-09

Notes:
(1) Dose calculated using Equation 19-13. Offsite soil concentrations were obtained from Table 19-20. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-24 and 19-25, respectively.
(2) Dose calculated using Equation 19-14. Offsite soil concentrations were obtained from Table 19-20. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-24 and 19-25, respectively.
(3) Dose calculated using Equation 19-15. Offsite vapor concentrations were obtained from Table 19-20. Receptor-specific exposure assumptions were obtained from Table 19-24.
(4) Dose calculated using Equation 19-16. Offsite dust concentrations were obtained from Table 19-20. Receptor-specific exposure assumptions were obtained from Table 19-24.
(5) ND represents "not determined;" these doses were assumed to be negligible.

Table 19-28

CALCULATED DOSES FOR ALL PATHWAYS

BASELINE SCENARIO
RAA #1

OFFSITE SENSITIVE RECEPTOR

Chemical of Concern	Soil Ingestion Pathway		Dermal Absorption Pathway		Vapor Inhalation Pathway		Dust Inhalation Pathway	
	Carcinogenic Dose (1) (mg/kg/day)	Noncarcinogenic Dose (1) (mg/kg/day)	Carcinogenic Dose (2) (mg/kg/day)	Noncarcinogenic Dose (2) (mg/kg/day)	Carcinogenic Dose (3) (mg/kg/day)	Noncarcinogenic Dose (3) (mg/kg/day)	Carcinogenic Dose (4) (mg/kg/day)	Noncarcinogenic Dose (4) (mg/kg/day)
Metals								
Arsenic	9.2E-07	1.1E-05	6.3E-08	7.4E-07	ND (5)	ND	3.2E-10	3.7E-09
Barium	7.0E-05	8.2E-04	4.8E-06	5.6E-05	ND	ND	2.4E-08	2.8E-07
Chromium	2.0E-06	2.3E-05	1.4E-07	1.6E-06	ND	ND	6.9E-10	8.0E-09
Lead	2.5E-06	3.0E-05	1.7E-07	2.0E-06	ND	ND	8.7E-10	1.0E-08
Nickel	1.7E-06	2.0E-05	1.2E-07	1.4E-06	ND	ND	5.8E-10	6.8E-09
Silver	1.3E-06	1.5E-05	9.0E-08	1.0E-06	ND	ND	4.5E-10	5.2E-09

Notes:
(1) Dose calculated using Equation 19-13. Offsite soil concentrations were obtained from Table 19-20. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-24 and 19-25, respectively.
(2) Dose calculated using Equation 19-14. Offsite soil concentrations were obtained from Table 19-20. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-24 and 19-25, respectively.
(3) Dose calculated using Equation 19-15. Offsite vapor concentrations were obtained from Table 19-20. Receptor-specific exposure assumptions were obtained from Table 19-24.
(4) Dose calculated using Equation 19-16. Offsite dust concentrations were obtained from Table 19-20. Receptor-specific exposure assumptions were obtained from Table 19-24.
(5) ND represents "not determined;" these doses were assumed to be negligible.

Table 19-29

CALCULATED DOSES FOR ALL PATHWAYS

BASELINE SCENARIO
RAA #2

ONSITE WORKER

Chemical of Concern	Soil Ingestion Pathway		Dermal Absorption Pathway		Vapor Inhalation Pathway		Dust Inhalation Pathway	
	Carcinogenic Dose (1) (mg/kg/day)	Noncarcinogenic Dose (1) (mg/kg/day)	Carcinogenic Dose (2) (mg/kg/day)	Noncarcinogenic Dose (2) (mg/kg/day)	Carcinogenic Dose (3) (mg/kg/day)	Noncarcinogenic Dose (3) (mg/kg/day)	Carcinogenic Dose (4) (mg/kg/day)	Noncarcinogenic Dose (4) (mg/kg/day)
BTEX								
Toluene	2.1E-07	5.9E-07	1.5E-06	4.1E-06	2.5E-04	7.0E-04	ND (5)	ND
Ethylbenzene	7.3E-07	2.1E-06	5.1E-06	1.4E-05	4.6E-04	1.3E-03	ND	ND
Xylenes	5.6E-06	1.6E-05	3.9E-05	1.1E-04	5.6E-03	1.6E-02	ND	ND
Non-BTEX TCL VOCs								
Acetone	1.9E-08	5.4E-08	1.3E-07	3.7E-07	7.6E-05	2.1E-04	ND	ND
Methylene Chloride	2.6E-08	7.3E-08	1.8E-07	5.1E-07	1.6E-04	4.4E-04	ND	ND
Metals								
Barium	1.3E-04	3.8E-04	9.3E-05	2.6E-04	ND	ND	3.7E-06	1.0E-05
Nickel	1.4E-06	3.9E-06	9.6E-07	2.7E-06	ND	ND	3.8E-08	1.1E-07
Vanadium	2.6E-06	7.1E-06	1.8E-06	5.0E-06	ND	ND	7.0E-08	1.9E-07

Notes:
(1) Dose calculated using Equation 19-13. Onsite soil concentrations were obtained from Table 19-21. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-24 and 19-25, respectively.
(2) Dose calculated using Equation 19-14. Onsite soil concentrations were obtained from Table 19-21. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-24 and 19-25, respectively.
(3) Dose calculated using Equation 19-15. Onsite vapor concentrations were obtained from Table 19-21. Receptor-specific exposure assumptions were obtained from Table 19-24.
(4) Dose calculated using Equation 19-16. Onsite dust concentrations were obtained from Table 19-21. Receptor-specific exposure assumptions were obtained from Table 19-24.
(5) ND represents "not determined;" these doses were assumed to be negligible.

Table 19-30

CALCULATED DOSES FOR ALL PATHWAYS

BASELINE SCENARIO
RAA #2

OFFSITE RESIDENTIAL RECEPTOR

Chemical of Concern	Soil Ingestion Pathway		Dermal Absorption Pathway		Vapor Inhalation Pathway		Dust Inhalation Pathway	
	Carcinogenic Dose (1) (mg/kg/day)	Noncarcinogenic Dose (1) (mg/kg/day)	Carcinogenic Dose (2) (mg/kg/day)	Noncarcinogenic Dose (2) (mg/kg/day)	Carcinogenic Dose (3) (mg/kg/day)	Noncarcinogenic Dose (3) (mg/kg/day)	Carcinogenic Dose (4) (mg/kg/day)	Noncarcinogenic Dose (4) (mg/kg/day)
Metals								
Barium	3.3E-08	7.8E-08	1.2E-08	2.7E-08	ND (5)	ND	2.2E-09	5.0E-09
Nickel	3.4E-10	8.0E-10	1.2E-10	2.8E-10	ND	ND	2.2E-11	5.2E-11
Vanadium	6.4E-10	1.5E-09	2.2E-10	5.2E-10	ND	ND	4.1E-11	9.6E-11

Notes:

(1) Dose calculated using Equation 19-13. Offsite soil concentrations were obtained from Table 19-21. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-24 and 19-25, respectively.

(2) Dose calculated using Equation 19-14. Offsite soil concentrations were obtained from Table19-21. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-24 and 19-25, respectively.

(3) Dose calculated using Equation 19-15. Offsite vapor concentrations were obtained from Table 19-21. Receptor-specific exposure assumptions were obtained from Table 19-24.

(4) Dose calculated using Equation 19-16. Offsite dust concentrations were obtained from Table 19-21. Receptor-specific exposure assumptions were obtained from Table 19-24.

(5) ND represents "not determined;" these doses were assumed to be negligible.

Table 19-31

CALCULATED DOSES FOR ALL PATHWAYS

BASELINE SCENARIO
RAA #2

OFFSITE SENSITIVE RECEPTOR

Chemical of Concern	Soil Ingestion Pathway		Dermal Absorption Pathway		Vapor Inhalation Pathway		Dust Inhalation Pathway	
	Carcinogenic Dose (1) (mg/kg/day)	Noncarcinogenic Dose (1) (mg/kg/day)	Carcinogenic Dose (2) (mg/kg/day)	Noncarcinogenic Dose (2) (mg/kg/day)	Carcinogenic Dose (3) (mg/kg/day)	Noncarcinogenic Dose (3) (mg/kg/day)	Carcinogenic Dose (4) (mg/kg/day)	Noncarcinogenic Dose (4) (mg/kg/day)
Metals								
Barium	6.2E-08	7.3E-07	4.3E-09	5.0E-08	ND (5)	ND	2.0E-09	2.4E-08
Nickel	6.4E-10	7.5E-09	4.4E-11	5.2E-10	ND	ND	2.1E-11	2.4E-10
Vanadium	1.2E-09	1.4E-08	8.2E-11	9.6E-10	ND	ND	3.8E-11	4.5E-10

Notes:
(1) Dose calculated using Equation 19-13. Offsite soil concentrations were obtained from Table 19-21. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-24 and 19-25, respectively.
(2) Dose calculated using Equation 19-14. Offsite soil concentrations were obtained from Table 19-21. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-24 and 19-25, respectively.
(3) Dose calculated using Equation 19-15. Offsite vapor concentrations were obtained from Table 19-21. Receptor-specific exposure assumptions were obtained from Table 19-24.
(4) Dose calculated using Equation 19-16. Offsite dust concentrations were obtained from Table 19-21. Receptor-specific exposure assumptions were obtained from Table 19-24.
(5) ND represents "not determined;" these doses were assumed to be negligible.

Table 19-32

CALCULATED DOSES FOR ALL PATHWAYS

BASELINE SCENARIO
RAA #3

ONSITE WORKER

Chemical of Concern	Soil Ingestion Pathway		Dermal Absorption Pathway		Vapor Inhalation Pathway		Dust Inhalation Pathway	
	Carcinogenic Dose (1) (mg/kg/day)	Noncarcinogenic Dose (1) (mg/kg/day)	Carcinogenic Dose (2) (mg/kg/day)	Noncarcinogenic Dose (2) (mg/kg/day)	Carcinogenic Dose (3) (mg/kg/day)	Noncarcinogenic Dose (3) (mg/kg/day)	Carcinogenic Dose (4) (mg/kg/day)	Noncarcinogenic Dose (4) (mg/kg/day)
Metals								
Barium	1.3E-04	3.7E-04	9.1E-05	2.5E-04	ND (5)	ND	8.5E-06	2.4E-05
Beryllium	1.1E-07	3.0E-07	7.4E-08	2.1E-07	ND	ND	7.0E-09	2.0E-08
Lead	2.5E-06	7.0E-06	1.8E-06	4.9E-06	ND	ND	1.6E-07	4.6E-07
Manganese	2.6E-05	7.3E-05	1.8E-05	5.1E-05	ND	ND	1.7E-06	4.7E-06
Nickel	1.6E-06	4.5E-06	1.1E-06	3.1E-06	ND	ND	1.1E-07	2.9E-07
Silver	5.9E-07	1.7E-06	4.1E-07	1.2E-06	ND	ND	3.9E-08	1.1E-07
Zinc	2.4E-05	6.7E-05	1.7E-05	4.7E-05	ND	ND	1.6E-06	4.4E-06

Notes:

(1) Dose calculated using Equation 19-13. Onsite soil concentrations were obtained from Table 19-22. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-24 and 19-25, respectively.

(2) Dose calculated using Equation 19-14. Onsite soil concentrations were obtained from Table 19-22. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-24 and 19-25, respectively.

(3) Dose calculated using Equation 19-15. Onsite vapor concentrations were obtained from Table 19-22. Receptor-specific exposure assumptions were obtained from Table 19-24.

(4) Dose calculated using Equation 19-16. Onsite dust concentrations were obtained from Table 19-22. Receptor-specific exposure assumptions were obtained from Table 19-24.

(5) ND represents "not determined;" these doses were assumed to be negligible.

Table 19-33

CALCULATED DOSES FOR ALL PATHWAYS

BASELINE SCENARIO
RAA #3

OFFSITE RESIDENTIAL RECEPTOR

Chemical of Concern	Soil Ingestion Pathway		Dermal Absorption Pathway		Vapor Inhalation Pathway		Dust Inhalation Pathway	
	Carcinogenic Dose (1) (mg/kg/day)	Noncarcinogenic Dose (1) (mg/kg/day)	Carcinogenic Dose (2) (mg/kg/day)	Noncarcinogenic Dose (2) (mg/kg/day)	Carcinogenic Dose (3) (mg/kg/day)	Noncarcinogenic Dose (3) (mg/kg/day)	Carcinogenic Dose (4) (mg/kg/day)	Noncarcinogenic Dose (4) (mg/kg/day)
Metals								
Barium	1.1E-07	2.5E-07	3.8E-08	8.8E-08	ND (5)	ND	6.0E-09	1.4E-08
Beryllium	8.9E-11	2.1E-10	3.1E-11	7.2E-11	ND	ND	4.9E-12	1.1E-11
Lead	2.1E-09	4.9E-09	7.3E-10	1.7E-09	ND	ND	1.1E-10	2.7E-10
Manganese	2.2E-08	5.0E-08	7.5E-09	1.8E-08	ND	ND	1.2E-09	2.8E-09
Nickel	1.3E-09	3.1E-09	4.7E-10	1.1E-09	ND	ND	7.3E-11	1.7E-10
Silver	4.9E-10	1.2E-09	1.7E-10	4.0E-10	ND	ND	2.7E-11	6.3E-11
Zinc	2.0E-08	4.6E-08	6.9E-09	1.6E-08	ND	ND	1.1E-09	2.5E-09

Notes:

(1) Dose calculated using Equation 19-13. Offsite soil concentrations were obtained from Table 19-22. Receptor and chemical-specific exposure assumptions were obtained from Tables19-24 and 19-25, respectively.

(2) Dose calculated using Equation 19-14. Offsite soil concentrations were obtained from Table 19-22. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-24 and 19-25, respectively.

(3) Dose calculated using Equation 19-15. Offsite vapor concentrations were obtained from Table 19-22. Receptor-specific exposure assumptions were obtained from Table 19-24.

(4) Dose calculated using Equation 19-16. Offsite dust concentrations were obtained from Table 19-22. Receptor-specific exposure assumptions were obtained from Table 19-24.

(5) ND represents "not determined;" these doses were assumed to be negligible.

Table 19-34

CALCULATED DOSES FOR ALL PATHWAYS

BASELINE SCENARIO
RAA #3

OFFSITE SENSITIVE RECEPTOR

Chemical of Concern	Soil Ingestion Pathway		Dermal Absorption Pathway		Vapor Inhalation Pathway		Dust Inhalation Pathway	
	Carcinogenic Dose (1) (mg/kg/day)	Noncarcinogenic Dose (1) (mg/kg/day)	Carcinogenic Dose (2) (mg/kg/day)	Noncarcinogenic Dose (2) (mg/kg/day)	Carcinogenic Dose (3) (mg/kg/day)	Noncarcinogenic Dose (3) (mg/kg/day)	Carcinogenic Dose (4) (mg/kg/day)	Noncarcinogenic Dose (4) (mg/kg/day)
Metals								
Barium	2.0E-07	2.4E-06	1.4E-08	1.6E-07	ND (5)	ND	5.6E-09	6.5E-08
Beryllium	1.7E-10	1.9E-09	1.1E-11	1.3E-10	ND	ND	4.5E-12	5.3E-11
Lead	3.9E-09	4.6E-08	2.7E-10	3.1E-09	ND	ND	1.1E-10	1.3E-09
Manganese	4.0E-08	4.7E-07	2.8E-09	3.2E-08	ND	ND	1.1E-09	1.3E-08
Nickel	2.5E-09	2.9E-08	1.7E-10	2.0E-09	ND	ND	6.9E-11	8.0E-10
Silver	9.2E-10	1.1E-08	6.4E-11	7.4E-10	ND	ND	2.5E-11	3.0E-10
Zinc	3.7E-08	4.3E-07	2.6E-09	3.0E-08	ND	ND	1.0E-09	1.2E-08

Notes:
(1) Dose calculated using Equation 19-13. Offsite soil concentrations were obtained from Table 19-22. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-24 and 19-25, respectively.
(2) Dose calculated using Equation 19-14. Offsite soil concentrations were obtained from Table 19-22. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-24 and 19-25, respectively.
(3) Dose calculated using Equation 19-15. Offsite vapor concentrations were obtained from Table 19-22. Receptor-specific exposure assumptions were obtained from Table 19-24.
(4) Dose calculated using Equation 19-16. Offsite dust concentrations were obtained from Table 19-22. Receptor-specific exposure assumptions were obtained from Table 19-24.
(5) ND represents "not determined;" these doses were assumed to be negligible.

Table 19-35

CALCULATED DOSES FOR ALL PATHWAYS

BASELINE SCENARIO
RAA #4

ONSITE WORKER

Chemical of Concern	Soil Ingestion Pathway		Dermal Absorption Pathway		Vapor Inhalation Pathway		Dust Inhalation Pathway	
	Carcinogenic Dose (1) (mg/kg/day)	Noncarcinogenic Dose (1) (mg/kg/day)	Carcinogenic Dose (2) (mg/kg/day)	Noncarcinogenic Dose (2) (mg/kg/day)	Carcinogenic Dose (3) (mg/kg/day)	Noncarcinogenic Dose (3) (mg/kg/day)	Carcinogenic Dose (4) (mg/kg/day)	Noncarcinogenic Dose (4) (mg/kg/day)
Metals								
Nickel	1.3E-06	3.7E-06	9.2E-07	2.6E-06	ND (5)	ND	1.9E-07	5.3E-07

Notes:
(1) Dose calculated using Equation 19-13. Onsite soil concentrations were obtained from Table 19-23. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-24 and 19-25, respectively.
(2) Dose calculated using Equation 19-14. Onsite soil concentrations were obtained from Table 19-23. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-24 and 19-25, respectively.
(3) Dose calculated using Equation 19-15. Onsite vapor concentrations were obtained from Table 19-23. Receptor-specific exposure assumptions were obtained from Table 19-24.
(4) Dose calculated using Equation 19-16. Onsite dust concentrations were obtained from Table 19-23. Receptor-specific exposure assumptions were obtained from Table 19-24.
(5) ND represents "not determined;" these doses were assumed to be negligible.

Table 19-36

CALCULATED DOSES FOR ALL PATHWAYS

BASELINE SCENARIO
RAA #4

OFFSITE RESIDENTIAL RECEPTOR

Chemical of Concern	Soil Ingestion Pathway		Dermal Absorption Pathway		Vapor Inhalation Pathway		Dust Inhalation Pathway	
	Carcinogenic Dose (1) (mg/kg/day)	Noncarcinogenic Dose (1) (mg/kg/day)	Carcinogenic Dose (2) (mg/kg/day)	Noncarcinogenic Dose (2) (mg/kg/day)	Carcinogenic Dose (3) (mg/kg/day)	Noncarcinogenic Dose (3) (mg/kg/day)	Carcinogenic Dose (4) (mg/kg/day)	Noncarcinogenic Dose (4) (mg/kg/day)
Metals								
Nickel	1.7E-10	3.9E-10	5.8E-11	1.3E-10	ND (5)	ND	2.0E-11	4.6E-11

Notes:

(1) Dose calculated using Equation 19-13. Offsite soil concentrations were obtained from Table 19-23. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-24 and 19-25, respectively.

(2) Dose calculated using Equation 19-14. Offsite soil concentrations were obtained from Table 19-23. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-24 and 19-25, respectively.

(3) Dose calculated using Equation 19-15. Offsite vapor concentrations were obtained from Table 19-23. Receptor-specific exposure assumptions were obtained from Table 19-24.

(4) Dose calculated using Equation 19-16. Offsite dust concentrations were obtained from Table 19-23. Receptor-specific exposure assumptions were obtained from Table 19-24.

(5) ND represents "not determined;" these doses were assumed to be negligible.

Table 19-37

CALCULATED DOSES FOR ALL PATHWAYS

BASELINE SCENARIO
RAA #4

OFFSITE SENSITIVE RECEPTOR

Chemical of Concern	Soil Ingestion Pathway		Dermal Absorption Pathway		Vapor Inhalation Pathway		Dust Inhalation Pathway	
	Carcinogenic Dose (1) (mg/kg/day)	Noncarcinogenic Dose (1) (mg/kg/day)	Carcinogenic Dose (2) (mg/kg/day)	Noncarcinogenic Dose (2) (mg/kg/day)	Carcinogenic Dose (3) (mg/kg/day)	Noncarcinogenic Dose (3) (mg/kg/day)	Carcinogenic Dose (4) (mg/kg/day)	Noncarcinogenic Dose (4) (mg/kg/day)
Metals								
Nickel	3.1E-10	3.6E-09	2.1E-11	2.5E-10	ND (5)	ND	1.8E-11	2.1E-10

Notes:
(1) Dose calculated using Equation 19-13. Offsite soil concentrations were obtained from Table 19-23. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-24 and 19-25, respectively.
(2) Dose calculated using Equation 19-14. Offsite soil concentrations were obtained from Table 19-23. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-24 and 19-25, respectively.
(3) Dose calculated using Equation 19-15. Offsite vapor concentrations were obtained from Table 19-23. Receptor-specific exposure assumptions were obtained from Table 19-24.
(4) Dose calculated using Equation 19-16. Offsite dust concentrations were obtained from Table 19-23. Receptor-specific exposure assumptions were obtained from Table 19-24.
(5) ND represents "not determined;" these doses were assumed to be negligible.

Table 19-38

THIBODEAUX-HWANG LAND TREATMENT MODEL INPUT PARAMETERS

CONSTRUCTION SCENARIO
RAA #1

Parameter	Units	COC					
		Toluene	Xylenes	1,1,1-Trichloroethane	Acetone	Methylene Chloride	Tetrachloroethene
Dai (molecular diffusivity)	cm2/s	0.087	0.087	0.078	0.124	0.101	0.072
T1 (temperature of diffusion coefficient)	deg C	25	25	25	25	25	25
T2 (temperature of calculations)	deg C	25	25	25	25	25	25
BD (soil bulk density) (1)	g/cm3	1.78	1.78	1.78	1.78	1.78	1.78
SD (soil particle density)	g/cm3	2.65	2.65	2.65	2.65	2.65	2.65
m (moisture content) (2)	by volume	0.149	0.149	0.149	0.149	0.149	0.149
H (Henry's Law constant)	atm-m3/g-mole	0.00668	0.00526	0.0172	0.000025	0.00319	0.029
Kow (octanol/water partition coefficient)	unitless	537.03	588.84	316.23	0.58	17.78	398.11
a (solvent regression equation coefficient)	unitless	0.894	0.894	0.894	0.894	0.894	0.894
b (solvent regression equation coefficient)	unitless	0.29	0.29	0.29	0.29	0.29	0.29
PPMi (PPM of chemical in soil) (3)	mg/kg	0.043	0.052	0.008	0.25	0.006	0.014
A (surface area of Risk Assessment Area) (4)	cm2	1.71E+07	1.71E+07	1.71E+07	1.71E+07	1.71E+07	1.71E+07
Hp (depth of contaminated soil) (4)	cm	304.8	304.8	304.8	304.8	304.8	304.8
T (time at which emissions are determined)	sec	3600	3600	3600	3600	3600	3600

Notes:
Unless otherwise noted, values for parameters obtained from "Air/Superfund National Technical Guidance Study Series, Volume II, Estimation of Baseline Air Emissions at Superfund Sites" (USEPA, 1989).
(1) Value obtained from "Remedial Investigation Report for 18 Solid Waste Management Units, Cannon Air Force Base, Clovis, NM" (Woodward-Clyde Consultants, 1992).
(2) Value obtained from site-specific soil samples taken for this report.
(3) Onsite soil concentrations obtained from Table 19-9.
(4) Surface area is the approximate area encompassed by the sampling investigation. Depth of the contaminated soil is assumed to be equal to 10 feet.

Table 19-39

THIBODEAUX-HWANG LAND TREATMENT MODEL INPUT PARAMETERS

CONSTRUCTION SCENARIO
RAA #2

Parameter	Units	COC				
		Toluene	Ethylbenzene	Xylenes	Acetone	Methylene Chloride
Dai (molecular diffusivity)	cm2/s	0.087	0.075	0.087	0.124	0.101
T1 (temperature of diffusion coefficient)	deg C	25	25	25	25	25
T2 (temperature of diffusion coefficient)	deg C	25	25	25	25	25
BD (soil bulk density) (1)	g/cm3	1.78	1.78	1.78	1.78	1.78
SD (soil particle density)	g/cm3	2.65	2.65	2.65	2.65	2.65
m (moisture content) (2)	by volume	0.189	0.189	0.189	0.189	0.189
H (Henry's Law constant)	atm-m3/g-mole	0.00668	0.00644	0.00526	0.000025	0.00319
Kow (octanol/water partition coefficient)	unitless	537.03	1412.54	588.84	0.58	17.78
a (solvent regression equation coefficient)	unitless	0.894	0.894	0.894	0.894	0.894
b (solvent regression equation coefficient)	unitless	0.29	0.29	0.29	0.29	0.29
PPMi (PPM of chemical in soil) (3)	mg/kg	1.2	4.2	32	0.11	0.15
A (surface area of Risk Assessment Area) (4)	cm2	9.29E+04	9.29E+04	9.29E+04	9.29E+04	9.29E+04
Hp (depth of contaminated soil) (4)	cm	304.8	304.8	304.8	304.8	304.8
T (time at which emissions are determined)	sec	3600	3600	3600	3600	3600

Notes:
Unless otherwise noted, values for parameters obtained from "Air/Superfund National Technical Guidance Study Series, Volume II, Estimation of Baseline Air Emissions at Superfund Sites" (USEPA, 1989).
(1) Value obtained from "Remedial Investigation Report for 18 Solid Waste Management Units, Cannon Air Force Base, Clovis, NM" (Woodward-Clyde Consultants, 1992).
(2) Value obtained from site-specific soil samples taken for this report.
(3) Onsite soil concentrations obtained from Table 19-9.
(4) Surface area is the approximate area encompassed by the sampling investigation. Depth of the contaminated soil is assumed to be equal to 10 feet.

Table 19-40

VOC EMISSIONS RESULTS

CONSTRUCTION SCENARIO

Chemical of Concern	RAA #1 Onsite Soil Concentration (1) (mg/kg)	RAA #1 Vapor Flux (2) (mg/m2/s)	RAA #1 Onsite Vapor Concentration (3) (mg/m3)	RAA #2 Onsite Soil Concentration (1) (mg/kg)	RAA #2 Vapor Flux (2) (mg/m2/s)	RAA #2 Onsite Vapor Concentration (3) (mg/m3)
BTEX						
Toluene	4.3E-02	2.69E-05	2.2E-04	1.2E+00	4.40E-04	3.6E-03
Ethylbenzene	NA	NA	NA	4.2E+00	8.18E-04	6.7E-03
Xylenes	5.2E-02	2.74E-05	2.2E-04	3.2E+01	9.89E-03	8.0E-02
Non-BTEX TCL VOCs						
1,1,1-Trichloroethane	8.0E-03	1.02E-05	8.3E-05	NA	NA	NA
Acetone	2.5E-01	5.21E-04	4.2E-03	1.1E-01	1.34E-04	1.1E-03
Methylene Chloride	6.0E-03	1.88E-05	1.5E-04	1.5E-01	2.75E-04	2.2E-03
Tetrachloroethene	1.4E-02	1.96E-05	1.6E-04	NA	NA	NA

Notes:

(1) Onsite soil concentrations were obtained from Table 19-9.

(2) Vapor fluxes were calculated using the Thibodeaux-Hwang Land Treatment Air-Emission Model (Equations 19-4 through 19-7).

(3) Onsite vapor concentrations were calculated from the vapor fluxes using Equation 19-8.

(4) "NA" means not applicable. This chemical was not considered a chemical of concern for this RAA.

Table 19-41

ESTIMATION OF PARTICULATE EMISSION FACTORS

CONSTRUCTION SCENARIO

	Units	RAA #1	RAA #2	RAA #3	RAA #4
Input Parameters					
s (Silt content) (1)	%	29	29	29	28
M (Moisture content) (2)	%	8.3	10.5	7.4	9.3
k (Particle size multiplier) (3)	unitless	1.0/0.35	1.0/0.35	1.0/0.35	1.0/0.35
U (Mean wind speed) (1)	m/s	4.47	4.47	4.47	4.47
p (Precipitation > 0.01 inches) (1)	days/year	60	60	60	60
f (Annual occurrence of winds > 12 mph) (1)	%	49	49	49	49
Length (4)	m	1402	7.6	12.2	27.4
Width (4)	m	1.22	1.22	1.22	1.22
Surface area	m2	1709.4	9.3	14.9	33.4
Depth (4)	M	3.05	3.05	3.05	3.05
Volume of excavated soil	m3	5216.8	28.3	45.3	101.9
Soil density (1)	g/cm3	1.78	1.78	1.78	1.78
Mass of excavated soil	g	9.28E+09	5.04E+07	8.06E+07	1.81E+08
Construction time (5)	sec	8.64E+05	8.64E+05	8.64E+05	8.64E+05
TSP Emission Factors (6)					
Excavation (bulldozer)	g/m2-s	1.53E-03	2.08E-01	2.05E-01	6.49E-02
	g/m-s	1.87E-03	2.54E-01	2.50E-01	7.91E-02
Dumping	g/m2-s	3.45E-06	2.48E-06	4.05E-06	2.94E-06
	g/m-s	4.20E-06	3.02E-06	4.93E-06	3.58E-06
Storage/wind erosion	g/m2-s	5.41E-04	5.41E-04	5.41E-04	5.22E-04
	g/m-s	6.59E-04	6.59E-04	6.59E-04	6.37E-04
Total TSP	g/m2-s	2.08E-03	2.09E-01	2.05E-01	6.54E-02
	g/m-s	2.53E-03	2.54E-01	2.50E-01	7.97E-02
PM10 Emission Factors (7)					
Excavation (bulldozer)	g/m2-s	5.90E-04	7.81E-02	7.97E-02	2.44E-02
	g/m-s	7.20E-04	9.53E-02	9.72E-02	2.98E-02
Dumping	g/m2-s	1.21E-06	8.68E-07	1.42E-06	1.03E-06
	g/m-s	1.47E-06	1.06E-06	1.73E-06	1.25E-06
Storage/wind erosion	g/m2-s	1.89E-04	1.89E-04	1.89E-04	1.83E-04
	g/m-s	2.31E-04	2.31E-04	2.31E-04	2.23E-04
Total PM10	g/m2-s	7.81E-04	7.83E-02	7.99E-02	2.46E-02
	g/m-s	9.52E-04	9.55E-02	9.74E-02	3.00E-02

Notes:

(1) Values obtained from "Remedial Investigation Report for 18 Solid Waste Management Units, Cannon AFB, Clovis, NM" (Woodward-Clyde Consultants, 1992).

(2) Values obtained from soil analytical results for this report.

(3) Particle size multiplier represents the PM10 fraction of the TSP load. For TSP, k = 1.0. For PM10, k = 0.35.

(4) Dimensions of RAAs correspond to an excavation trench running the length of the RAA, 4 feet wide, 10 feet deep. RAA #1 encompasses many SWMUs, therefore the length is much greater than sum of the lengths of the individual SWMUs.

(5) Time equivalent to 30 8-hour days.

(6) TSP Emission Factors calculated from Equations 19-17, 19-18, and 19-19, respectively. Emission factors converted to g/m-s by multiplying by the width of the trench since trenches were modeled as line sources in the Fugitive Dust Model.

(6) PM10 Emission Factors calculated from Equations 19-17, 19-18, and 19-19, respectively. Emission factors converted to g/m-s by multiplying by the width of the trench since trenches were modeled as line sources in the Fugitive Dust Model.

Table 19-42

FUGITIVE DUST MODEL (FDM) INPUT PARAMETERS AND RESULTS

CONSTRUCTION SCENARIO

	Units	RAA #1	RAA #2	RAA #3	RAA #4
Particulate Emission Factors (1)					
TSP	g/m-s	2.53E-03	2.54E-01	2.50E-01	7.97E-02
PM10	g/m-s	9.52E-04	9.55E-02	9.74E-02	3.00E-02
Other Input Parameters					
Time (2)	minutes	14,400	14,400	14,400	14,400
Surface roughness height (3)	cm	11.4/370	11.4/370	11.4/370	11.4/370
Particulate density (4)	g/cm3	1.78	1.78	1.78	1.78
Source type (5)		line	line	line	line
Length (6)	m	1402	7.6	12.2	27.4
Width (6)	m	1.22	1.22	1.22	1.22
Surface area	m2	1709.4	9.3	14.9	33.4
Wind speed (7)	m/sec	2.5	2.5	2.5	2.5
Turner stability class (7)		F	F	F	F
Mixing height (7)	m	100	100	100	100
Ambient temperature	deg K	293	293	293	293
Results					
Onsite ambient PM10	ug/m3	373.0	30832.3	37027.3	11749.7
Offsite TSP deposition rate	ug/m2-s	0.20	0.22	0.38	0.01
Offsite ambient PM10	ug/m3	9.3	9.9	17.4	1.0

Notes:

(1) Particulate emission factors were obtained from Table 19-41.

(2) Time equivalent to 30 8-hour days.

(3) Value of 11.4 used for modeling onsite, 370 for modeling offsite.

(4) Particulate density assumed equal to soil density. Soil density was obtained from "Remedial Investigation Report for 18 Solid Waste Management Units, Cannon AFB, Clovis, NM" (Woodward-Clyde Consultants, 1992)

(5) RAAs modeled as a line source since length is greater than 5 times the width.

(6) Dimensions of RAAs correspond to an excavation trench running the length of the RAA, 4 feet wide, 10 feet deep. RAA #1 encompasses many SWMUs, therefore the length is much greater than sum of the lengths of the individual SWMUs. of the individual SWMUs.

(7) Wind speed, stability class, and mixing height chosen to simulate worst-case conditions.

Table 19-43

PARTICULATE EMISSIONS RESULTS

CONSTRUCTION SCENARIO
RAA #1

Chemical of Concern	Onsite			Offsite			
	Soil Concentration (1) (mg/kg)	PM10 Concentration (2) (ug/m3)	Dust Concentration (3) (mg/m3)	TSP Deposition Rate (4) (ug/m2/s)	Soil Concentration (5) (mg/kg)	PM10 Concentration (6) (ug/m3)	Dust Concentration (7) (mg/m3)
Metals							
Arsenic	4.1E+00	3.7E+02	1.5E-06	2.0E-01	4.1E-05	9.3E+00	3.8E-08
Barium	3.1E+02	3.7E+02	1.2E-04	2.0E-01	3.1E-03	9.3E+00	2.9E-06
Chromium	8.9E+00	3.7E+02	3.3E-06	2.0E-01	8.8E-05	9.3E+00	8.3E-08
Lead	1.1E+01	3.7E+02	4.2E-06	2.0E-01	1.1E-04	9.3E+00	1.1E-07
Nickel	7.5E+00	3.7E+02	2.8E-06	2.0E-01	7.4E-05	9.3E+00	7.0E-08
Silver	5.8E+00	3.7E+02	2.2E-06	2.0E-01	5.7E-05	9.3E+00	5.4E-08

Notes:
(1) Onsite soil concentrations were obtained from Table 19-9.
(2) Onsite ambient PM10 concentrations were calculated using the FDM at a distance of 10 meters beyond the RAA boundary.
(3) Onsite airborne dust concentrations were calculated from the onsite soil exposure concentrations using Equation 19-10.
(4) Offsite TSP deposition rates were calculated using the FDM; the receptor location giving rise to the greatest deposition rate was selected for purposes of conservatism.
(5) Offsite soil concentrations were calculated from the TSP deposition rate using Equation 19-11.
(6) Offsite PM10 concentrations were calculated using the FDM; the receptor location giving rise to the greatest PM10 concentrations was selected for purposes of conservatism.
(7) Offsite airborne dust concentrations were calculated from the onsite soil exposure concentration using Equation 19-12.

Table 19-44

PARTICULATE EMISSIONS RESULTS

CONSTRUCTION SCENARIO
RAA #2

Chemical of Concern	Onsite			Offsite			
	Soil Concentration (1) (mg/kg)	PM10 Concentration (2) (ug/m3)	Dust Concentration (3) (mg/m3)	TSP Deposition Rate (4) (ug/m2/s)	Soil Concentration (5) (mg/kg)	PM10 Concentration (6) (ug/m3)	Dust Concentration (7) (mg/m3)
Metals							
Barium	7.7E+02	3.1E+04	2.4E-02	2.2E-01	8.1E-03	9.9E+00	7.6E-06
Nickel	7.9E+00	3.1E+04	2.4E-04	2.2E-01	8.4E-05	9.9E+00	7.8E-08
Vanadium	1.5E+01	3.1E+04	4.5E-04	2.2E-01	1.6E-04	9.9E+00	1.4E-07

Notes:
(1) Onsite soil concentrations were obtained from Table 19-9.
(2) Onsite ambient PM10 concentrations were calculated using the FDM at a distance of 10 meters beyond the RAA boundary.
(3) Onsite airborne dust concentrations were calculated from the onsite soil exposure concentrations using Equation 19-10.
(4) Offsite TSP deposition rates were calculated using the FDM; the receptor location giving rise to the greatest deposition rate was selected for purposes of conservatism.
(5) Offsite soil concentrations were calculated from the TSP deposition rate using Equation 19-11.
(6) Offsite PM10 concentrations were calculated using the FDM; the receptor location giving rise to the greatest PM10 concentrations was selected for purposes of conservatism.
(7) Offsite airborne dust concentrations were calculated from the onsite soil exposure concentration using Equation 19-12.

Table 19-45

PARTICULATE EMISSIONS RESULTS

CONSTRUCTION SCENARIO
RAA #3

Chemical of Concern	Onsite			Offsite			
	Soil Concentration (1) (mg/kg)	PM10 Concentration (2) (ug/m3)	Dust Concentration (3) (mg/m3)	TSP Deposition Rate (4) (ug/m2/s)	Soil Concentration (5) (mg/kg)	PM10 Concentration (6) (ug/m3)	Dust Concentration (7) (mg/m3)
Metals							
Barium	7.5E+02	3.7E+04	2.8E-02	3.8E-01	1.4E-02	1.7E+01	1.3E-05
Beryllium	6.1E-01	3.7E+04	2.3E-05	3.8E-01	1.1E-05	1.7E+01	1.1E-08
Lead	1.4E+01	3.7E+04	5.3E-04	3.8E-01	2.6E-04	1.7E+01	2.5E-07
Manganese	1.5E+02	3.7E+04	5.5E-03	3.8E-01	2.7E-03	1.7E+01	2.6E-06
Nickel	9.2E+00	3.7E+04	3.4E-04	3.8E-01	1.7E-04	1.7E+01	1.6E-07
Silver	3.4E+00	3.7E+04	1.3E-04	3.8E-01	6.2E-05	1.7E+01	5.9E-08
Zinc	1.4E+02	3.7E+04	5.1E-03	3.8E-01	2.5E-03	1.7E+01	2.4E-06

Notes:
(1) Onsite soil concentrations were obtained from Table 19-9.
(2) Onsite ambient PM10 concentrations were calculated using the FDM at a distance of 10 meters beyond the RAA boundary.
(3) Onsite airborne dust concentrations were calculated from the onsite soil exposure concentrations using Equation 19-10.
(4) Offsite TSP deposition rates were calculated using the FDM; the receptor location giving rise to the greatest deposition rate was selected for purposes of conservatism.
(5) Offsite soil concentrations were calculated from the TSP deposition rate using Equation 19-11.
(6) Offsite PM10 concentrations were calculated using the FDM; the receptor location giving rise to the greatest PM10 concentrations was selected for purposes of conservatism.
(7) Offsite airborne dust concentrations were calculated from the onsite soil exposure concentration using Equation 19-12.

Table 19-46

PARTICULATE EMISSIONS RESULTS

CONSTRUCTION SCENARIO
RAA #4

	Onsite			Offsite			
Chemical of Concern	Soil Concentration (1) (mg/kg)	PM10 Concentration (2) (ug/m3)	Dust Concentration (3) (mg/m3)	TSP Deposition Rate (4) (ug/m2/s)	Soil Concentration (5) (mg/kg)	PM10 Concentration (6) (ug/m3)	Dust Concentration (7) (mg/m3)
Metals							
Nickel	7.6E+00	1.2E+04	8.9E-05	1.2E-02	4.4E-06	1.0E+00	7.9E-09

Notes:
(1) Onsite soil concentrations were obtained from Table 19-9.
(2) Onsite ambient PM10 concentrations were calculated using the FDM at a distance of 10 meters beyond the RAA boundary.
(3) Onsite airborne dust concentrations were calculated from the onsite soil exposure concentrations using Equation 19-10.
(4) Offsite TSP deposition rates were calculated using the FDM; the receptor location giving rise to the greatest deposition rate was selected for purposes of conservatism.
(5) Offsite soil concentrations were calculated from the TSP deposition rate using Equation 19-11.
(6) Offsite PM10 concentrations were calculated using the FDM; the receptor location giving rise to the greatest PM10 concentrations was selected for purposes of conservatism.
(7) Offsite airborne dust concentrations were calculated from the onsite soil exposure concentration using Equation 19-12.

Table 19-47

EXPOSURE POINT CONCENTRATIONS

CONSTRUCTION SCENARIO
RAA #1

Chemical of Concern	Onsite Exposure			Offsite Exposure		
	Soil Concentration (1) (mg/kg)	Vapor Concentration (2) (mg/m3)	Dust Concentration (3) (mg/m3)	Soil Concentration (4) (mg/kg)	Vapor Concentration (mg/m3)	Dust Concentration (5) (mg/m3)
BTEX						
Toluene	4.3E-02	2.2E-04	ND (6)	ND	ND	ND
Xylenes	5.2E-02	2.2E-04	ND	ND	ND	ND
Non-BTEX TCL VOCs						
1,1,1-Trichloroethane	8.0E-03	8.3E-05	ND	ND	ND	ND
Acetone	2.5E-01	4.2E-03	ND	ND	ND	ND
Methylene Chloride	6.0E-03	1.5E-04	ND	ND	ND	ND
Tetrachloroethene	1.4E-02	1.6E-04	ND	ND	ND	ND
Metals						
Arsenic	4.1E+00	ND	1.5E-06	4.1E-05	ND	3.8E-08
Barium	3.1E+02	ND	1.2E-04	3.1E-03	ND	2.9E-06
Chromium	8.9E+00	ND	3.3E-06	8.8E-05	ND	8.3E-08
Lead	1.1E+01	ND	4.2E-06	1.1E-04	ND	1.1E-07
Nickel	7.5E+00	ND	2.8E-06	7.4E-05	ND	7.0E-08
Silver	5.8E+00	ND	2.2E-06	5.7E-05	ND	5.4E-08

Notes:
(1) Onsite soil concentrations were obtained from Table 19-9.
(2) Onsite ambient air vapor concentrations were obtained from Table 19-40.
(3) Onsite airborne dust concentrations were obtained from Table 19-43.
(4) Offsite soil concentrations were obtained from Table 19-43.
(5) Offsite airborne dust concentrations were obtained from Table 19-43.
(6) ND represents "not determined;" these concentrations were assumed to be neglibible.

Table 19-48

EXPOSURE POINT CONCENTRATIONS

CONSTRUCTION SCENARIO
RAA #2

Chemical of Concern	Onsite Exposure			Offsite Exposure		
	Soil Concentration (1) (mg/kg)	Vapor Concentration (2) (mg/m3)	Dust Concentration (3) (mg/m3)	Soil Concentration (4) (mg/kg)	Vapor Concentration (mg/m3)	Dust Concentration (5) (mg/m3)
BTEX						
Toluene	1.2E+00	3.6E-03	ND (5)	ND	ND	ND
Ethylbenzene	4.2E+00	6.7E-03	ND	ND	ND	ND
Xylenes	3.2E+01	8.0E-02	ND	ND	ND	ND
Non-BTEX TCL VOCs						
Acetone	1.1E-01	1.1E-03	ND	ND	ND	ND
Methylene Chloride	1.5E-01	2.2E-03	ND	ND	ND	ND
Metals						
Barium	7.7E+02	ND	2.4E-02	8.1E-03	ND	7.6E-06
Nickel	7.9E+00	ND	2.4E-04	8.4E-05	ND	7.8E-08
Vanadium	1.5E+01	ND	4.5E-04	1.6E-04	ND	1.4E-07

Notes:

(1) Onsite soil concentrations were obtained from Table 19-9.
(2) Onsite ambient air vapor concentrations were obtained from Table 19-40.
(3) Onsite airborne dust concentrations were obtained from Table 19-44.
(4) Offsite soil concentrations were obtained from Table 19-44.
(5) Offsite airborne dust concentrations were obtained from Table 19-44.
(6) ND represents "not determined;" these concentrations were assumed to be neglibible.

Table 19-49

EXPOSURE POINT CONCENTRATIONS

CONSTRUCTION SCENARIO
RAA #3

Chemical of Concern	Onsite Exposure			Offsite Exposure		
	Soil Concentration (1) (mg/kg)	Vapor Concentration (mg/m3)	Dust Concentration (2) (mg/m3)	Soil Concentration (3) (mg/kg)	Vapor Concentration (mg/m3)	Dust Concentration (4) (mg/m3)
Metals						
Barium	7.5E+02	ND (5)	2.8E-02	1.4E-02	ND	1.3E-05
Beryllium	6.1E-01	ND	2.3E-05	1.1E-05	ND	1.1E-08
Lead	1.4E+01	ND	5.3E-04	2.6E-04	ND	2.5E-07
Manganese	1.5E+02	ND	5.5E-03	2.7E-03	ND	2.6E-06
Nickel	9.2E+00	ND	3.4E-04	1.7E-04	ND	1.6E-07
Silver	3.4E+00	ND	1.3E-04	6.2E-05	ND	5.9E-08
Zinc	1.4E+02	ND	5.1E-03	2.5E-03	ND	2.4E-06

Notes:
(1) Onsite soil concentrations were obtained from Table 19-9.
(2) Onsite airborne dust concentrations were obtained from Table 19-45.
(3) Offsite soil concentrations were obtained from Table 19-45.
(4) Offsite airborne dust concentrations were obtained from Table 19-45.
(5) ND represents "not determined;" these concentrations were assumed to be negligible.

Table 19-50

EXPOSURE POINT CONCENTRATIONS

CONSTRUCTION SCENARIO
RAA #4

Chemical of Concern	Onsite Exposure			Offsite Exposure		
	Soil Concentration (1) (mg/kg)	Vapor Concentration (mg/m3)	Dust Concentration (2) (mg/m3)	Soil Concentration (3) (mg/kg)	Vapor Concentration (mg/m3)	Dust Concentration (4) (mg/m3)
Metals						
Nickel	7.6E+00	ND (5)	8.9E-05	4.4E-06	ND	7.9E-09

Notes:
(1) Onsite soil concentrations were obtained from Table 19-9.
(2) Onsite airborne dust concentrations were obtained from Table 19-46.
(3) Offsite soil concentrations were obtained from Table 19-46.
(4) Offsite airborne dust concentrations were obtained from Table 19-46.
(5) ND represents "not determined;" these concentrations were assumed to be negligible.

Table 19-51

EXPOSURE ASSUMPTIONS
CONSTRUCTION SCENARIO

Parameter (1)	Units	Receptors: Onsite Construction Worker	Onsite Worker	Offsite Residential	Onsite Offsite Sensitive
Exposure Pathways		Soil Ingestion Dermal Absorption Inhalation of vapors Inhalation of dusts	Soil Ingestion Dermal Absorption Inhalation of vapors Inhalation of dusts	Soil Ingestion Dermal Absorption Inhalation of dusts	Soil Ingestion Dermal Absorption Inhalation of dusts
Body weight	kg	70	70	70	15
Soil Ingestion Pathway					
Ingestion Rate	mg soil/day	480	50	100	200
Fraction Ingested (2)	unitless	1	1	1	1
Exposure Frequency (3)	days/year	30	30	350	350
Exposure Duration (3)	years	1	1	30	6
Averaging Time (4)					
Carcinogens	days	25550	25550	25550	25550
Noncarcinogens	days	365	365	10950	2190
Dermal Absorption Pathway					
Skin Surface Area Available (5)	cm2/event	5800	5800	5800	2295
Soil to Skin Adherence Factor (6)	mg/cm2	0.6	0.6	0.6	0.6
Skin Absorption Factor (7)					
VOCs	unitless	0.1	0.1	0.1	0.1
Inorganics	unitless	0.01	0.01	0.01	0.01
Exposure Frequency (3)	events/year	30	30	350	350
Exposure Duration (3)	years	1	1	30	6
Averaging Time (4)					
Carcinogens	days	25550	25550	25550	25550
Noncarcinogens	days	365	365	10950	2190
Vapor Inhalation Pathway					
Inhalation Rate (8)	m3/hr	2.5	2.5	0.83	0.83
Exposure Time (8)	hours/day	8	8	24	24
Exposure Frequency (9)	days/year	30	30	30	30
Exposure Duration (9)	years	1	1	1	1
Averaging Time (4)					
Carcinogens	days	25550	25550	25550	25550
Noncarcinogens	days	365	365	365	365
Dust Inhalation Pathway					
Inhalation Rate (8)	m3/hr	2.5	2.5	0.83	0.83
Exposure Time (8)	hours/day	8	8	24	24
Exposure Frequency (9)	days/year	30	30	30	30
Exposure Duration (9)	years	1	1	1	1
Averaging Time (4)					
Carcinogens	days	25550	25550	25550	25550
Noncarcinogens	days	365	365	365	365

Notes:

(1) Unless otherwise noted, values for parameters obtained from Risk Assessment Guidance for Superfund (RAGS), Volume 1: Human Health Evaluation Manual, Supplemental Guidance, Standard Default Exposure Factors (USEPA, 1991)

(2) Values obtained from RAGS, Volume 1: Human Health Evaluation Manual, Part A (EPA, 1989d)
Value assumed applicable to both adults and children.

(3) For Soil Ingestion and Dermal Adsorption Pathways, values for these parameters were based on the assumed construction period of 30 eight-hour days in a one year period. Onsite receptors exposed to the onsite soil concentrations for the duration of the construction period.
Offsite receptors exposed to the offsite deposited soil concentrations beyond the construction period.

(4) According to RAGS, Volume 1: Human Health Evaluation Manual, Part A (USEPA, 1989), Averaging Time (AT) is defined as the period over which exposure is averaged. For carcinogens, AT is 70 years x 365 days per year, representing a lifetime exposure.
For noncarcinogens, AT is the exposure duration x 365 days per year.

(5) Values obtained from Dermal Exposure Assessment: Principals and Applications, Interim Report (USEPA, 1992).

(6) Values obtained from Remedial Investigation Report for 18 Solid Waste Management Units, Cannon Air Force Base, Clovis, NM (Woodward-Clyde Consultants, 1992).

(7) Values obtained from Table 19-25.

(8) Inhalation rates equivalent to 20m3 per 8-hour working day for onsite workers and 20m3 per 24-hour day for offsite receptors.

(9) For Vapor Inhalation and Dust Inhalation Pathways, values for these parameters were based on the assumed construction period of 30 eight-hour days in a one year period. Onsite and Offsite receptors exposed to the vapor and dust concentrations for the duration of the construction period.

Table 19-52

CALCULATED DOSES FOR ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #1

ONSITE CONSTRUCTION WORKER

Chemical of Concern	Soil Ingestion Pathway		Dermal Absorption Pathway		Vapor Inhalation Pathway		Dust Inhalation Pathway	
	Carcinogenic Dose (1) (mg/kg/day)	Noncarcinogenic Dose (1) (mg/kg/day)	Carcinogenic Dose (2) (mg/kg/day)	Noncarcinogenic Dose (2) (mg/kg/day)	Carcinogenic Dose (3) (mg/kg/day)	Noncarcinogenic Dose (3) (mg/kg/day)	Carcinogenic Dose (4) (mg/kg/day)	Noncarcinogenic Dose (4) (mg/kg/day)
BTEX								
Toluene	3.5E-10	2.4E-08	2.5E-10	1.8E-08	7.3E-08	5.1E-06	ND (5)	ND
Xylenes	4.2E-10	2.9E-08	3.0E-10	2.1E-08	7.5E-08	5.2E-06	ND	ND
Non-BTEX TCL VOCs								
1,1,1-Trichloroethane	6.4E-11	4.5E-09	4.7E-11	3.3E-09	2.8E-08	1.9E-06	ND	ND
Acetone	2.0E-09	1.4E-07	1.5E-09	1.0E-07	1.4E-06	9.9E-05	ND	ND
Methylene Chloride	4.8E-11	3.4E-09	3.5E-11	2.5E-09	5.1E-08	3.6E-06	ND	ND
Tetrachloroethene	1.1E-10	7.9E-09	8.2E-11	5.7E-09	5.3E-08	3.7E-06	ND	ND
Metals								
Arsenic	3.3E-08	2.3E-06	2.4E-09	1.7E-07	ND	ND	5.1E-10	3.6E-08
Barium	2.5E-06	1.8E-04	1.8E-07	1.3E-05	ND	ND	3.9E-08	2.7E-06
Chromium	7.2E-08	5.0E-06	5.2E-09	3.6E-07	ND	ND	1.1E-09	7.8E-08
Lead	9.1E-08	6.4E-06	6.6E-09	4.6E-07	ND	ND	1.4E-09	9.9E-08
Nickel	6.0E-08	4.2E-06	4.4E-09	3.1E-07	ND	ND	9.4E-10	6.6E-08
Silver	4.7E-08	3.3E-06	3.4E-09	2.4E-07	ND	ND	7.3E-10	5.1E-08

Notes:

(1) Dose calculated using Equation 19-13. Onsite soil concentrations were obtained from Table 19-47. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.

(2) Dose calculated using Equation 19-14. Onsite soil concentrations were obtained from Table 19-47. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.

(3) Dose calculated using Equation 19-15. Onsite vapor concentrations were obtained from Table 19-47. Receptor-specific exposure assumptions were obtained from Table 19-51.

(4) Dose calculated using Equation 19-16. Onsite dust concentrations were obtained from Table 19-47. Receptor-specific exposure assumptions were obtained from Table 19-51.

(5) ND represents "not determined;" these doses were assumed to be negligible.

Table 19-53

CALCULATED DOSES FOR ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #1

ONSITE WORKER

Chemical of Concern	Soil Ingestion Pathway		Dermal Absorption Pathway		Vapor Inhalation Pathway		Dust Inhalation Pathway	
	Carcinogenic Dose (1) (mg/kg/day)	Noncarcinogenic Dose (1) (mg/kg/day)	Carcinogenic Dose (2) (mg/kg/day)	Noncarcinogenic Dose (2) (mg/kg/day)	Carcinogenic Dose (3) (mg/kg/day)	Noncarcinogenic Dose (3) (mg/kg/day)	Carcinogenic Dose (4) (mg/kg/day)	Noncarcinogenic Dose (4) (mg/kg/day)
BTEX								
Toluene	3.6E-11	2.5E-09	2.5E-10	1.8E-08	7.3E-08	5.1E-06	ND (5)	ND
Xylenes	4.4E-11	3.1E-09	3.0E-10	2.1E-08	7.5E-08	5.2E-06	ND	ND
Non-BTEX TCL VOCs								
1,1,1-Trichloroethane	6.7E-12	4.7E-10	4.7E-11	3.3E-09	2.8E-08	1.9E-06	ND	ND
Acetone	2.1E-10	1.5E-08	1.5E-09	1.0E-07	1.4E-06	9.9E-05	ND	ND
Methylene Chloride	5.0E-12	3.5E-10	3.5E-11	2.5E-09	5.1E-08	3.6E-06	ND	ND
Tetrachloroethene	1.2E-11	8.2E-10	8.2E-11	5.7E-09	5.3E-08	3.7E-06	ND	ND
Metals								
Arsenic	3.4E-09	2.4E-07	2.4E-09	1.7E-07	ND	ND	5.1E-10	3.6E-08
Barium	2.6E-07	1.8E-05	1.8E-07	1.3E-05	ND	ND	3.9E-08	2.7E-06
Chromium	7.5E-09	5.2E-07	5.2E-09	3.6E-07	ND	ND	1.1E-09	7.8E-08
Lead	9.5E-09	6.6E-07	6.6E-09	4.6E-07	ND	ND	1.4E-09	9.9E-08
Nickel	6.3E-09	4.4E-07	4.4E-09	3.1E-07	ND	ND	9.4E-10	6.6E-08
Silver	4.9E-09	3.4E-07	3.4E-09	2.4E-07	ND	ND	7.3E-10	5.1E-08

Notes:
(1) Dose calculated using Equation 19-13. Onsite soil concentrations were obtained from Table 19-47. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.
(2) Dose calculated using Equation 19-14. Onsite soil concentrations were obtained from Table 19-47. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.
(3) Dose calculated using Equation 19-15. Onsite vapor concentrations were obtained from Table 19-47. Receptor-specific exposure assumptions were obtained from Table 19-51.
(4) Dose calculated using Equation 19-16. Onsite dust concentrations were obtained from Table 19-47. Receptor-specific exposure assumptions were obtained from Table 19-51.
(5) ND represents "not determined;" these doses were assumed to be negligible.

Table 19-54

CALCULATED DOSES FOR ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #1

OFFSITE RESIDENTIAL RECEPTOR

Chemical of Concern	Soil Ingestion Pathway		Dermal Absorption Pathway		Vapor Inhalation Pathway		Dust Inhalation Pathway	
	Carcinogenic Dose (1) (mg/kg/day)	Noncarcinogenic Dose (1) (mg/kg/day)	Carcinogenic Dose (2) (mg/kg/day)	Noncarcinogenic Dose (2) (mg/kg/day)	Carcinogenic Dose (3) (mg/kg/day)	Noncarcinogenic Dose (3) (mg/kg/day)	Carcinogenic Dose (4) (mg/kg/day)	Noncarcinogenic Dose (4) (mg/kg/day)
Metals								
Arsenic	2.4E-11	5.6E-11	8.3E-12	1.9E-11	ND (5)	ND	1.3E-11	9.0E-10
Barium	1.8E-09	4.2E-09	6.3E-10	1.5E-09	ND	ND	9.7E-10	6.8E-08
Chromium	5.2E-11	1.2E-10	1.8E-11	4.2E-11	ND	ND	2.8E-11	1.9E-09
Lead	6.6E-11	1.5E-10	2.3E-11	5.3E-11	ND	ND	3.5E-11	2.5E-09
Nickel	4.4E-11	1.0E-10	1.5E-11	3.5E-11	ND	ND	2.3E-11	1.6E-09
Silver	3.4E-11	7.9E-11	1.2E-11	2.7E-11	ND	ND	1.8E-11	1.3E-09

Notes:
(1) Dose calculated using Equation 19-13. Onsite soil concentrations were obtained from Table 19-47. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.
(2) Dose calculated using Equation 19-14. Onsite soil concentrations were obtained from Table 19-47. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.
(3) Dose calculated using Equation 19-15. Onsite vapor concentrations were obtained from Table 19-47. Receptor-specific exposure assumptions were obtained from Table 19-51.
(4) Dose calculated using Equation 19-16. Onsite dust concentrations were obtained from Table 19-47. Receptor-specific exposure assumptions were obtained from Table 19-51.
(5) ND represents "not determined;" these doses were assumed to be negligible.

Table 19-55

CALCULATED DOSES FOR ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #1

OFFSITE SENSITIVE RECEPTOR

Chemical of Concern	Soil Ingestion Pathway		Dermal Absorption Pathway		Vapor Inhalation Pathway		Dust Inhalation Pathway	
	Carcinogenic Dose (1) (mg/kg/day)	Noncarcinogenic Dose (1) (mg/kg/day)	Carcinogenic Dose (2) (mg/kg/day)	Noncarcinogenic Dose (2) (mg/kg/day)	Carcinogenic Dose (3) (mg/kg/day)	Noncarcinogenic Dose (3) (mg/kg/day)	Carcinogenic Dose (4) (mg/kg/day)	Noncarcinogenic Dose (4) (mg/kg/day)
Metals								
Arsenic	4.4E-11	5.2E-10	3.1E-12	3.6E-11	ND (5)	ND	6.0E-11	4.2E-09
Barium	3.4E-09	3.9E-08	2.3E-10	2.7E-09	ND	ND	4.5E-09	3.2E-07
Chromium	9.7E-11	1.1E-09	6.6E-12	7.8E-11	ND	ND	1.3E-10	9.1E-09
Lead	1.2E-10	1.4E-09	8.4E-12	9.8E-11	ND	ND	1.6E-10	1.2E-08
Nickel	8.1E-11	9.5E-10	5.6E-12	6.5E-11	ND	ND	1.1E-10	7.7E-09
Silver	6.3E-11	7.3E-10	4.3E-12	5.1E-11	ND	ND	8.5E-11	5.9E-09

Notes:
(1) Dose calculated using Equation 19-13. Onsite soil concentrations were obtained from Table 19-47. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.
(2) Dose calculated using Equation 19-14. Onsite soil concentrations were obtained from Table 19-47. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.
(3) Dose calculated using Equation 19-15. Onsite vapor concentrations were obtained from Table 19-47. Receptor-specific exposure assumptions were obtained from Table 19-51.
(4) Dose calculated using Equation 19-16. Onsite dust concentrations were obtained from Table 19-47. Receptor-specific exposure assumptions were obtained from Table 19-51.
(5) ND represents "not determined;" these doses were assumed to be negligible.

Table 19-56

CALCULATED DOSES FOR ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #2

ONSITE CONSTRUCTION WORKER

Chemical of Concern	Soil Ingestion Pathway		Dermal Absorption Pathway		Vapor Inhalation Pathway		Dust Inhalation Pathway	
	Carcinogenic Dose (1) (mg/kg/day)	Noncarcinogenic Dose (1) (mg/kg/day)	Carcinogenic Dose (2) (mg/kg/day)	Noncarcinogenic Dose (2) (mg/kg/day)	Carcinogenic Dose (3) (mg/kg/day)	Noncarcinogenic Dose (3) (mg/kg/day)	Carcinogenic Dose (4) (mg/kg/day)	Noncarcinogenic Dose (4) (mg/kg/day)
BTEX								
Toluene	9.7E-09	6.8E-07	7.0E-09	4.9E-07	1.2E-06	8.4E-05	ND (5)	ND
Ethylbenzene	3.4E-08	2.4E-06	2.5E-08	1.7E-06	2.2E-06	1.6E-04	ND	ND
Xylenes	2.6E-07	1.8E-05	1.9E-07	1.3E-05	2.7E-05	1.9E-03	ND	ND
Non-BTEX TCL VOCs								
Acetone	8.9E-10	6.2E-08	6.4E-10	4.5E-08	3.7E-07	2.6E-05	ND	ND
Methylene Chloride	1.2E-09	8.5E-08	8.8E-10	6.1E-08	7.5E-07	5.3E-05	ND	ND
Metals								
Barium	6.2E-06	4.3E-04	4.5E-07	3.1E-05	ND	ND	7.9E-06	5.6E-04
Nickel	6.4E-08	4.5E-06	4.6E-09	3.2E-07	ND	ND	8.2E-08	5.7E-06
Vanadium	1.2E-07	8.2E-06	8.5E-09	6.0E-07	ND	ND	1.5E-07	1.1E-05

Notes:

(1) Dose calculated using Equation 19-13. Onsite soil concentrations were obtained from Table 19-48. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.

(2) Dose calculated using Equation 19-14. Onsite soil concentrations were obtained from Table 19-48. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.

(3) Dose calculated using Equation 19-15. Onsite vapor concentrations were obtained from Table 19-48. Receptor-specific exposure assumptions were obtained from Table 19-51.

(4) Dose calculated using Equation 19-16. Onsite dust concentrations were obtained from Table 19-48. Receptor-specific exposure assumptions were obtained from Table 19-51.

(5) ND represents "not determined;" these doses were assumed to be negligible.

Table 19-57

CALCULATED DOSES FOR ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #2

ONSITE WORKER

Chemical of Concern	Soil Ingestion Pathway		Dermal Absorption Pathway		Vapor Inhalation Pathway		Dust Inhalation Pathway	
	Carcinogenic Dose (1) (mg/kg/day)	Noncarcinogenic Dose (1) (mg/kg/day)	Carcinogenic Dose (2) (mg/kg/day)	Noncarcinogenic Dose (2) (mg/kg/day)	Carcinogenic Dose (3) (mg/kg/day)	Noncarcinogenic Dose (3) (mg/kg/day)	Carcinogenic Dose (4) (mg/kg/day)	Noncarcinogenic Dose (4) (mg/kg/day)
BTEX								
Toluene	1.0E-09	7.0E-08	7.0E-09	4.9E-07	1.2E-06	8.4E-05	ND (5)	ND
Ethylbenzene	3.5E-09	2.5E-07	2.5E-08	1.7E-06	2.2E-06	1.6E-04	ND	ND
Xylenes	2.7E-08	1.9E-06	1.9E-07	1.3E-05	2.7E-05	1.9E-03	ND	ND
Non-BTEX TCL VOCs								
Acetone	9.2E-11	6.5E-09	6.4E-10	4.5E-08	3.7E-07	2.6E-05	ND	ND
Methylene Chloride	1.3E-10	8.8E-09	8.8E-10	6.1E-08	7.5E-07	5.3E-05	ND	ND
Metals								
Barium	6.4E-07	4.5E-05	4.5E-07	3.1E-05	ND	ND	7.9E-06	5.6E-04
Nickel	6.6E-09	4.6E-07	4.6E-09	3.2E-07	ND	ND	8.2E-08	5.7E-06
Vanadium	1.2E-08	8.6E-07	8.5E-09	6.0E-07	ND	ND	1.5E-07	1.1E-05

Notes:
(1) Dose calculated using Equation 19-13. Onsite soil concentrations were obtained from Table 19-48. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.
(2) Dose calculated using Equation 19-14. Onsite soil concentrations were obtained from Table 19-48. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.
(3) Dose calculated using Equation 19-15. Onsite vapor concentrations were obtained from Table 19-48. Receptor-specific exposure assumptions were obtained from Table 19-51.
(4) Dose calculated using Equation 19-16. Onsite dust concentrations were obtained from Table 19-48. Receptor-specific exposure assumptions were obtained from Table 19-51.
(5) ND represents "not determined;" these doses were assumed to be negligible.

Table 19-58

CALCULATED DOSES FOR ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #2

OFFSITE RESIDENTIAL RECEPTOR

Chemical of Concern	Soil Ingestion Pathway		Dermal Absorption Pathway		Vapor Inhalation Pathway		Dust Inhalation Pathway	
	Carcinogenic Dose (1) (mg/kg/day)	Noncarcinogenic Dose (1) (mg/kg/day)	Carcinogenic Dose (2) (mg/kg/day)	Noncarcinogenic Dose (2) (mg/kg/day)	Carcinogenic Dose (3) (mg/kg/day)	Noncarcinogenic Dose (3) (mg/kg/day)	Carcinogenic Dose (4) (mg/kg/day)	Noncarcinogenic Dose (4) (mg/kg/day)
Metals								
Barium	4.8E-09	1.1E-08	1.7E-09	3.9E-09	ND (5)	ND	2.5E-09	1.8E-07
Nickel	4.9E-11	1.1E-10	1.7E-11	4.0E-11	ND	ND	2.6E-11	1.8E-09
Vanadium	9.1E-11	2.1E-10	3.2E-11	7.4E-11	ND	ND	4.8E-11	3.4E-09

Notes:
(1) Dose calculated using Equation 19-13. Onsite soil concentrations were obtained from Table 19-48. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.
(2) Dose calculated using Equation 19-14. Onsite soil concentrations were obtained from Table 19-48. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.
(3) Dose calculated using Equation 19-15. Onsite vapor concentrations were obtained from Table 19-48. Receptor-specific exposure assumptions were obtained from Table 19-51.
(4) Dose calculated using Equation 19-16. Onsite dust concentrations were obtained from Table 19-48. Receptor-specific exposure assumptions were obtained from Table 19-51.
(5) ND represents "not determined;" these doses were assumed to be negligible.

Table 19-59

CALCULATED DOSES FOR ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #2

OFFSITE SENSITIVE RECEPTOR

Chemical of Concern	Soil Ingestion Pathway		Dermal Absorption Pathway		Vapor Inhalation Pathway		Dust Inhalation Pathway	
	Carcinogenic Dose (1) (mg/kg/day)	Noncarcinogenic Dose (1) (mg/kg/day)	Carcinogenic Dose (2) (mg/kg/day)	Noncarcinogenic Dose (2) (mg/kg/day)	Carcinogenic Dose (3) (mg/kg/day)	Noncarcinogenic Dose (3) (mg/kg/day)	Carcinogenic Dose (4) (mg/kg/day)	Noncarcinogenic Dose (4) (mg/kg/day)
Metals								
Barium	8.9E-09	1.0E-07	6.1E-10	7.2E-09	ND (5)	ND	1.2E-08	8.3E-07
Nickel	9.2E-11	1.1E-09	6.3E-12	7.4E-11	ND	ND	1.2E-10	8.6E-09
Vanadium	1.7E-10	2.0E-09	1.2E-11	1.4E-10	ND	ND	2.3E-10	1.6E-08

Notes:
(1) Dose calculated using Equation 19-13. Onsite soil concentrations were obtained from Table 19-48. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.
(2) Dose calculated using Equation 19-14. Onsite soil concentrations were obtained from Table 19-48. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.
(3) Dose calculated using Equation 19-15. Onsite vapor concentrations were obtained from Table 19-48. Receptor-specific exposure assumptions were obtained from Table 19-51.
(4) Dose calculated using Equation 19-16. Onsite dust concentrations were obtained from Table 19-48. Receptor-specific exposure assumptions were obtained from Table 19-51.
(5) ND represents "not determined;" these doses were assumed to be negligible.

Table 19-60

CALCULATED DOSES FOR ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #3

ONSITE CONSTRUCTION WORKER

Chemical of Concern	Soil Ingestion Pathway		Dermal Absorption Pathway		Vapor Inhalation Pathway		Dust Inhalation Pathway	
	Carcinogenic Dose (1) (mg/kg/day)	Noncarcinogenic Dose (1) (mg/kg/day)	Carcinogenic Dose (2) (mg/kg/day)	Noncarcinogenic Dose (2) (mg/kg/day)	Carcinogenic Dose (3) (mg/kg/day)	Noncarcinogenic Dose (3) (mg/kg/day)	Carcinogenic Dose (4) (mg/kg/day)	Noncarcinogenic Dose (4) (mg/kg/day)
Metals								
Barium	6.0E-06	4.2E-04	4.4E-07	3.0E-05	ND (5)	ND	9.3E-06	6.5E-04
Beryllium	4.9E-09	3.4E-07	3.6E-10	2.5E-08	ND	ND	7.6E-09	5.3E-07
Lead	1.2E-07	8.1E-06	8.4E-09	5.9E-07	ND	ND	1.8E-07	1.3E-05
Manganese	1.2E-06	8.4E-05	8.7E-08	6.1E-06	ND	ND	1.8E-06	1.3E-04
Nickel	7.4E-08	5.2E-06	5.4E-09	3.8E-07	ND	ND	1.1E-07	8.0E-06
Silver	2.7E-08	1.9E-06	2.0E-09	1.4E-07	ND	ND	4.2E-08	3.0E-06
Zinc	1.1E-06	7.7E-05	8.0E-08	5.6E-06	ND	ND	1.7E-06	1.2E-04

Notes:
(1) Dose calculated using Equation 19-13. Onsite soil concentrations were obtained from Table 19-49. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.
(2) Dose calculated using Equation 19-14. Onsite soil concentrations were obtained from Table 19-49. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.
(3) Dose calculated using Equation 19-15. Onsite vapor concentrations were obtained from Table 19-49. Receptor-specific exposure assumptions were obtained from Table 19-51.
(4) Dose calculated using Equation 19-16. Onsite dust concentrations were obtained from Table 19-49. Receptor-specific exposure assumptions were obtained from Table 19-51.
(5) ND represents "not determined;" these doses were assumed to be negligible.

Table 19-61

CALCULATED DOSES FOR ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #3

ONSITE WORKER

Chemical of Concern	Soil Ingestion Pathway		Dermal Absorption Pathway		Vapor Inhalation Pathway		Dust Inhalation Pathway	
	Carcinogenic Dose (1) (mg/kg/day)	Noncarcinogenic Dose (1) (mg/kg/day)	Carcinogenic Dose (2) (mg/kg/day)	Noncarcinogenic Dose (2) (mg/kg/day)	Carcinogenic Dose (3) (mg/kg/day)	Noncarcinogenic Dose (3) (mg/kg/day)	Carcinogenic Dose (4) (mg/kg/day)	Noncarcinogenic Dose (4) (mg/kg/day)
Metals								
Barium	6.3E-07	4.4E-05	4.4E-07	3.0E-05	ND (5)	ND	9.3E-06	6.5E-04
Beryllium	5.1E-10	3.6E-08	3.6E-10	2.5E-08	ND	ND	7.6E-09	5.3E-07
Lead	1.2E-08	8.5E-07	8.4E-09	5.9E-07	ND	ND	1.8E-07	1.3E-05
Manganese	1.2E-07	8.7E-06	8.7E-08	6.1E-06	ND	ND	1.8E-06	1.3E-04
Nickel	7.7E-09	5.4E-07	5.4E-09	3.8E-07	ND	ND	1.1E-07	8.0E-06
Silver	2.9E-09	2.0E-07	2.0E-09	1.4E-07	ND	ND	4.2E-08	3.0E-06
Zinc	1.1E-07	8.0E-06	8.0E-08	5.6E-06	ND	ND	1.7E-06	1.2E-04

Notes:

(1) Dose calculated using Equation 19-13. Onsite soil concentrations were obtained from Table 19-49. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.

(2) Dose calculated using Equation 19-14. Onsite soil concentrations were obtained from Table 19-49. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.

(3) Dose calculated using Equation 19-15. Onsite vapor concentrations were obtained from Table 19-49. Receptor-specific exposure assumptions were obtained from Table 19-51.

(4) Dose calculated using Equation 19-16. Onsite dust concentrations were obtained from Table 19-49. Receptor-specific exposure assumptions were obtained from Table 19-51.

(5) ND represents "not determined;" these doses were assumed to be negligible.

Table 19-62

CALCULATED DOSES FOR ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #3

OFFSITE RESIDENTIAL RECEPTOR

Chemical of Concern	Soil Ingestion Pathway		Dermal Absorption Pathway		Vapor Inhalation Pathway		Dust Inhalation Pathway	
	Carcinogenic Dose (1) (mg/kg/day)	Noncarcinogenic Dose (1) (mg/kg/day)	Carcinogenic Dose (2) (mg/kg/day)	Noncarcinogenic Dose (2) (mg/kg/day)	Carcinogenic Dose (3) (mg/kg/day)	Noncarcinogenic Dose (3) (mg/kg/day)	Carcinogenic Dose (4) (mg/kg/day)	Noncarcinogenic Dose (4) (mg/kg/day)
Metals								
Barium	8.0E-09	1.9E-08	2.8E-09	6.5E-09	ND (5)	ND	4.3E-09	3.0E-07
Beryllium	6.6E-12	1.5E-11	2.3E-12	5.3E-12	ND	ND	3.6E-12	2.5E-10
Lead	1.6E-10	3.6E-10	5.4E-11	1.3E-10	ND	ND	8.4E-11	5.9E-09
Manganese	1.6E-09	3.7E-09	5.6E-10	1.3E-09	ND	ND	8.6E-10	6.0E-08
Nickel	9.9E-11	2.3E-10	3.4E-11	8.0E-11	ND	ND	5.4E-11	3.7E-09
Silver	3.7E-11	8.5E-11	1.3E-11	3.0E-11	ND	ND	2.0E-11	1.4E-09
Zinc	1.5E-09	3.4E-09	5.1E-10	1.2E-09	ND	ND	8.0E-10	5.6E-08

Notes:
(1) Dose calculated using Equation 19-13. Onsite soil concentrations were obtained from Table 19-49. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.
(2) Dose calculated using Equation 19-14. Onsite soil concentrations were obtained from Table 19-49. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.
(3) Dose calculated using Equation 19-15. Onsite vapor concentrations were obtained from Table 19-49. Receptor-specific exposure assumptions were obtained from Table 19-51.
(4) Dose calculated using Equation 19-16. Onsite dust concentrations were obtained from Table 19-49. Receptor-specific exposure assumptions were obtained from Table 19-51.
(5) ND represents "not determined;" these doses were assumed to be negligible.

Table 19-63

CALCULATED DOSES FOR ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #3

OFFSITE SENSITIVE RECEPTOR

Chemical of Concern	Soil Ingestion Pathway		Dermal Absorption Pathway		Vapor Inhalation Pathway		Dust Inhalation Pathway	
	Carcinogenic Dose (1) (mg/kg/day)	Noncarcinogenic Dose (1) (mg/kg/day)	Carcinogenic Dose (2) (mg/kg/day)	Noncarcinogenic Dose (2) (mg/kg/day)	Carcinogenic Dose (3) (mg/kg/day)	Noncarcinogenic Dose (3) (mg/kg/day)	Carcinogenic Dose (4) (mg/kg/day)	Noncarcinogenic Dose (4) (mg/kg/day)
								Dose (1)
Metals								
Barium	1.5E-08	1.7E-07	1.0E-09	1.2E-08	ND (5)	ND	2.0E-08	1.4E-06
Beryllium	1.2E-11	1.4E-10	8.4E-13	9.8E-12	ND	ND	1.7E-11	1.2E-09
Lead	2.9E-10	3.4E-09	2.0E-11	2.3E-10	ND	ND	3.9E-10	2.7E-08
Manganese	3.0E-09	3.5E-08	2.1E-10	2.4E-09	ND	ND	4.0E-09	2.8E-07
Nickel	1.8E-10	2.2E-09	1.3E-11	1.5E-10	ND	ND	2.5E-10	1.7E-08
Silver	6.8E-11	8.0E-10	4.7E-12	5.5E-11	ND	ND	9.2E-11	6.5E-09
Zinc	2.7E-09	3.2E-08	1.9E-10	2.2E-09	ND	ND	3.7E-09	2.6E-07

Notes:
(1) Dose calculated using Equation 19-13. Onsite soil concentrations were obtained from Table 19-49. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.
(2) Dose calculated using Equation 19-14. Onsite soil concentrations were obtained from Table 19-49. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.
(3) Dose calculated using Equation 19-15. Onsite vapor concentrations were obtained from Table 19-49. Receptor-specific exposure assumptions were obtained from Table 19-51.
(4) Dose calculated using Equation 19-16. Onsite dust concentrations were obtained from Table 19-49. Receptor-specific exposure assumptions were obtained from Table 19-51.
(5) ND represents "not determined;" these doses were assumed to be negligible.

Table 19-64

CALCULATED DOSES FOR ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #4

ONSITE CONSTRUCTION WORKER

Chemical of Concern	Soil Ingestion Pathway		Dermal Absorption Pathway		Vapor Inhalation Pathway		Dust Inhalation Pathway	
	Carcinogenic Dose (1) (mg/kg/day)	Noncarcinogenic Dose (1) (mg/kg/day)	Carcinogenic Dose (2) (mg/kg/day)	Noncarcinogenic Dose (2) (mg/kg/day)	Carcinogenic Dose (3) (mg/kg/day)	Noncarcinogenic Dose (3) (mg/kg/day)	Carcinogenic Dose (4) (mg/kg/day)	Noncarcinogenic Dose (4) (mg/kg/day)
Metals								
Nickel	6.1E-08	4.3E-06	4.4E-09	3.1E-07	ND (5)	ND	3.0E-08	2.1E-06

Notes:
(1) Dose calculated using Equation 19-13. Onsite soil concentrations were obtained from Table 19-50. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.
(2) Dose calculated using Equation 19-14. Onsite soil concentrations were obtained from Table 19-50. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.
(3) Dose calculated using Equation 19-15. Onsite vapor concentrations were obtained from Table 19-50. Receptor-specific exposure assumptions were obtained from Table 19-51.
(4) Dose calculated using Equation 19-16. Onsite dust concentrations were obtained from Table 19-50. Receptor-specific exposure assumptions were obtained from Table 19-51.
(5) ND represents "not determined;" these doses were assumed to be negligible.

Table 19-65

CALCULATED DOSES FOR ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #4

ONSITE WORKER

Chemical of Concern	Soil Ingestion Pathway		Dermal Absorption Pathway		Vapor Inhalation Pathway		Dust Inhalation Pathway	
	Carcinogenic Dose (1) (mg/kg/day)	Noncarcinogenic Dose (1) (mg/kg/day)	Carcinogenic Dose (2) (mg/kg/day)	Noncarcinogenic Dose (2) (mg/kg/day)	Carcinogenic Dose (3) (mg/kg/day)	Noncarcinogenic Dose (3) (mg/kg/day)	Carcinogenic Dose (4) (mg/kg/day)	Noncarcinogenic Dose (4) (mg/kg/day)
Metals								
Nickel	6.4E-09	4.5E-07	4.4E-09	3.1E-07	ND (5)	ND	3.0E-08	2.1E-06

Notes:

(1) Dose calculated using Equation 19-13. Onsite soil concentrations were obtained from Table 19-50. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.
(2) Dose calculated using Equation 19-14. Onsite soil concentrations were obtained from Table 19-50. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.
(3) Dose calculated using Equation 19-15. Onsite vapor concentrations were obtained from Table 19-50. Receptor-specific exposure assumptions were obtained from Table 19-51.
(4) Dose calculated using Equation 19-16. Onsite dust concentrations were obtained from Table 19-50. Receptor-specific exposure assumptions were obtained from Table 19-51.
(5) ND represents "not determined;" these doses were assumed to be negligible.

Table 19-66

CALCULATED DOSES FOR ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #4

OFFSITE RESIDENTIAL RECEPTOR

Chemical of Concern	Soil Ingestion Pathway		Dermal Absorption Pathway		Vapor Inhalation Pathway		Dust Inhalation Pathway	
	Carcinogenic Dose (1) (mg/kg/day)	Noncarcinogenic Dose (1) (mg/kg/day)	Carcinogenic Dose (2) (mg/kg/day)	Noncarcinogenic Dose (2) (mg/kg/day)	Carcinogenic Dose (3) (mg/kg/day)	Noncarcinogenic Dose (3) (mg/kg/day)	Carcinogenic Dose (4) (mg/kg/day)	Noncarcinogenic Dose (4) (mg/kg/day)
Metals								
Nickel	2.6E-12	6.1E-12	9.0E-13	2.1E-12	ND (5)	ND	2.6E-12	1.9E-10

Notes:

(1) Dose calculated using Equation 19-13. Onsite soil concentrations were obtained from Table 19-50. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.

(2) Dose calculated using Equation 19-14. Onsite soil concentrations were obtained from Table 19-50. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.

(3) Dose calculated using Equation 19-15. Onsite vapor concentrations were obtained from Table 19-50. Receptor-specific exposure assumptions were obtained from Table 19-51.

(4) Dose calculated using Equation 19-16. Onsite dust concentrations were obtained from Table 19-50. Receptor-specific exposure assumptions were obtained from Table 19-51.

(5) ND represents "not determined;" these doses were assumed to be negligible.

Table 19-67

CALCULATED DOSES FOR ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #4

OFFSITE SENSITIVE RECEPTOR

Chemical of Concern	Soil Ingestion Pathway		Dermal Absorption Pathway		Vapor Inhalation Pathway		Dust Inhalation Pathway	
	Carcinogenic Dose (1) (mg/kg/day)	Noncarcinogenic Dose (1) (mg/kg/day)	Carcinogenic Dose (2) (mg/kg/day)	Noncarcinogenic Dose (2) (mg/kg/day)	Carcinogenic Dose (3) (mg/kg/day)	Noncarcinogenic Dose (3) (mg/kg/day)	Carcinogenic Dose (4) (mg/kg/day)	Noncarcinogenic Dose (4) (mg/kg/day)
Metals								
Nickel	4.8E-12	5.7E-11	3.3E-13	3.9E-12	ND (5)	ND	1.2E-11	8.7E-10

Notes:
(1) Dose calculated using Equation 19-13. Onsite soil concentrations were obtained from Table 19-50. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.
(2) Dose calculated using Equation 19-14. Onsite soil concentrations were obtained from Table 19-50. Receptor and chemical-specific exposure assumptions were obtained from Tables 19-51 and 19-25, respectively.
(3) Dose calculated using Equation 19-15. Onsite vapor concentrations were obtained from Table 19-50. Receptor-specific exposure assumptions were obtained from Table 19-51.
(4) Dose calculated using Equation 19-16. Onsite dust concentrations were obtained from Table 19-50. Receptor-specific exposure assumptions were obtained from Table 19-51.
(5) ND represents "not determined;" these doses were assumed to be negligible.

19.4 Toxicity Assessment

A toxicity assessment was performed to identify and summarize the toxicological properties of the potential chemicals of concern selected in Section 19.2 for the human health risk assessment. In addition, toxicity values were obtained for use in conjunction with the results of the exposure assessment presented in Section 19.3, in order to quantitatively and qualitatively assess the potential for adverse effects to occur to receptors associated with the site.

Two types of adverse effects, carcinogenic and noncarcinogenic, are generally taken into consideration to assess potential impacts to human health. Quantitative toxicological assessments for many chemicals, including both noncarcinogenic and carcinogenic responses, can be found in the Integrated Risk Information System (IRIS) database and in the Health Effects Assessment Summary Tables (HEAST) documents, produced by EPA (EPA, 1993a; EPA, 1993b).

19.4.1 Carcinogenic Effects

Carcinogenic effects are characterized by the production of tumors resulting from cellular changes that lead to uncontrolled cellular proliferation. The EPA currently assumes that there is not a threshold effect for substances which cause cancer, and that there is a linear relationship between the exposure concentration and the probability that cancer will be produced due to exposure. Therefore, carcinogenic risk is defined as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen.

The EPA identifies carcinogens by a weight-of-evidence-classification system. The weight-of-evidence-classification system characterizes the extent to which the data available indicate that a chemical is carcinogenic to humans; the classifications are presented in Table 19-68. In general, quantitative carcinogenic risk assessments are performed only for chemicals in Groups A and B, but they may also be performed for chemicals in Group C. Generally, carcinogenic slope factors for such chemicals are calculated using the linearized multistage model, which is a linear non-threshold mathematical model for low dose extrapolation. To derive slope factors, the EPA calculates the upper 95% confidence limit of the slope describing the probability of carcinogenic response versus the unit intake of a chemical over a given lifetime in units of $(mg/kg\text{-}day)^{-1}$. Methodologies for deriving slope factors are described in RAGS (EPA, 1989a).

Slope factors are often derived separately to evaluate oral and inhalation risks associated with chemical exposures. Often studies will derive drinking water unit risk factors from oral studies, and inhalation unit risk factors from inhalation studies. Unit risk factors are values representing the level of risk of cancer associated with the exposure to a unit of a carcinogen. Drinking water unit risk factors and inhalation unit risk factors can be converted to oral and inhalation slope factors using the following equations:

$$\text{Oral Slope Factor } (mg/kg\text{-}day)^{-1} = \text{Drinking Water Unit Risk } (ug/l)^{-1} \times 1 \text{ day}/ 2 \text{ liters} \times 70 \text{ kg} \times 10^3 \text{ ug/mg} \quad (19\text{-}19)$$

Inhalation Slope Factor $(mg/kg\text{-}day)^{-1}$
$= \text{Inhalation Unit Risk } (ug/m^3)^{-1} \times 70 \text{ kg} \times 1 \text{ day}/20 \text{ m}^3 \text{ air} \times 10^3 \text{ ug/mg}$ (19-20)

where

2 liters	=	Default value for the average human intake of drinking water per day
20 m^3	=	Default value for the average daily inhalation rate for humans
70 kg	=	Default value for the weight of an average human
1,000 ug/mg	=	Conversion factor from micrograms to milligrams.

Dermal slope factors (SFs), which are used to assess dermal exposures to potential carcinogens, are usually not available directly from the EPA; therefore, when possible, dermal SFs have been derived for the purposes of this risk assessment. A dermal SF can be derived by dividing available oral slope factors by absorption factors derived from literature searches to obtain an estimated absorbed slope factor. From this estimated absorbed dermal slope factor, the carcinogenic risk from dermal exposure may be calculated.

19.4.2 Noncarcinogenic Effects

Noncarcinogenic effects cover a wide range of toxicological responses ranging from effects on specific organs (e.g. the liver), to systemic effects (e.g. the central nervous system) to effects on reproduction and offspring (e.g., teratogenicity and mutagenicity). Based on scientific understanding of homeostatic and adaptive mechanisms, systemic or noncarcinogenic toxicity is assumed to have an identifiable threshold for both the individual and the population, which means that the organisms or receptors can tolerate a range of exposures without adverse effects. The benchmark value of this threshold is the reference dose or RfD, expressed in milligrams of chemical per kilogram of body weight of individual per day (mg/kg-day) (EPA, 1993b).

For the purposes of risk assessment, noncarcinogenic effects are assessed using chronic reference doses (RfDs) in milligram-chemical per kilogram-body weight of individual per day (mg/kg-day). A chronic RfD is an estimate (with uncertainty spanning as high as an order of magnitude) of a human daily intake that is likely to be without an appreciable risk of deleterious effects during a lifetime or a portion of a lifetime (greater than 7 years), including sensitive subpopulations (EPA, 1993a).

Usually, exposures that are less than the RfD (resulting in a hazard quotient or hazard index equal to or less than 1) are not likely to be associated with adverse health risks. As the frequency and level of exposures exceeding the RfD increases, the likelihood for adverse effects also increases. However, a clear distinction that could categorize all exposures below the RfD as "acceptable" (risk-free) and all exposures in excess of the RfD as "unacceptable" (causing adverse effects) cannot be made (EPA, 1993b).

The RfD, in mg/kg-day, is derived by using the following equation:

$$\text{RfD mg/kg-day} = \frac{\text{NOAEL mg/Kg-day}}{\text{UF} \times \text{MF}} \quad (19\text{-}21)$$

where

NOAEL = No-Observed-Adverse-Effect Level
UF = Uncertainty Factor
MF = Modifying Factor

The no-observed-adverse-effect level (NOAEL) is the key datum in the dose-response assessment process. It is defined as the highest experimental dose of a chemical at which there is no statistical or biologically significant increase in frequency or severity of adverse effects between the exposed population and its appropriate control. That is, effects may be produced at this level, but they are not considered to be adverse. Adverse effects are defined as functional impairment or pathological lesions which may affect the performance of the whole organism, or which reduce an organism's ability to respond to an additional challenge (EPA, 1989a).

For health protection purposes, standard uncertainty factors (UFs) are ten-fold factors that address various types of uncertainty in extrapolation; these include the following:

- 10H: A ten-fold factor to account for the variation in sensitivity among members of the human population, especially children, pregnant women, and the elderly.

- 10A: A ten-fold factor to account for the uncertainty involved in extrapolating from animal data to humans, assuming that humans are the most sensitive species.

- 10S: A ten-fold factor to account for the uncertainty involved in extrapolating from less than chronic NOAEL (or subchronic NOAEL) to chronic NOAEL.

- 10L: A ten-fold factor to account for the uncertainty involved in extrapolating from the lowest observed adverse effect level (LOAEL) to NOAEL.

Modifying factors (MFs), varying from greater than 1 to 10, are used to address the scientific uncertainties of the study and database that are not explicitly treated by uncertainty factors. The default value for MFs is 1 (EPA, 1989a). In addition to UFs and MFs, NOAELs obtained from animal studies must be adjusted for the human equivalent NOAEL for exposure duration and other factors, including body weight and difference in regional deposited dose.

RfDs are often available from the EPA for oral and inhalation routes of exposure. The appropriate type of RfD should be used to assess corresponding exposures. Often toxicity values for noncarcinogenic inhalation exposures are presented as reference concentrations, which are levels of exposure (in mg/m^3) that are not expected to result in adverse effects. For the purposes of this risk assessment, reference concentrations (RfCs) identified for chemicals of concern have been converted into inhalation reference doses according to EPA guidance (EPA, 1989a). RfCs are converted into RfDs using the following equation:

$$\text{Inhalation RfD (mg/kg-day)} = \text{RfC (mg/m}^3\text{)} \times 1/70 \text{ kg} \times 20 \text{ m}^3\text{/day} \qquad (19\text{-}22)$$

The conversion factors (1/70 kg and 20 m^3/day) used represent the default factors assumed for the average weight and the average daily air intake of a typical human.

Dermal exposures have been identified as potential routes of exposure for this study. In general, dermal RfDs are not available for risk assessment purposes, but they have been derived for some of the chemicals of concern in order to assess potential dermal exposures. The dermal RfDs have been derived by multiplying available oral RfDs by absorption factors identified in literature searches. The result is an assumed absorbed dose of contaminant, below which exposures are not expected to result in adverse effects, and above which potential hazards may exist.

19.4.3 Carcinogenic and Noncarcinogenic Toxicity Values

A summary of the carcinogenic and noncarcinogenic toxicity values identified for the chemicals of concern at the 15 SWMUs investigated at Cannon AFB is presented in Table 19-69. A summary of the carcinogenic and noncarcinogenic effects associated with the chemicals of concern, including the site of action and effect produced by noncarcinogenic substances, and the locations and types of tumors produced by carcinogenic substances, is presented in Table 19-70.

19.4.4 Uncertainties and Limitations

Due to the nature of the studies which are used to determine the toxic potential of chemicals, all toxicity assessments inherently contain at least some level of uncertainty concerning confidence in the validity, accuracy, and appropriateness of the derived toxicity values. The toxicity values derived for the purposes of risk assessment are collected from a wide range of sources, using a variety of techniques and study designs to estimate RfDs and slope factors. The methodologies and assumptions used to estimate these toxicity values results in differing levels of confidence in the toxicity values used. The following discussion gives an overview of the uncertainties generally associated with toxicity assessments, and methodologies used to account for these in developing numbers used to assess the potential hazards associated with chemical exposures.

Epidemiological studies of certain chemicals, especially those found in the workplace and in public drinking water supplies, have produced some reliable information sources on the hazards of chemical exposures. In general, however, data concerning direct human exposures to hazardous chemicals is still scarce. As a result, studies conducted on laboratory animals provide necessary information to evaluate the toxicity of exposures to potentially dangerous substances.

Animal studies are performed under controlled conditions in terms of exposure conditions and dose levels, and effects analyses can be rigorously scrutinized. Regardless of the measures taken, laboratory animals do not necessarily represent human responses, and extrapolating the results of animal studies to predictions on the effects of humans is a major source of uncertainty in assessing the toxicity of potentially hazardous chemicals. There are many important differences between laboratory animals and humans, and these differences may all be sources of variation between the responses to toxic exposures between humans and animals. Differences in life span, body size, metabolic rates, metabolic processes, and exposure routes make extrapolations difficult to assess. When animal studies are used to develop a toxicity value for human health risk assessment purposes, a safety or uncertainty factor is often used to account for potential differences in response to hazardous chemicals. A value of 10 is usually incorporated for extrapolations from animal studies to human toxicity values.

Toxicity values, especially cancer slope factors, are based on the assumption that there is a linear relationship between the amount of exposure and the severity of the effect. For carcinogens, it is assumed that there is no threshold level below which exposure to the substance is without risk of developing cancer. Studies used to derive slope factors use high levels of concentrations of the carcinogen to generate data, and then extrapolate to low doses to predict the risks associated with low level exposures. Justification for these methods has not been sufficiently provided to this point. Use of toxicity values based on extrapolation from high doses to low level exposures may not take into account threshold levels which may exist, and overestimations of actual risk may be the result.

Uncertainties also may arise when studies use inbred strains of homogeneous animals, or when healthy populations of human workers are used to predict the effects of potentially hazardous chemicals on a heterogeneous population of humans. The general human population comprises a wide variety of genetic, cultural, and behavioral patterns which all influence responses to all types of stressors, including toxic chemicals. Sensitive subpopulations must be taken into account when estimates of toxicity are developed, and in general, an uncertainty factor of 10 is applied to ensure the protection of all populations potentially exposed.

The use of toxicity values to assess the potential effects of hazardous chemicals on a wide variety of potential receptors contains considerable uncertainties. Nevertheless, the toxicity values derived are considered conservative estimates, and although risk assessments using these toxicity values may overstate the actual risks present on a site, the protection of all possible receptors is sound justification for using these methodologies.

Table 19-68. EPA Carcinogenic Weight-of-Evidence Classification[1]

EPA Weight-of-Evidence Classification	Carcinogenic Status (Evidence for Carcinogenic Classification)
A	Human Carcinogen (sufficient evidence of carcinogenicity in humans)
B1	Probable Human Carcinogen (limited evidence of carcinogenicity in humans)
B2	Probable Human Carcinogen (sufficient evidence of carcinogenicity in animals with inadequate or lack of evidence in humans)
C	Possible Human Carcinogen (limited evidence of carcinogenicity in animals and inadequate or lack of human data)
D	Not classifiable as to Human Carcinogenicity (inadequate or no evidence)
E	Evidence of Noncarcinogenicity for Humans (no evidence of carcinogenicity in adequate studies)

1 Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A)(EPA, 1989d).

Table 19-69. Toxicity Values for Chemicals of Concern

Chemical	EPA Weight of Evidence Classification	Chronic Oral RfD (mg/kg-day)	Chronic Inhalation RfD[d] (mg/kg-day)	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Inhalation Slope Factor $(mg/kg\text{-}day)^{-1}$	Gastrointestinal Absorption Factor	Dermal RfD (mg/kg-day)[k]	Dermal Slope Factor $(mg/kg\text{-}dy)^{-1}$ [l]
METALS								
Arsenic	A	3.0×10^{-4} [a]	--	1.8 [e]	$1.5 \times 10^{+1}$ [f]	0.94[h]	2.8×10^{-4}	1.9
Barium	--	7.0×10^{-2} [a]	1.4×10^{-4} [c]	--	--	moderate[g]	7.0×10^{-2}	
Beryllium	B2	5.0×10^{-3} [a]	--	4.3 [a]	8.4 [b]	low[g]	5.0×10^{-3}	4.3
Chromium (III)	--	1.0 [a]	--	--	--	0.01[g]	1.0×10^{-2}	
Chromium (VI)	A	5.0×10^{-3} [a]	--	--	$4.1 \times 10^{+1}$ [b]	0.01[g]	5.0×10^{-5}	
Lead	B2	--	--	--	--	0.1[g]	--	--
Manganese	D	1.4×10^{-1}[a](food) 5.0×10^{-3} (water)	1.1×10^{-4}	--	--	0.04[g]	5.6×10^{-3}	
Nickel	A (under review)	2.0×10^{-2} [a]	--	--	8.4×10^{-1} [b]	low[g]	2.0×10^{-2}	
Silver	D	5.0×10^{-3} [a]	--	--	--	moderate[g]	5.0×10^{-3}	
Vanadium	--	7.0×10^{-3} [b]	--	--	--	moderate[g]	7.0×10^{-3}	
Zinc	D	3.0×10^{-1} [a]	--	--	--	0.3[i]	9.0×10^{-2}	

[a] Integrated Risk Information System (IRIS), October,1993.
[b] Health Effects Assessment Summary Tables (HEAST), January, 1992.
[c] Health Effects Assessment Summary Tables (HEAST), March, 1993.
[d] Inhalation RfDs have been calculated from Inhalation RfCs identified in IRIS and HEAST using the equation: Inhalation RfD (mg/kg-day) = [RfC (mg/m^3)] x [1/70 kg] x [20 m^3 air intake/day]
[e] The Oral Slope Factor for Arsenic has been calculated from the Drinking Water Unit Risk Factors identified in IRIS, using the equation:
Oral Slope Factor $(mg/kg\text{-}day)^{-1}$ = [Drinking Water Unit Risk $(ug/l)^{-1}$] x [1 day/2 liters] x [70 kg] x [10^3 ug/mg]
[f] Inhalation Slope Factors for Arsenic and methylene chloride have been calculated from the Inhalation Unit Risk Factors identified in IRIS, using the equation:
Inhalation Slope Factor $(mg/kg\text{-}day)^{-1}$ = [Inhalation Unit Risk $(ug/m^3)^{-1}$ x [70 kg] x [1 day/20 m^3 air] x [10^3 ug/mg]
[g] Casarett and Doull's Toxicology, 1986
[h] Vahter and Norvin (1980)
[i] Davies et al. (1980)
[j] No gastrointestinal absorption factors identified for these compounds. Due to their organic solvent properties, an absorption factor of 1 has been assumed.
[k] Dermal RfDs were calculated by multiplying Chronic Oral Rfd values by identified Gastrointestinal Absorption Factors to adjust for the amount of contaminant potentially absorbed by dermal contact. For Barium, Beryllium, Nickel, Silver, and Vanadium, an absorption factor of 1 has been assumed.
[l] Dermal Slope Factors were calculated by dividing Oral Slope Factor values by identified Gastrointestinal Absorption Factors to adjust for the amount of contaminant potentially absorbed by dermal contact. For Beryllium, an absorption factor of 1 has been assumed.
[m] Superfund Health Risk Technical Support Center, Cincinnati, OH
-- Means not available from EPA sources.

Table 19-69. Toxicity Values for Chemicals of Concern (continued)

Chemical	EPA Weight of Evidence Classification	Chronic Oral RfD (mg/kg-day)	Chronic Inhalation RfD[d] (mg/kg-day)	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Inhalation Slope Factor $(mg/kg\text{-}day)^{-1}$	Gastrointestinal Absorption Factor	Dermal RfD (mg/kg-day)[k]	Dermal Slope Factor $(mg/kg\text{-}dy)^{-1}$ [l]
ORGANICS								
Acetone	D	1.0×10^{-1} [a]	--	--	--	1[j]	1.0×10^{-1}	
Ethylbenzene	D	1.0×10^{-1} [a]	2.9×10^{-1}	--	--	1[j]	1.0×10^{-1}	
Methylene Chloride	B	6.0×10^{-2} [a]	8.6×10^{-1}	7.5×10^{-3} [e]	1.7×10^{-3} [f]	1[j]	6.0×10^{-2}	7.5×10^{-3}
Tetrachloroethylene	B2/C	1.0×10^{-2} [a]	--	5.2×10^{-2} [m]	2.0×10^{-3} [m]	1[j]	1.0×10^{-2}	5.2×10^{-2}
1,1,1-Trichloroethane	D	9.0×10^{-2} [b]	--	--	--	1[j]	9.0×10^{-2}	
Toluene	D	2.0×10^{-1} [a]	1.1×10^{-1}	--	--	1[j]	2.0×10^{-1}	
Xylenes	D	2.0 [a]	--	--	--	1[j]	2.0	

[a] Integrated Risk Information System (IRIS), October,1993.
[b] Health Effects Assessment Summary Tables (HEAST), January, 1992.
[c] Health Effects Assessment Summary Tables (HEAST), March, 1993.
[d] Inhalation RfDs have been calculated from Inhalation RfCs identified in IRIS and HEAST using the equation: Inhalation RfD (mg/kg-day) = [RfC (mg/m^3)] x [1/70 kg] x [20 m^3 air intake/day]
[e] The Oral Slope Factor for Arsenic has been calculated from the Drinking Water Unit Risk Factors identified in IRIS, using the equation:
Oral Slope Factor $(mg/kg\text{-}day)^{-1}$ = [Drinking Water Unit Risk $(ug/l)^{-1}$] x [1 day/2 liters] x [70 kg] x [10^3 ug/mg]
[f] Inhalation Slope Factors for Arsenic and methylene chloride have been calculated from the Inhalation Unit Risk Factors identified in IRIS, using the equation:
Inhalation Slope Factor $(mg/kg\text{-}day)^{-1}$ = [Inhalation Unit Risk $(ug/m^3)^{-1}$ x [70 kg] x [1 day/20 m^3 air] x [10^3 ug/mg]
[g] Casarett and Doull's Toxicology, 1986
[h] Vahter and Norvin (1980)
[i] Davies et al. (1980)
[j] No gastrointestinal absorption factors identified for these compounds. Due to their organic solvent properties, an absorption factor of 1 has been assumed.
[k] Dermal RfDs were calculated by multiplying Chronic Oral Rfd values by identified Gastrointestinal Absorption Factors to adjust for the amount of contaminant potentially absorbed by dermal contact. For Barium, Beryllium, Nickel, Silver, and Vanadium, an absorption factor of 1 has been assumed.
[l] Dermal Slope Factors were calculated by dividing Oral Slope Factor values by identified Gastrointestinal Absorption Factors to adjust for the amount of contaminant potentially absorbed by dermal contact. For Beryllium, an absorption factor of 1 has been assumed.
[m] Superfund Health Risk Technical Support Center, Cincinnati, OH
-- Means not available from EPA sources.

Table19-70. Carcinogenic and Noncarcinogenic Effects of Chemicals of Concern

Chemical	Noncarcinogenic Effect		Carcinogenic Effect	
	Target Organ	Critical Effect	Target Organ / Tumor Type	EPA Carcinogenic Class
METALS				
Arsenic	Skin[1,2] Nervous System[1,2] Liver[1]	Blackfoots disease; Hyperpigmentation; Keratosis; Skin lesions Abnormal nerve conduction Jaundice; cirrhosis; ascites	Respiratory tumors[2] Skin tumors: [3] melanosis Liver tumors: [2,3] hemangioendothelial tumors angiosarcomas	A
Barium	Gastrointestinal tract[1] Nervous system[1] Cardiovascular system[4] Lung[1]	Gastroenteritis Muscular paralysis Decreased pulse rate; Ventricular fibrillation; Increased blood pressure Pneumoconiosis	N/A	--
Beryllium	Lung[1] Skin[1]	Pneumonitis; Berylliosis Contact Dermatitis	Lung tumors[2,5]	B2
Chromium (III)	Kidney[1]	Renal Tubular Necrosis	N/A	--

Table19-70. Carcinogenic and Noncarcinogenic Effects of Chemicals of Concern (continued)

Chemical	Noncarcinogenic Effect		Carcinogenic Effect	
	Target Organ	Critical Effect	Target Organ / Tumor Type	EPA Carcinogenic Class
Chromium (VI)	Kidney[1,2] Respiratory System[1]	Renal Tubular Necrosis Nasal irritation; bronchitis	Lung tumors:[1,2,6] Squamous cell carcinomas Anaplastic tumors Adenocarcinomas	A
Lead	Nervous system[1] Blood[1] Kidney[1] Cardiovascular system[1] Reproductive system[1] Immune system[1]	Impaired CNS function; peripheral neuropathy Impaired heme synthesis; shortened erythrocyte lifespan impaired kidney function Increased blood pressure Increased reproductive dysfunction Decreased immune response	Kidney tumors[1] Renal adenocarcinomas Respiratory tumors GI tumors	B2
Manganese	Lung[1,2] Central Nervous System[1,2] Liver	Pneumonitis Psychomotor disturbances; CNS effects Cirrhosis	N/A	D

Table19-70. Carcinogenic and Noncarcinogenic Effects of Chemicals of Concern (continued)

Chemical	Noncarcinogenic Effect		Carcinogenic Effect	
	Target Organ	Critical Effect	Target Organ / Tumor Type	EPA Carcinogenic Class
Nickel	Skin[1] Reproductive system[1] Lung[1] Whole body[2] Major organs[2]	Contact dermatitis Decreased reproductive capacity Pulmonary edema Decreased weight Decreased weight		--
Silver	Skin Gastrointestinal tract Reproductive system	Argyria Irritation Decreased reproductive capacity in males	N/A	D
Vanadium	Respiratory system[1] Mucous membranes (eyes, nose, G.I.)[1]	Bronchitis; bronchopneumonia Irritant		
Zinc	Respiratory system[1] Gastrointestinal tract[1]	Irritant irritant		D

Table19-70. Carcinogenic and Noncarcinogenic Effects of Chemicals of Concern (continued)

Chemical	Noncarcinogenic Effect		Carcinogenic Effect	
	Target Organ	Critical Effect	Target Organ / Tumor Type	EPA Carcinogenic Class
ORGANICS				
Acetone	Liver[1,2] Kidney[1,2] CNS[1] Mucous membranes[1]	Fatty liver Increased Weight; tubular degeneration; nephrotoxicity CNS depression; narcosis Irritant	N/A	D
Ethylbenzene	Fetus[1] Liver[2] Kidney[2] CNS[1]	Developmental Toxicity Hepatotoxicity Nephrotoxicity CNS Depression; narcosis	N/A	D
Methylene chloride	Liver[1,2] CNS[1] Kidney[1]	Fatty liver Depressed neurologic functioning Tubular degeneration	Liver:[1,2] hepatocellular carcinomas hepatocellular adenomas neoplastic nodules Lung:[1] alveolar / bronchiolar adenomas Carcinomas	B2

Table19-70. Carcinogenic and Noncarcinogenic Effects of Chemicals of Concern (continued)

Chemical	Noncarcinogenic Effect		Carcinogenic Effect	
	Target Organ	Critical Effect	Target Organ / Tumor Type	EPA Carcinogenic Class
Tetrachloroethylene	Liver[1,2]	Hepatotoxicity; fatty tissue	N/A	B2/C
	Respiratory[1]	Irritant		
	Mucous membranes (eyes and nose)[1]	Irritant		
1,1,1-Trichloroethane	Liver[1]	Fatty liver; necrosis	N/A	D
Toluene	CNS[1,2]	Narcosis; depressed neurologic function	N/A	D
	Liver[1,2]	Increased weight		
	Kidney[1,2]	Acidosis, lesions		
	Respiratory[1]	Irritant		
	Mucous membranes (eyes and nose)[1]	Irritant		
Xylenes	CNS	Depressed neurologic function; narcosis	N/A	D

1 Casarett and Doull's Toxicology, 1986
2 Integrated Risk Information System (IRIS), October, 1993
3 Popper et al, 1978
4 Reeves, 1979
5 Kuschner, 1981
6 Norseth, 1987

19.5 Risk Characterization - Baseline Scenario

In Section 19.3.2.4, exposure doses were estimated for each receptor. In Section 19.4, toxicity values were determined for each COC. This section estimates cancer risk and noncancer hazard index for the baseline scenario by integrating exposure doses with the toxicity values for each receptor.

Because the development of carcinogenic and noncarcinogenic effects are assumed to be caused by different mechanisms of action, different methodologies are used to quantitate these effects. The methods used to estimate cancer risk and noncancer hazard indices are presented in Sections 19.5.1 and 19.5.2, respectively. The cancer risk and noncancer hazard indices are presented and discussed for each RAA in Section 19.5.3. The results are summarized in Section 19.5.4. A discussion regarding the uncertainties and limitations of the risk characterization is presented in Section 19.5.5. Finally, because of the lack of EPA-verified toxicity values for lead, cancer risk and noncancer hazard were not quantitated for lead exposure. Instead, potential health impacts arising from lead exposure were evaluated using EPA's Uptake Biokinetic Model (UBK), which calculates blood-lead concentrations arising in child receptors due to lead exposure. The results of this analysis are discussed in Section 19.5.6.

19.5.1 Cancer Risk Estimation

In assessing the carcinogenic effects resulting from exposures to COCs, the excess cancer risk, in addition to the background fatal cancer risk, is calculated using the following equation (EPA, 1989d):

$$\text{Risk} = \text{Dose}_c \times \text{CSF} \qquad (19\text{-}23)$$

where

Risk = Excess cancer risk;

Dose_c = For each COC, the carcinogenic daily dose due to a particular exposure pathway (mg/kg/day). Exposure doses under the baseline scenario for each RAA are presented in Tables 19-26 through 19-37; and,

CSF = Chemical-specific cancer slope factor $(\text{mg/kg/day})^{-1}$, as obtained from Table 19-69.

The term "excess cancer risk" refers to the incremental cancer risk above the normal background cancer risk that arises due to onsite COCs. This equation was used to estimate the excess cancer risk from each exposure pathway for the onsite worker, offsite resident adult, and offsite sensitive receptors.

These excess cancer risk values are expressed in terms such as one-in-ten-thousand (1×10^{-4}, 10^{-4}, 1E-04, or 0.0001) or one-in-a-million (1×10^{-6}, 10^{-6}, 1E-06, or 0.000001). An individual excess cancer risk of 1×10^{-6} means that an exposed individual may have a one-in-a-million chance of developing cancer over a lifetime (in excess of background) or one person among one million exposed people might be expected to develop cancer as a result of exposure to site COCs. The background cancer incidence rate in the United States is approximately 25% (HCRA, 1992; Crouch and Wilson, 1982). Therefore an individual excess cancer risk of 1×10^{-6} would indicate that instead of 250,000 persons contracting cancer out of a population of one million (background incidence rate), 250,001 persons would contract cancer.

Cancer risks for each COC for each exposure pathway for each RAA/receptor combination were calculated. The results are summed for each RAA/receptor combination in two ways: for each COC, the results are summed across all exposure pathways; and for each exposure pathway, the results are summed across all COCs.

For multiple pathway exposures, the total COC excess cancer risk is conservatively estimated by summing the excess cancer risks for all exposure pathways for each COC, using the following additive equation:

$$\text{Multiple Pathway Risk}_{COC} = \Sigma\ \text{Risk}_i \qquad (19\text{-}24)$$

where

Risk_{COC} = Total COC excess cancer risk from multiple pathways; and,
Risk_i = Excess cancer risk for the ith pathway for a COC.

For multiple COC exposures, the total pathway excess cancer risk is conservatively estimated by summing the excess cancer risks for all COCs for each pathway, using the following additive equation (EPA, 1989d):

$$\text{Multiple Substance Risk}_P = \Sigma\ \text{Risk}_i \qquad (19\text{-}25)$$

where

Risk_P = Total pathway excess cancer risk from multiple substances; and,
Risk_i = Excess cancer risk for the ith COC for pathway p.

The additive model is based on the assumption that the chemicals being considered independently have the same mode of action and elicit the same effects. Although the additive model has been shown to predict the acute toxicities of many mixtures of similar and dissimilar chemicals (U.S. Council on Environmental Quality, 1989), it can lead to substantial errors in risk estimates if synergistic or antagonistic interactions occur. For carcinogenic effects, the total excess cancer risk estimate might become artificially conservative because the upper 95th percentile slope factors are not strictly additive. Also, the above equation sums all carcinogens with different weight-of-evidence and tumor sites equally.

Finally, lifetime excess cancer risks from all pathways and all COCs are assumed to be additive, as indicated in the following equation (EPA, 1989a):

$$\text{Total Exposure Risk} = \Sigma\ \text{Risk}_p \qquad (19\text{-}26)$$

The sum of all cancer risks for all potential pathways of concern and for all COCs provides an additional step of conservatism in the preliminary risk assessment process (EPA, 1989a).

The acceptable excess cancer risk range for regulatory purposes ranges between 10^{-4} and 10^{-6} (EPA, 1990a; EPA, 1991c). Depending on the nature and type of regulatory program under which work is being conducted, and on site-specific exposures and conditions, cleanup goals and/or treatment standards will be set towards one end or the other of the range. For instance, risk management decisions made under RCRA programs generally are concerned with risk in the 10^{-4} range; under Clean Water Act programs, with risk in the 10^{-5} range; and under Safe

Drinking Water Act programs, with risk in the 10^{-6} range. The use of risk assessment results by the EPA in supporting risk management decisions and developing remedial alternatives can be summarized by the following (EPA, 1991c):

- Where the cumulative carcinogenic risk to an individual based on an RME for both current and future land use is less than 10^{-4} and the noncarcinogenic hazard index is less than 1, action generally is not warranted unless there are adverse environmental impacts.

- Records of Decision for remedial actions taken at sites posing risks within the 10^{-4} to 10^{-6} risk range must explain why remedial action is warranted.

- The upper boundary of the risk range is not a discrete line at 10^{-4}, although EPA generally uses 10^{-4} in making risk management decisions. In certain cases EPA may consider risk estimates slightly greater than 10^{-4} to be protective.

The acceptable excess cancer risk range of 10^{-4} to 10^{-6} for regulatory purposes is consistent with study results (Travis, 1987). The study examined 132 regulatory decisions and found that population sizes had an influence on regulatory decisions regarding trigger levels of excess cancer risk. It found that for small population sizes, regulatory actions were taken when the excess cancer risk is about 4×10^{-3} and higher, but were never taken for risk less than 1×10^{-4}, which is similar to EPA guidance for typical Superfund sites where small populations are potentially exposed (EPA, 1991c). For large population sizes (such as the entire U.S. population), regulatory actions were always taken when the excess cancer risk is about 3×10^{-4} or higher, with 10^{-6} used as a point of departure.

The acceptable excess cancer risk range of 10^{-4} to 10^{-6} for regulatory purposes is also lower than the lifetime fatal risks due to home accidents (8×10^{-3} or 8E-03) in the United States, based on the 1975 U.S. Bureau of the Census (Crouch and Wilson, 1982). These home accidents include some proportion of seven risks: falls (4E-03), drowning (3E-03), fires (2E-03), inhalation and ingestion of objects (1E-03), firearms (7E-04), accidental poisoning (5E-04), and electrocution (4E-04) (Crouch and Wilson, 1982). Due to the conservativeness of current cancer risk assessment methodologies, the estimated risks associated with exposure to COCs may even be zero (EPA, 1989a; Kostecki and others, 1993).

19.5.2 Noncancer Hazard Index Estimation

To assess the potential adverse noncarcinogenic effects resulting from exposure to COCs, the pathway-specific dose is compared with the appropriate RfD to arrive at a ratio called the hazard index (HI) (EPA, 1989a):

$$\text{Hazard Index (HI)} = \text{Dose}_{nc} / \text{RfD} \qquad (19\text{-}27)$$

where:

HI	=	Noncancer hazard index;
Dose_{nc}	=	For each COC, the noncarcinogenic daily dose due to a particular exposure pathway (mg/kg/day). Exposure doses under the baseline scenario for each RAA are presented in Tables 19-26 through 19-37; and,
RfD	=	Chronic reference dose (mg/kg/day), as obtained from Table 19-69.

This equation was used to estimate the hazard index for each RAA/receptor combination from each COC and each pathway. As with the case of carcinogenic effects, the potential additivity of noncarcinogenic hazard due to exposure to multiple substances over multiple exposure pathways is quantified as the sum of all possible chemical-specific hazard indices (EPA, 1989a):

$$\text{Total Noncarcinogenic Risk} = \Sigma \text{ HI} \qquad (19\text{-}28)$$

Usually, if the HI is greater than unity or one, meaning the exposure level exceeds the threshold RfD, a potential for adverse noncarcinogenic health effects may exist. If the HI is equal to or less than one, exposures to the COCs are not expected to result in a systemic toxic response. As the frequency of exposures exceeding the RfD increases and the size of the excess increases, the probability for adverse effects also increases. However, a clear distinction that could categorize all exposures below the RfD as "acceptable" (risk-free) and all exposures in excess of the RfD as "unacceptable" (causing adverse effects) cannot be made (EPA, 1991d, 1992d). Note that HIs are not statistical probabilities, such as excess cancer risks, and the level of concern does not increase linearly as the RfD is approached or exceeded. For regulatory purposes, an HI of one or less is considered to be an acceptable noncarcinogenic risk level (EPA, 1989a, 1990a, 1991c). If the pathway-specific or total exposure HI is greater than one, segregation of the HI, based on the type of effects or mechanisms, may have to be considered (EPA, 1989a).

19.5.3 Results and Discussion

For each RAA/receptor combination, carcinogenic risks and noncarcinogenic hazard indices were estimated for each exposure pathway and COC using the exposure doses estimated in Section 19.3.2.4 in conjunction with the risk characterization methods described above. This section summarizes and discusses the results for each of the Risk Assessment Areas.

19.5.3.1 Risk Assessment Area 1

The carcinogenic COCs identified for this RAA were methylene chloride, tetrachloroethene, arsenic, chromium, and nickel. The cancer risks for each of the receptors are presented in Tables 19-71 through 19-73. The carcinogenic risk for each of the receptors evaluated were within the EPA's target risk range of 10^{-4} to 10^{-6}. Onsite workers have the greatest estimated cancer risk among the receptors, at 4×10^{-5}. The greatest contribution to the cancer risk for onsite workers is derived from chromium exposure through the inhalation pathway (3×10^{-5}), followed by the dust inhalation (5×10^{-6}), soil ingestion (1×10^{-6}), and dermal absorption of arsenic (1×10^{-6}). The toxicity values for chromium assumed that the COC was present in its hexavalent (VI) form. However, if the chromium were present in its trivalent (III) form, the carcinogenic risk would not be quantifiable due to the lack of toxicity data for trivalent chromium.

Offsite resident receptors have a cancer risk of 1×10^{-6}, with the greatest contribution being derived from the ingestion and dermal absorption of arsenic in deposited soils. Offsite sensitive receptors have a cancer risk of 2×10^{-6}, also with the greatest contribution being derived from the ingestion and dermal absorption of arsenic in deposited soils.

Noncancer hazard indices were calculated for each of the COCs identified: toluene, xylenes, TCA, acetone, methylene chloride, tetrachloroethene, arsenic, barium, chromium, nickel, and silver. The risk characterization for lead is discussed in Section 19.5.6. The hazard indices for each of the receptors are presented in Tables 19-74 through 19-76. The hazard index for each of the receptors evaluated did not exceed EPA's "level of concern" of unity (1.0) for noncarcinogenic effects. Onsite workers have the greatest estimated hazard index among the receptors, at 6.1×10^{-1}. Offsite resident receptors have a hazard index of 2.6×10^{-2}. Offsite sensitive receptors have a hazard index of 9.5×10^{-2}.

19.5.3.2 Risk Assessment Area 2

The carcinogenic COCs identified for this RAA were methylene chloride and nickel. The cancer risks for each of the receptors are presented in Tables 19-77 through 19-79. The carcinogenic risk for each of the receptors evaluated were less than the EPA's target risk range of 10^{-4} to 10^{-6}. Onsite workers have the greatest estimated cancer risk among the receptors, at 3×10^{-7}. Offsite resident receptors have a cancer risk of 2×10^{-11}, while offsite sensitive receptors have a cancer risk of 2×10^{-11}.

Noncancer hazard indices were calculated for each of the COCs identified: toluene, ethylbenzene, xylenes, acetone, methylene chloride, barium, nickel, and vanadium. The hazard indices for each of the receptors are presented in Tables 19-80 through 19-82. The total hazard index for each of the receptors evaluated did not exceed EPA's "level of concern" of unity (1.0) for noncarcinogenic effects. Onsite workers have the greatest estimated hazard index among the receptors, at 9.4×10^{-2}. Offsite resident receptors have a hazard index of 3.8×10^{-5}, while offsite sensitive receptors have a total hazard index of 1.8×10^{-4}.

19.5.3.3 Risk Assessment Area 3

The carcinogenic COCs identified for this RAA were beryllium and nickel. The cancer risks for each of the receptors are presented in Tables 19-83 through 19-85. The carcinogenic risk for each of the receptors evaluated was less than the EPA's target risk range of 10^{-4} to 10^{-6}. Onsite workers have the greatest estimated cancer risk among all the receptors, at 9×10^{-7}. Offsite resident receptors have a cancer risk of 6×10^{-10}, while offsite sensitive receptors have a cancer risk of 9×10^{-10}.

Noncancer hazard indices were calculated for each of the COCs identified: barium, beryllium, manganese, nickel, silver, and zinc. The risk characterization for lead is discussed in Section 19.5.6. The hazard indices for each of the receptors are presented in Tables 19-86 through 19-88. The total hazard index for each of the receptors evaluated did not exceed EPA's "level of concern" of unity (1.0) for noncarcinogenic effects. Onsite workers have the greatest estimated hazard index among the receptors, at 2.3×10^{-1}. Offsite resident receptors have a hazard index of 1.3×10^{-4}, while offsite sensitive receptors have a hazard index of 6.3×10^{-4}.

19.5.3.4 Risk Assessment Area 4

The carcinogenic COCs identified for this RAA included nickel, which was the only COC identified for this RAA. The cancer risk for each of the receptors are presented in Tables 19-89 through 19-91. The carcinogenic risk for each of the receptors evaluated was less than the

EPA's target risk range of 10^{-4} to 10^{-6}. Onsite workers have the greatest estimated cancer risk among the receptors, at 2×10^{-7}. Offsite resident receptors have a cancer risk of 2×10^{-11}, while offsite sensitive receptors also have a cancer risk of 2×10^{-11}.

Noncancer hazard indices were calculated for nickel. The hazard indices for each of the receptors are presented in Tables 19-92 through 19-94. The total hazard index for each of the receptors evaluated did not exceed EPA's "level of concern" of unity (1.0) for noncarcinogenic effects. Onsite workers have the greatest estimated hazard index among the receptors, at 3.2×10^{-4}. Offsite resident receptors have a hazard index of 2.6×10^{-8}, while offsite sensitive receptors have a hazard index of 1.9×10^{-7}.

19.5.4 Summary of Results for the Baseline Scenario

A summary of the cancer risk results for the baseline scenario, by RAA/receptor combination, is presented below.

	Cancer Risk From All Pathways		
Risk Assessment Area	Onsite Worker	Offsite Residential Receptor	Offsite Sensitive Receptor
RAA#1	4×10^{-5}	1×10^{-6}	2×10^{-6}
RAA#2	3×10^{-7}	2×10^{-11}	2×10^{-11}
RAA#3	9×10^{-7}	6×10^{-10}	9×10^{-10}
RAA#4	2×10^{-7}	2×10^{-11}	2×10^{-11}

For regulatory purposes, the acceptable excess cancer risk range is considered to be 10^{-4} to 10^{-6} (see Section 19.5.1). The cancer risks for the three receptors for RAA#1 were all within this range, while the cancer risk for other RAA/receptor combinations were all lower than 10^{-6}. Therefore, all the excess cancer risks were within or below the acceptable excess cancer risk range.

A summary of the noncancer hazard index results for the baseline scenario, by RAA/receptor combination, is presented below.

	Noncancer Hazard Index From All Pathways		
Risk Assessment Area	Onsite Worker	Offsite Residential Receptor	Offsite Sensitive Receptor
RAA#1	6.1×10^{-1}	2.6×10^{-2}	9.5×10^{-2}
RAA#2	9.4×10^{-2}	3.8×10^{-5}	1.8×10^{-4}
RAA#3	2.3×10^{-1}	1.3×10^{-4}	6.3×10^{-4}
RAA#4	3.2×10^{-4}	2.6×10^{-8}	1.9×10^{-7}

For regulatory purposes, a noncancer hazard index of one or less is considered to be an acceptable noncarcinogenic risk level (see Section 19.5.2). The maximum noncancer hazard index calculated was 6.1×10^{-1} for the onsite worker for RAA#1. Therefore, all the noncancer hazard indices calculated were below the acceptable noncarcinogenic risk level.

19.5.5 Uncertainties and Limitations

This section discusses the uncertainties and limitations associated with the risk characterization of COCs identified at Cannon AFB. A source of uncertainty involves the additivity of cancer risks and noncancer hazard indices. Synergistic effects are those in which the net effect of the simultaneous action of two or more COCs is greater than the sum of their individual effects. Antagonistic effects are those in which the net effect of exposure to two or more COCs is less than the sum of their individual effects. Data concerning combined effects of complex mixtures of chemicals are generally limited. In the absence of such data, the approach recommended by EPA for evaluating the health risks of chemical mixtures assumes risk additivity. This approach does not account for potential synergism, antagonism, or differences in target organ specificity and mechanism of action. This approach may overestimate or underestimate the potential human health risks.

The uncertainties and limitations associated with the estimation of cancer risk and noncancer hazard indices for COCs depends on the propagation of previously discussed uncertainties and limitations. To minimize the consequences of uncertainty, this HRA relied on EPA guidance, which incorporated the use of conservative estimates in each step of the risk assessment process. The overall result is that risk estimates presented in this HRA are much more likely to overestimate the potential risk rather than to underestimate it.

19.5.6 Lead Risk Analysis

This section presents the estimation of blood lead concentrations due to chronic exposure to lead. Chronic lead exposure can be quantitatively evaluated using available modeling tools. Currently the only model recommended by the United States Environmental Protection Agency (EPA) for the quantification of lead exposure is the Uptake/Biokinetic (UBK) model. Therefore, the UBK modeling approach was used to evaluate site-specific lead concentrations.

The following section provides a brief description of the UBK model, presents model input parameters, discusses the modeling results, and evaluates uncertainties and limitations associated with using the UBK model. However, prior to discussing modeling methods and results it is imperative to review and understand the regulatory issues surrounding risks associated with lead exposure.

19.5.6.1 Regulatory Issues

The EPA advocates use of the UBK model to "provide a strong scientific basis for choosing a soil cleanup level for a specific RCRA/CERCLA site." Using a series of assumptions, the UBK model estimates the blood-lead concentration of a sensitive child receptor associated with a site-specific soil lead concentration. From a human health risk point of view, children are

considered more sensitive to lead exposure than adults. In other words, children exposed to a particular lead concentration are more likely to develop adverse noncancer health effects than adults exposed to the same lead concentration. Thus, although the UBK model specifically calculates only blood-lead concentrations for child receptors, blood-lead concentrations calculated using the model can also be applied to adult receptors for purposes of conservatism.

The United States Department of Health and Human Services Center for Disease Control has established a blood lead concentration of concern in children of 10 micrograms per deciliter (μg/dL) (CDC, 1991). In addition, the USEPA Office of Solid Waste and Emergency Response (OSWER) in its 1991 progress memo recommended a benchmark be set at a 95% probability of an individual having a blood-lead concentration below the concentration of concern, or 95% of the sensitive population having blood-lead concentrations below the concentration of concern. This was consistent with EPA's agency-wide lead strategy. UBK modeling was used to generate blood-lead concentrations in child receptors based on the baseline scenario exposure conditions; these concentrations were then compared to the established standard of 10 μg/dL.

19.5.6.2 Model Description

The UBK model calculates the steady-state blood lead concentration for children living in residential areas arising from chronic lead exposure (EPA, 1991e). It is based on a simplified model describing the intake, distribution, and excretion of lead throughout a child's bodily organs and systems (herein referred to as biological compartments). For a child, the intake of lead is most likely to occur through either ingestion or inhalation. The dermal absorption of lead was not accounted for in the UBK model because dermal absorption is not considered a significant source of exposure (EPA, 1991e). The lead absorption mechanism for ingestion and inhalation according to the UBK model is described below.

Ingestion

The distribution of lead within biological compartments is shown for the ingestion pathway in Figure 19-1. Once ingested, lead goes directly to the gastro-intestinal (GI) tract. In the GI tract, a portion of the lead ingested is excreted as solid waste and is never absorbed by the body. The remainder (herein referred to as the uptake) is absorbed by the cardiovascular system. Once in the cardiovascular system, a portion of the lead absorbed is excreted as urine. The remainder is distributed to the bones, kidney, and liver. The portion of the lead absorbed by the liver is returned to the GI tract and consequently excreted as solid waste.

Inhalation

Once inhaled, lead goes directly to the lungs. In the lungs, a portion of the lead inhaled is absorbed by the cardiovascular system (the uptake). A portion of the lead uptake is excreted as urine while the remainder is distributed to the bones, kidney, and eventually the liver. From the liver the lead is returned to the GI tract in a manner identical to that described above.

The UBK model essentially determines the accumulation of lead in a population of children based on rates of intake, uptake, distribution, and excretion. The model assumes that

distribution of lead throughout the various biological compartments (the GI tract, cardiovascular system, liver, kidney, and bones) can be described by first-order, steady state Michaelis-Menton enzyme-kinetics. Steady state rate constants for the distribution of lead between each biological compartment are depicted in Figure 19-1. The reaction rate constants K_{xy} refer to the exchange of lead between biological compartments due to absorption/desorption mechanisms. For example, K_{12} represents the absorption rate constant for lead absorption from the blood compartment (1) to the bone compartment (2). The rate constants shown in the figure are applicable only to 2-year old children; compartment-specific reaction rate constants will change with a child's age. In the model, the reaction rates are coupled with lead exposure assumptions and concentrations and a variety of physiological factors to estimate a distribution of blood-lead concentrations in a population of children.

19.5.6.3 Model Input

Rates of distribution among the biological compartments and rates of excretion are fixed by the UBK model. The only input variables for the model are the lead uptakes through various exposure pathways. Once the total lead uptake is determined by the model from these inputs, the resulting distribution of blood-lead concentrations in the biological compartments is estimated.

Lead uptake through the following exposure pathways was considered: air, food, dust and soils, and drinking water. Source-specific exposure assumptions were then combined with source-specific exposure concentrations to estimate the total lead intake. In addition, fetal intake from the mother was considered for an added layer of conservatism. Total lead intake was combined with gastro-intestinal or respiratory absorption rates to determine total lead uptake. Thus, input parameters required by the UBK model consist of source-specific exposure assumptions, source-specific exposure concentrations, and gastro-intestinal and respiratory absorption rates. Input parameters assumed for the purposes of this HRA are presented in Table 19-95.

In this HRA, two sets of exposure assumptions were used to estimate blood-lead concentrations. First, blood-lead concentrations were estimated using default exposure assumptions and concentrations representative of national background conditions. Blood-lead concentrations were also estimated using exposure assumptions and concentrations representative of site conditions. Both sets of results were compared to the EPA level of concern of 10 μg/dL. The site-specific baseline scenarios investigated included those for RAA#1 and RAA#3, which were the only two RAAs at which lead was a COC.

The default values representative of national background conditions and the site-specific values for each input parameter for RAAs #1 and #3 are presented in Table 19-95. If a site-specific value for a particular input parameter was not available, the default value was used. Exposure to airborne lead was adjusted for the time spent indoors versus time spent outdoors and for the different sizes of airborne particulates likely to be present indoor and outdoor. Age-specific inhalation and ingestion rates were used, as were dietary, soil, and dust intakes of lead, which included the potential for pica.

19.5.6.4 Model Results

For the UBK model default values, the log-normal distribution of blood lead concentrations is presented in Figure 19-2. This background distribution is compared to the blood-lead concentration of concern of 10 μg/dL. A small portion of the background distribution exceeds the concentration of concern and thus extends to the right of 10 μg/dL. The area underneath that portion of the distribution extending to the right of 10 μg/dL represents the percentage of children that may have blood lead concentrations greater than 10 μg/dL. The larger the area underneath the portion of the distribution extending to the right of 10 μg/dL, the higher the percentage of children with blood lead concentrations greater than 10 μg/dL. Based on the UBK results using the standard default values, approximately 0.06% of the population of children chronically exposed to lead at the national background conditions will have blood lead concentrations above 10 μg/dL.

For the site-specific conditions of the RAA#1 and #3 baseline scenarios, the probability density distributions were calculated for blood-lead concentrations of child receptors. These distributions are presented in Figures 19-3 and 19-4, respectively. Both distributions lie completely to the left of the concentration of concern of 10 μg/dL. In other words, based on the site-specific conditions of the RAA #1 and #3 baseline scenarios, zero percent of the child receptors chronically exposed to these conditions would have blood lead concentrations above the concentration of concern of 10 μg/dL.

19.5.6.5 Uncertainties and Limitations

The UBK modeling approach recommended by the EPA is consistent with the current physiological and behavioral understanding of the effects of exposure of lead at doses below 30 micrograms of lead per deciliter of blood. There are, however, several uncertainties that must be kept in mind during the course of risk assessment of lead exposure.

There is a multiplicity of potential adverse health effects that range from neurologic to behavioral. It would be more appropriate and precise to account for each independently in this analysis. In addition, the overall treatment of the uncertainty is merely understood to be data-based where the log-normal distribution at the output is assumed to sufficiently characterize the overall uncertainty. It would be preferable to account for the uncertainty in the data inputs and the intermediate input to output calculations throughout the model. The convolution of the data distribution would provide the overall expression of the data-related uncertainty in the output.

The basis for the mechanistic aspects of the fate of lead in the human body is principally governed by linearity. Physiological effects of lead exposure are treated qualitatively. It is difficult to precisely ascertain whether linearity, and thus the superimposition of linear effects, is biologically sound or whether linearity is more likely to be the result of simplifying assumptions. Whether there is a threshold, or the model is non-linear, is crucial. It is surprising that the potential for non-linearity is subsumed into a threshold when a less dramatic assumption may still reduce the risk considerably, particularly if non-linearity is pronounced. Similarly, the assumption of Michaelis-Menton kinetics are a simplification of pharmaco-kinetic

and pharmaco-dynamic transformations. This simplification may also tend to be conservative by an unknown amount, particularly when the dynamic system contains variables (rates) that evolve at different velocities.

A compartmental model is based on the assumption that the concentration in each compartment is homogenous and can be described by a single number. Thus the distribution of the compartmental concentrations can be described by ordinary differential equations (lumped parameter models). However, in physiological systems, the distribution of a chemical (measured by a concentration) can affect the dynamic uptake, storage, and excretion and transfer to another compartment, particularly at low dose. The approximations of the compartmental model may produce modeling uncertainties that are not well characterized.

In general the experience of practical applications of the UBK model are based on default values (EPA, 1992e). However, health risk from lead exposure can be calculated using site-specific data. For example, in California the state requires the use of site-specific data and the acceptable blood lead concentration is that associated with the 99th percentile of the log-normal distribution. The use of a log-normal distribution depends on whether the log-normal plot of the data are linear and the size of the sample population is large.

Finally, it should be noted that EPA suggests that the analyses performed using the UBK model "may underpredict the highest level expected to occur in an exposed population." (EPA, 1991e).

19.5.6.6 Summary of UBK Modeling Results

The UBK model was selected to estimate the blood-lead concentrations associated with site-specific exposures. The resulting mean blood-lead concentrations were below the 10 μg/dL level of concern. Additionally, the resulting distribution curves showed that zero percent of the potentially exposed child population would exhibit blood-lead concentrations exceeding the level of concern. These results were based on site-specific contributions to lead exposure versus a general significance level where 95% of population fall below the level of concern. In other words, zero percent of the child population considered in the UBK model were at risk of developing noncancer lead-related adverse health effects at the 95% significance level. These results can be conservatively assumed to represent the adult receptors as well, since adult lead exposure is postulated to be lower than exposure in children. Finally, a qualitative uncertainty analysis showed that simplifications and approximations of the model may produce uncertainties that are not well characterized.

Table 19-71

CANCER RISK FROM ALL PATHWAYS

BASELINE SCENARIO
RAA #1

ONSITE WORKER

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total Cancer Risk by Chemical (unitless)
	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	
Non-BTEX TCL VOCs										
Methylene Chloride	1.0E-09	7.5E-03	8E-12	7.3E-09	7.5E-03	5E-11	1.1E-05	1.7E-03	2E-08	2E-08
Tetrachloroethene	2.4E-09	5.2E-02	1E-10	1.7E-08	5.2E-02	9E-10	1.1E-05	2.0E-03	2E-08	2E-08
Metals										
Arsenic	7.2E-07	1.8E+00	1E-06	5.0E-07	1.9E+00	1E-06	3.5E-07	1.5E+01	5E-06	8E-06
Chromium	1.6E-06	NA	NA	1.1E-06	NA	NA	7.6E-07	4.1E+01	3E-05	3E-05
Nickel	1.3E-06	NA	NA	9.1E-07	NA	NA	6.4E-07	8.4E-01	5E-07	5E-07
Total Cancer Risk by Pathway (unitless)			1E-06			1E-06			4E-05	4E-05

Notes:
(1) Carcinogenic doses were obtained from Table 19-26.
(2) CSFs were obtained from Table 19-69.
(3) Cancer risks calculated using Equation 19-23.
"NA" means CSF not available from EPA sources, therefore the cancer risk was not calculated.

Table 19-72

CANCER RISK FROM ALL PATHWAYS

BASELINE SCENARIO
RAA #1

OFFSITE RESIDENTIAL RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total Cancer Risk by Chemical (unitless)
	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	
Metals										
Arsenic	4.9E-07	1.8E+00	9E-07	1.7E-07	1.9E+00	3E-07	3.4E-10	1.5E+01	5E-09	1E-06
Chromium	1.1E-06	NA	NA	3.7E-07	NA	NA	7.4E-10	4.1E+01	3E-08	3E-08
Nickel	9.0E-07	NA	NA	3.1E-07	NA	NA	6.2E-10	8.4E-01	5E-10	5E-10
Total Cancer Risk by Pathway (unitless)			9E-07			3E-07			4E-08	**1E-06**

Notes:
(1) Carcinogenic doses were obtained from Table 19-27.
(2) CSFs were obtained from Table 19-69.
(3) Cancer risks calculated using Equation 19-23.
"NA" means CSF not available from EPA sources, therefore the cancer risk was not calculated.

Table 19-73

CANCER RISK FROM ALL PATHWAYS

BASELINE SCENARIO
RAA #1

OFFSITE SENSITIVE RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total Cancer Risk by Chemical (unitless)
	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	
Metals										
Arsenic	9.2E-07	1.8E+00	2E-06	6.3E-08	1.9E+00	1E-07	3.2E-10	1.5E+01	5E-09	2E-06
Chromium	2.0E-06	NA	NA	1.4E-07	NA	NA	6.9E-10	4.1E+01	3E-08	3E-08
Nickel	1.7E-06	NA	NA	1.2E-07	NA	NA	5.8E-10	8.4E-01	5E-10	5E-10
Total Cancer Risk by Pathway (unitless)			2E-06			1E-07			3E-08	**2E-06**

Notes:
(1) Carcinogenic doses were obtained from Table 19-28.
(2) CSFs were obtained from Table 19-69.
(3) Cancer risks calculated using Equation 19-23.
"NA" means CSF not available from EPA sources, therefore the cancer risk was not calculated.

Table 19-74

NONCANCER HAZARD INDEX FROM ALL PATHWAYS

BASELINE SCENARIO
RAA #1

ONSITE WORKER

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total HI by Chemical (unitless)
	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	
BTEX										
Toluene	2.1E-08	2.0E-01	1.1E-07	1.5E-07	2.0E-01	7.5E-07	4.3E-05	1.1E-01	3.9E-04	3.9E-04
Xylenes	2.5E-08	2.0E+00	1.3E-08	1.8E-07	2.0E+00	9.0E-08	4.4E-05	NA	NA	1.0E-07
Non-BTEX TCL VOCs										
1,1,1-Trichloroethane	3.9E-09	9.0E-02	4.3E-08	2.7E-08	9.0E-02	3.0E-07	1.6E-05	NA	NA	3.4E-07
Acetone	1.2E-07	1.0E-01	1.2E-06	8.5E-07	1.0E-01	8.5E-06	8.3E-04	NA	NA	9.7E-06
Methylene Chloride	2.9E-09	6.0E-02	4.8E-08	2.0E-08	6.0E-02	3.3E-07	3.0E-05	8.6E-01	3.5E-05	3.5E-05
Tetrachloroethene	6.8E-09	1.0E-02	6.8E-07	4.8E-08	1.0E-02	4.8E-06	3.1E-05	NA	NA	5.5E-06
Metals										
Arsenic	2.0E-06	3.0E-04	6.7E-03	1.4E-06	2.8E-04	5.0E-03	9.8E-07	NA	NA	1.2E-02
Barium	1.5E-04	7.0E-02	2.1E-03	1.1E-04	7.0E-02	1.6E-03	7.5E-05	1.4E-04	5.4E-01	5.4E-01
Chromium	4.4E-06	5.0E-03	8.8E-04	3.0E-06	5.0E-05	6.0E-02	2.1E-06	NA	NA	6.1E-02
Lead (4)	5.5E-06	NA	NA	3.8E-06	NA	NA	2.7E-06	NA	NA	NA
Nickel	3.7E-06	2.0E-02	1.9E-04	2.6E-06	2.0E-02	1.3E-04	1.8E-06	NA	NA	3.2E-04
Silver	2.8E-06	5.0E-03	5.6E-04	2.0E-06	5.0E-03	4.0E-04	1.4E-06	NA	NA	9.6E-04
Total HI by Pathway (unitless)			1.0E-02			6.7E-02			5.4E-01	**6.1E-01**

Notes:
(1) Noncarcinogenic doses were obtained from Table 19-26.
(2) RfDs were obtained from Table 19-69
(3) Noncancer hazard indices calculated using Equation 19-27.
(4) Risk characterization for lead was evaluated using the EPA recommended Uptake/Biokinetic (UBK) modeling approach.
"NA" means RfD not available from EPA sources, therefore the hazard index was not calculated.

Table 19-75

NONCANCER HAZARD INDEX FROM ALL PATHWAYS

BASELINE SCENARIO
RAA #1

OFFSITE RESIDENTIAL RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total HI by Chemical (unitless)
	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	
Metals										
Arsenic	1.2E-06	3.0E-04	4.0E-03	4.0E-07	2.8E-04	1.4E-03	7.9E-10	NA	NA	5.4E-03
Barium	8.8E-05	7.0E-02	1.3E-03	3.0E-05	7.0E-02	4.3E-04	6.0E-08	1.4E-04	4.3E-04	2.1E-03
Chromium	2.5E-06	5.0E-03	5.0E-04	8.7E-07	5.0E-05	1.7E-02	1.7E-09	NA	NA	1.8E-02
Lead (4)	3.2E-06	NA	NA	1.1E-06	NA	NA	2.2E-09	NA	NA	NA
Nickel	2.1E-06	2.0E-02	1.1E-04	7.3E-07	2.0E-02	3.7E-05	1.5E-09	NA	NA	1.4E-04
Silver	1.6E-06	5.0E-03	3.2E-04	5.7E-07	5.0E-03	1.1E-04	1.1E-09	NA	NA	4.3E-04
Total HI by Pathway (unitless)			6.2E-03			1.9E-02			4.3E-04	**2.6E-02**

Notes:
(1) Noncarcinogenic doses were obtained from Table 19-27.
(2) RfDs were obtained from Table 19-69
(3) Noncancer hazard indices calculated using Equation 19-27.
(4) Risk characterization for lead was evaluated using the EPA recommended Uptake/Biokinetic (UBK) modeling approach.
"NA" means RfD not available from EPA sources, therefore the hazard index was not calculated.

Table 19-76

NONCANCER HAZARD INDEX FROM ALL PATHWAYS

BASELINE SCENARIO
RAA #1

OFFSITE SENSITIVE RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total HI by Chemical (unitless)
	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	
Metals										
Arsenic	1.1E-05	3.0E-04	3.7E-02	7.4E-07	2.8E-04	2.6E-03	3.7E-09	NA	NA	3.9E-02
Barium	8.2E-04	7.0E-02	1.2E-02	5.6E-05	7.0E-02	8.0E-04	2.8E-07	1.4E-04	2.0E-03	1.5E-02
Chromium	2.3E-05	5.0E-03	4.6E-03	1.6E-06	5.0E-05	3.2E-02	8.0E-09	NA	NA	3.7E-02
Lead (4)	3.0E-05	NA	NA	2.0E-06	NA	NA	1.0E-08	NA	NA	NA
Nickel	2.0E-05	2.0E-02	1.0E-03	1.4E-06	2.0E-02	7.0E-05	6.8E-09	NA	NA	1.1E-03
Silver	1.5E-05	5.0E-03	3.0E-03	1.0E-06	5.0E-03	2.0E-04	5.2E-09	NA	NA	3.2E-03
Total HI by Pathway (unitless)			5.7E-02			3.6E-02			2.0E-03	**9.5E-02**

Notes:
(1) Noncarcinogenic doses were obtained from Table 19-28.
(2) RfDs were obtained from Table 19-69
(3) Noncancer hazard indices calculated using Equation 19-27.
(4) Risk characterization for lead was evaluated using the EPA recommended Uptake/Biokinetic (UBK) modeling approach.
"NA" means RfD not available from EPA sources, therefore the hazard index was not calculated.

Table 19-77

CANCER RISK FROM ALL PATHWAYS

BASELINE SCENARIO
RAA #2

ONSITE WORKER

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total Cancer Risk by Chemical (unitless)
	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	
Non-BTEX TCL VOCs										
Methylene Chloride	2.6E-08	7.5E-03	2E-10	1.8E-07	7.5E-03	1E-09	1.6E-04	1.7E-03	3E-07	3E-07
Metals										
Nickel	1.4E-06	NA	NA	9.6E-07	NA	NA	3.8E-08	8.4E-01	3E-08	3E-08
Total Cancer Risk by Pathway (unitless)			2E-10			1E-09			3E-07	3E-07

Notes:
(1) Carcinogenic doses were obtained from Table 19-29.
(2) CSFs were obtained from Table 19-69.
(3) Cancer risks calculated using Equation 19-23.
"NA" means CSF not available from EPA sources, therefore the cancer risk was not calculated.

Table 19-78

CANCER RISK FROM ALL PATHWAYS

BASELINE SCENARIO
RAA #2

OFFSITE RESIDENTIAL RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total Cancer Risk by Chemical (unitless)
	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	
Metals										
Nickel	3.4E-10	NA	NA	1.2E-10	NA	NA	2.2E-11	8.4E-01	2E-11	2E-11
Total Cancer Risk by Pathway (unitless)			0E+00			0E+00			2E-11	**2E-11**

Notes:
(1) Carcinogenic doses were obtained from Table 19-30.
(2) CSFs were obtained from Table 19-69.
(3) Cancer risks calculated using Equation 19-23.
"NA" means CSF not available from EPA sources, therefore the cancer risk was not calculated.

Table 19-79

CANCER RISK FROM ALL PATHWAYS

BASELINE SCENARIO
RAA #2

OFFSITE SENSITIVE RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total Cancer Risk by Chemical (unitless)
	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	
Metals										
Nickel	6.4E-10	NA	NA	4.4E-11	NA	NA	2.1E-11	8.4E-01	2E-11	2E-11
Total Cancer Risk by Pathway (unitless)			0E+00			0E+00			2E-11	**2E-11**

Notes:
(1) Carcinogenic doses were obtained from Table 19-31.
(2) CSFs were obtained from Table 19-69.
(3) Cancer risks calculated using Equation 19-23.
"NA" means CSF not available from EPA sources, therefore the cancer risk was not calculated.

Table 19-80

NONCANCER HAZARD INDEX FROM ALL PATHWAYS

BASELINE SCENARIO
RAA #2

ONSITE WORKER

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total HI by Chemical (unitless)
	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	
BTEX										
Toluene	5.9E-07	2.0E-01	3.0E-06	4.1E-06	2.0E-01	2.1E-05	7.0E-04	1.1E-01	6.4E-03	6.4E-03
Ethylbenzene	2.1E-06	1.0E-01	2.1E-05	1.4E-05	1.0E-01	1.4E-04	1.3E-03	2.9E-01	4.5E-03	4.6E-03
Xylenes	1.6E-05	2.0E+00	8.0E-06	1.1E-04	2.0E+00	5.5E-05	1.6E-02	NA	NA	6.3E-05
Non-BTEX TCL VOCs										
Acetone	5.4E-08	1.0E-01	5.4E-07	3.7E-07	1.0E-01	3.7E-06	2.1E-04	NA	NA	4.2E-06
Methylene Chloride	7.3E-08	6.0E-02	1.2E-06	5.1E-07	6.0E-02	8.5E-06	4.4E-04	8.6E-01	5.1E-04	5.2E-04
Metals										
Barium	3.8E-04	7.0E-02	5.4E-03	2.6E-04	7.0E-02	3.7E-03	1.0E-05	1.4E-04	7.1E-02	8.1E-02
Nickel	3.9E-06	2.0E-02	2.0E-04	2.7E-06	2.0E-02	1.4E-04	1.1E-07	NA	NA	3.3E-04
Vanadium	7.1E-06	7.0E-03	1.0E-03	5.0E-06	7.0E-03	7.1E-04	1.9E-07	NA	NA	1.7E-03
Total HI by Pathway (unitless)			6.7E-03			4.8E-03			8.3E-02	**9.4E-02**

Notes:
(1) Noncarcinogenic doses were obtained from Table 19-29.
(2) RfDs were obtained from Table 19-69
(3) Noncancer hazard indices calculated using Equation 19-27.
"NA" means RfD not available from EPA sources, therefore the hazard index was not calculated.

Table 19-81

NONCANCER HAZARD INDEX FROM ALL PATHWAYS

BASELINE SCENARIO
RAA #2

OFFSITE RESIDENTIAL RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total HI by Chemical (unitless)
	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	
Metals										
Barium	7.8E-08	7.0E-02	1.1E-06	2.7E-08	7.0E-02	3.9E-07	5.0E-09	1.4E-04	3.6E-05	3.7E-05
Nickel	8.0E-10	2.0E-02	4.0E-08	2.8E-10	2.0E-02	1.4E-08	5.2E-11	NA	NA	5.4E-08
Vanadium	1.5E-09	7.0E-03	2.1E-07	5.2E-10	7.0E-03	7.4E-08	9.6E-11	NA	NA	2.9E-07
Total HI by Pathway (unitless)			1.4E-06			4.7E-07			3.6E-05	**3.8E-05**

Notes:
(1) Noncarcinogenic doses were obtained from Table 19-30.
(2) RfDs were obtained from Table 19-69
(3) Noncancer hazard indices calculated using Equation 19-27.
"NA" means RfD not available from EPA sources, therefore the hazard index was not calculated.

Table 19-82

NONCANCER HAZARD INDEX FROM ALL PATHWAYS

BASELINE SCENARIO
RAA #2

OFFSITE SENSITIVE RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total HI by Chemical (unitless)
	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	
Metals										
Barium	7.3E-07	7.0E-02	1.0E-05	5.0E-08	7.0E-02	7.1E-07	2.4E-08	1.4E-04	1.7E-04	1.8E-04
Nickel	7.5E-09	2.0E-02	3.8E-07	5.2E-10	2.0E-02	2.6E-08	2.4E-10	NA	NA	4.0E-07
Vanadium	1.4E-09	7.0E-03	2.0E-07	9.6E-10	7.0E-03	1.4E-07	4.5E-10	NA	NA	3.4E-07
Total HI by Pathway (unitless)			1.1E-05			8.8E-07			1.7E-04	**1.8E-04**

Notes:
(1) Noncarcinogenic doses were obtained from Table 19-31.
(2) RfDs were obtained from Table 19-69
(3) Noncancer hazard indices calculated using Equation 19-27.
"NA" means RfD not available from EPA sources, therefore the hazard index was not calculated.

Table 19-83

CANCER RISK FROM ALL PATHWAYS

BASELINE SCENARIO
RAA #3

ONSITE WORKER

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total Cancer Risk by Chemical (unitless)
	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	
Metals										
Beryllium	1.1E-07	4.3E+00	5E-07	7.4E-08	4.3E+00	3E-07	7.0E-09	8.4E+00	6E-08	9E-07
Nickel	1.6E-06	NA	NA	1.1E-06	NA	NA	1.1E-07	8.4E-01	9E-08	9E-08
Total Cancer Risk by Pathway (unitless)			5E-07			3E-07			2E-07	**9E-07**

Notes:
(1) Carcinogenic doses were obtained from Table 19-32.
(2) CSFs were obtained from Table 19-69.
(3) Cancer risks calculated using Equation 19-23.
"NA" means CSF not available from EPA sources, therefore the cancer risk was not calculated.

Table 19-84

CANCER RISK FROM ALL PATHWAYS

BASELINE SCENARIO
RAA #3

OFFSITE RESIDENTIAL RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total Cancer Risk by Chemical (unitless)
	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	
Metals										
Beryllium	8.9E-11	4.3E+00	4E-10	3.1E-11	4.3E+00	1E-10	4.9E-12	8.4E+00	4E-11	6E-10
Nickel	1.3E-09	NA	NA	4.7E-10	NA	NA	7.3E-11	8.4E-01	6E-11	6E-11
Total Cancer Risk by Pathway (unitless)			4E-10			1E-10			1E-10	**6E-10**

Notes:
(1) Carcinogenic doses were obtained from Table 19-33.
(2) CSFs were obtained from Table 19-69.
(3) Cancer risks calculated using Equation 19-23.
"NA" means CSF not available from EPA sources, therefore the cancer risk was not calculated.

Table 19-85

CANCER RISK FROM ALL PATHWAYS

BASELINE SCENARIO
RAA #3

OFFSITE SENSITIVE RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total Cancer Risk by Chemical (unitless)
	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	
Metals										
Beryllium	1.7E-10	4.3E+00	7E-10	1.1E-11	4.3E+00	5E-11	4.5E-12	8.4E+00	4E-11	8E-10
Nickel	2.5E-09	NA	NA	1.7E-10	NA	NA	6.9E-11	8.4E-01	6E-11	6E-11
Total Cancer Risk by Pathway (unitless)			7E-10			5E-11			1E-10	**9E-10**

Notes:
(1) Carcinogenic doses were obtained from Table 19-34.
(2) CSFs were obtained from Table 19-69.
(3) Cancer risks calculated using Equation 19-23.
"NA" means CSF not available from EPA sources, therefore the cancer risk was not calculated.

Table 19-86

NONCANCER HAZARD INDEX FROM ALL PATHWAYS

BASELINE SCENARIO
RAA #3

ONSITE WORKER

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total HI by Chemical (unitless)
	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	
Metals										
Barium	3.7E-04	7.0E-02	5.3E-03	2.5E-04	7.0E-02	3.6E-03	2.4E-05	1.4E-04	1.7E-01	1.8E-01
Beryllium	3.0E-07	5.0E-03	6.0E-05	2.1E-07	5.0E-03	4.2E-05	2.0E-08	NA	NA	1.0E-04
Lead (4)	7.0E-06	NA	NA	4.9E-06	NA	NA	4.6E-07	NA	NA	0.0E+00
Manganese	7.3E-05	1.4E-01	5.2E-04	5.1E-05	5.6E-03	9.1E-03	4.7E-06	1.1E-04	4.3E-02	5.2E-02
Nickel	4.5E-06	2.0E-02	2.3E-04	3.1E-06	2.0E-02	1.6E-04	2.9E-07	NA	NA	3.8E-04
Silver	1.7E-06	5.0E-03	3.4E-04	1.2E-06	5.0E-03	2.4E-04	1.1E-07	NA	NA	5.8E-04
Zinc	6.7E-05	3.0E-01	2.2E-04	4.7E-05	9.0E-02	5.2E-04	4.4E-06	NA	NA	7.5E-04
Total HI by Pathway (unitless)			6.7E-03			1.4E-02			2.1E-01	**2.3E-01**

Notes:
(1) Noncarcinogenic doses were obtained from Table 19-32.
(2) RfDs were obtained from Table 19-69
(3) Noncancer hazard indices calculated using Equation 19-27.
(4) Risk characterization for lead was evaluated using the EPA recommended Uptake/Biokinetic (UBK) modeling approach.
"NA" means RfD not available from EPA sources, therefore the hazard index was not calculated.

Table 19-87

NONCANCER HAZARD INDEX FROM ALL PATHWAYS

BASELINE SCENARIO
RAA #3

OFFSITE RESIDENTIAL RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total HI by Chemical (unitless)
	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	
Metals										
Barium	2.5E-07	7.0E-02	3.6E-06	8.8E-08	7.0E-02	1.3E-06	1.4E-08	1.4E-04	1.0E-04	1.0E-04
Beryllium	2.1E-10	5.0E-03	4.2E-08	7.2E-11	5.0E-03	1.4E-08	1.1E-11	NA	NA	5.6E-08
Lead (4)	4.9E-09	NA	NA	1.7E-09	NA	NA	2.7E-10	NA	NA	0.0E+00
Manganese	5.0E-08	1.4E-01	3.6E-07	1.8E-08	5.6E-03	3.2E-06	2.8E-09	1.1E-04	2.5E-05	2.9E-05
Nickel	3.1E-09	2.0E-02	1.6E-07	1.1E-09	2.0E-02	5.5E-08	1.7E-10	NA	NA	2.1E-07
Silver	1.2E-09	5.0E-03	2.4E-07	4.0E-10	5.0E-03	8.0E-08	6.3E-11	NA	NA	3.2E-07
Zinc	4.6E-08	3.0E-01	1.5E-07	1.6E-08	9.0E-02	1.8E-07	2.5E-09	NA	NA	3.3E-07
Total HI by Pathway (unitless)			4.5E-06			4.8E-06			1.3E-04	**1.3E-04**

Notes:
(1) Noncarcinogenic doses were obtained from Table 19-33.
(2) RfDs were obtained from Table 19-69
(3) Noncancer hazard indices calculated using Equation 19-27.
(4) Risk characterization for lead was evaluated using the EPA recommended Uptake/Biokinetic (UBK) modeling approach.
"NA" means RfD not available from EPA sources, therefore the hazard index was not calculated.

Table 19-88

NONCANCER HAZARD INDEX FROM ALL PATHWAYS

BASELINE SCENARIO
RAA #3

OFFSITE SENSITIVE RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total HI by Chemical (unitless)
	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	
Metals										
Barium	2.4E-06	7.0E-02	3.4E-05	1.6E-07	7.0E-02	2.3E-06	6.5E-08	1.4E-04	4.6E-04	5.0E-04
Beryllium	1.9E-09	5.0E-03	3.8E-07	1.3E-10	5.0E-03	2.6E-08	5.3E-11	NA	NA	4.1E-07
Lead (4)	4.6E-08	NA	NA	3.1E-09	NA	NA	1.3E-09	NA	NA	0.0E+00
Manganese	4.7E-07	1.4E-01	3.4E-06	3.2E-08	5.6E-03	5.7E-06	1.3E-08	1.1E-04	1.2E-04	1.3E-04
Nickel	2.9E-08	2.0E-02	1.5E-06	2.0E-09	2.0E-02	1.0E-07	8.0E-10	NA	NA	1.6E-06
Silver	1.1E-08	5.0E-03	2.2E-06	7.4E-10	5.0E-03	1.5E-07	3.0E-10	NA	NA	2.3E-06
Zinc	4.3E-07	3.0E-01	1.4E-06	3.0E-08	9.0E-02	3.3E-07	1.2E-08	NA	NA	1.8E-06
Total HI by Pathway (unitless)			4.3E-05			8.6E-06			5.8E-04	**6.3E-04**

Notes:
(1) Noncarcinogenic doses were obtained from Table 19-34.
(2) RfDs were obtained from Table 19-69
(3) Noncancer hazard indices calculated using Equation 19-27.
(4) Risk characterization for lead was evaluated using the EPA recommended Uptake/Biokinetic (UBK) modeling approach.
"NA" means RfD not available from EPA sources, therefore the hazard index was not calculated.

Table 19-89

CANCER RISK FROM ALL PATHWAYS

BASELINE SCENARIO
RAA #4

ONSITE WORKER

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total Cancer Risk by Chemical (unitless)
	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	
Metals										
Nickel	1.3E-06	NA	NA	9.2E-07	NA	NA	1.9E-07	8.4E-01	2E-07	2E-07
Total Cancer Risk by Pathway (unitless)			0E+00			0E+00			2E-07	**2E-07**

Notes:
(1) Carcinogenic doses were obtained from Table 19-35.
(2) CSFs were obtained from Table 19-69.
(3) Cancer risks calculated using Equation 19-23.
"NA" means CSF not available from EPA sources, therefore the cancer risk was not calculated.

Table 19-90

CANCER RISK FROM ALL PATHWAYS

BASELINE SCENARIO
RAA #4

OFFSITE RESIDENTIAL RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total Cancer Risk by Chemical (unitless)
	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	
Metals										
Nickel	1.7E-10	NA	NA	5.8E-11	NA	NA	2.0E-11	8.4E-01	2E-11	2E-11
Total Cancer Risk by Pathway (unitless)			0E+00			0E+00			2E-11	**2E-11**

Notes:
(1) Carcinogenic doses were obtained from Table 19-36.
(2) CSFs were obtained from Table 19-69.
(3) Cancer risks calculated using Equation 19-23.
"NA" means CSF not available from EPA sources, therefore the cancer risk was not calculated.

Table 19-91

CANCER RISK FROM ALL PATHWAYS

BASELINE SCENARIO
RAA #4

OFFSITE SENSITIVE RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total Cancer Risk by Chemical (unitless)
	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	
Metals										
Nickel	3.1E-10	NA	NA	2.1E-11	NA	NA	1.8E-11	8.4E-01	2E-11	2E-11
Total Cancer Risk by Pathway (unitless)			0E+00			0E+00			2E-11	**2E-11**

Notes:
(1) Carcinogenic doses were obtained from Table 19-37.
(2) CSFs were obtained from Table 19-69.
(3) Cancer risks calculated using Equation 19-23.
"NA" means CSF not available from EPA sources, therefore the cancer risk was not calculated.

Table 19-92

NONCANCER HAZARD INDEX FROM ALL PATHWAYS

BASELINE SCENARIO
RAA #4

ONSITE WORKER

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total HI by Chemical (unitless)
	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	
Metals										
Nickel	3.7E-06	2.0E-02	1.9E-04	2.6E-06	2.0E-02	1.3E-04	5.3E-07	NA	NA	3.2E-04
Total HI by Pathway (unitless)			1.9E-04			1.3E-04			0.0E+00	3.2E-04

Notes:
(1) Noncarcinogenic doses were obtained from Table 19-35.
(2) RfDs were obtained from Table 19-69
(3) Noncancer hazard indices calculated using Equation 19-27.
"NA" means RfD not available from EPA sources, therefore the hazard index was not calculated.

Table 19-93

NONCANCER HAZARD INDEX FROM ALL PATHWAYS

BASELINE SCENARIO
RAA #4

OFFSITE RESIDENTIAL RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total HI by Chemical (unitless)
	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	
Metals										
Nickel	3.9E-10	2.0E-02	2.0E-08	1.3E-10	2.0E-02	6.5E-09	2.0E-11	NA	NA	2.6E-08
Total HI by Pathway (unitless)			2.0E-08			6.5E-09			0.0E+00	**2.6E-08**

Notes:
(1) Noncarcinogenic doses were obtained from Table 19-36.
(2) RfDs were obtained from Table 19-69
(3) Noncancer hazard indices calculated using Equation 19-27.
"NA" means RfD not available from EPA sources, therefore the hazard index was not calculated.

Table 19-94

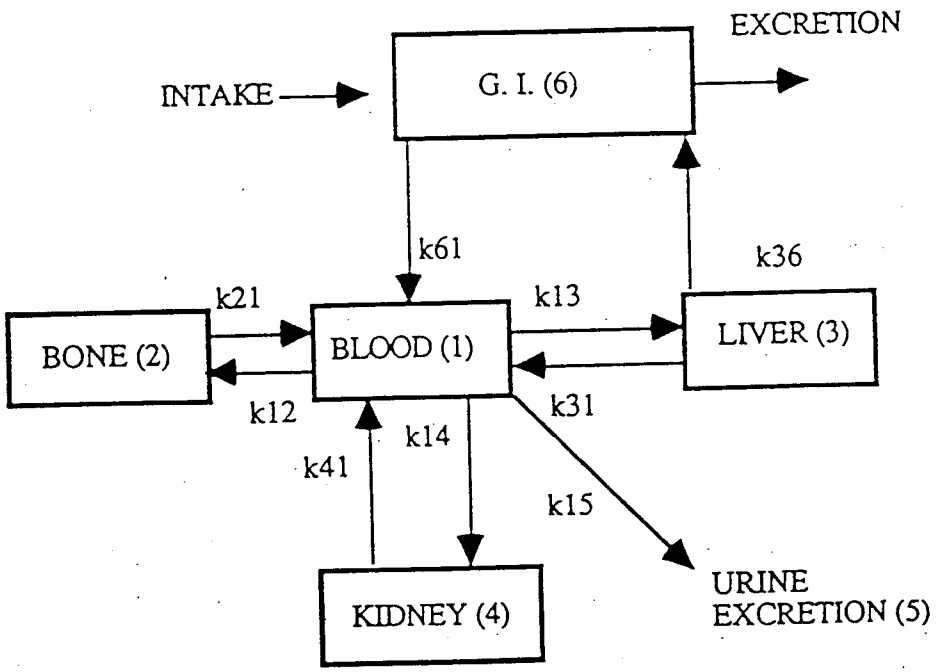
NONCANCER HAZARD INDEX FROM ALL PATHWAYS

BASELINE SCENARIO
RAA #4

OFFSITE SENSITIVE RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total HI by Chemical (unitless)
	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	
Metals										
Nickel	3.6E-09	2.0E-02	1.8E-07	2.5E-10	2.0E-02	1.3E-08	2.1E-10	NA	NA	1.9E-07
Total HI by Pathway (unitless)			1.8E-07			1.3E-08			0.0E+00	**1.9E-07**

Notes:
(1) Noncarcinogenic doses were obtained from Table 19-37.
(2) RfDs were obtained from Table 19-69
(3) Noncancer hazard indices calculated using Equation 19-27.
"NA" means RfD not available from EPA sources, therefore the hazard index was not calculated.



Legend:
G.I. means the gastro-intestinal tract.
Rate constants (1/seconds):

$k_{12} = 0.13$
$k_{21} = 6.11 \times 10^{-4}$
$k_{13} = 0.07$
$k_{31} = 0.03$
$k_{14} = 0.02$
$k_{41} = 0.07$
$k_{15} = 0.08$
$k_{36} = 0.14$
$k_{61} = 0.30$

Source: EPA, 1991

FIGURE 19-1

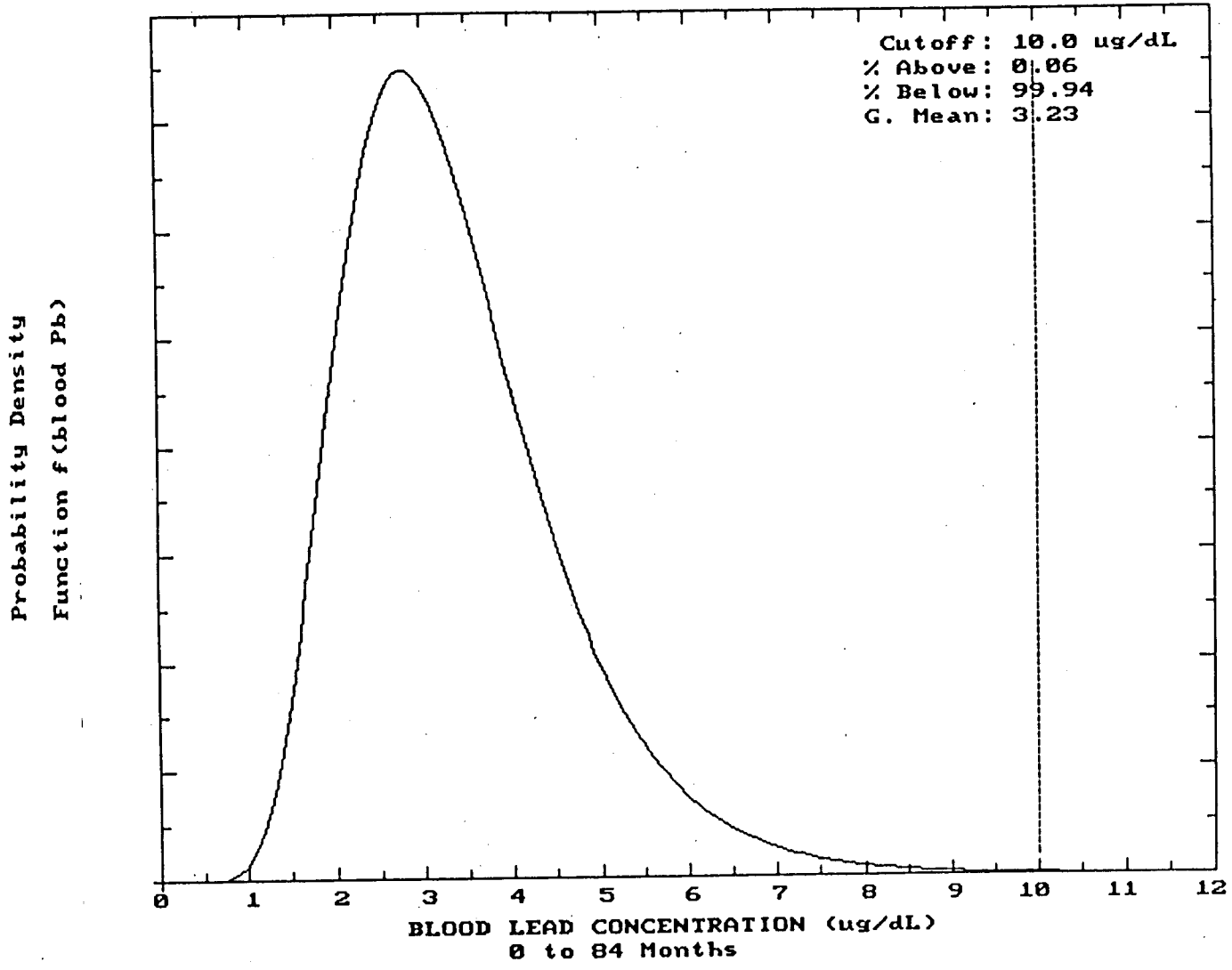
Uptake/Biokinetic Model: Lead Distribution Flow Chart

Table 19-95

UPTAKE/BIOKINETIC (UBK) MODEL INPUT PARAMETERS

Parameter	Units	UBK Model Default Values (1)	Site-Specific Value (2)	
			RAA#1	RAA#3
Air				
Outdoor Air Lead Concentration	µg/m3	2.0E-01	1.4E-02	2.4E-03
Indoor Air Lead Concentration (3)	µg/m3	7.0E-02	4.2E-03	7.2E-04
Time Spent Outdoors	hour/day	3.0	3.0	3.0
Breathing Volume	m3/day	5.0	5.0	5.0
Dietary				
Lead Intake From Diet	µg/day	6.79	0.00 (4)	0.00 (4)
Soil/Dust				
Outdoor Soil Lead Concentration	mg/kg	2.0E+02	1.1E+01	1.4E+01
Indoor Dust Lead Concentration	mg/kg	2.0E+02	1.1E+01	1.4E+01
Daily Soil-Dust Ingestion	mg/day	100	200	200
Weighting Factor (soil/dust)	percent	45/55	45/55	45/55
Gastrointestinal Absorption	percent	30	30	30
Water				
Drinking Water Lead Concentration	µg/L	4.00	0.00 (4)	0.00 (4)
Water Consumption	L/day	0.52	0.52	0.52
Paint				
Lead Paint Intake	µg/day	0.00	0.00	0.00

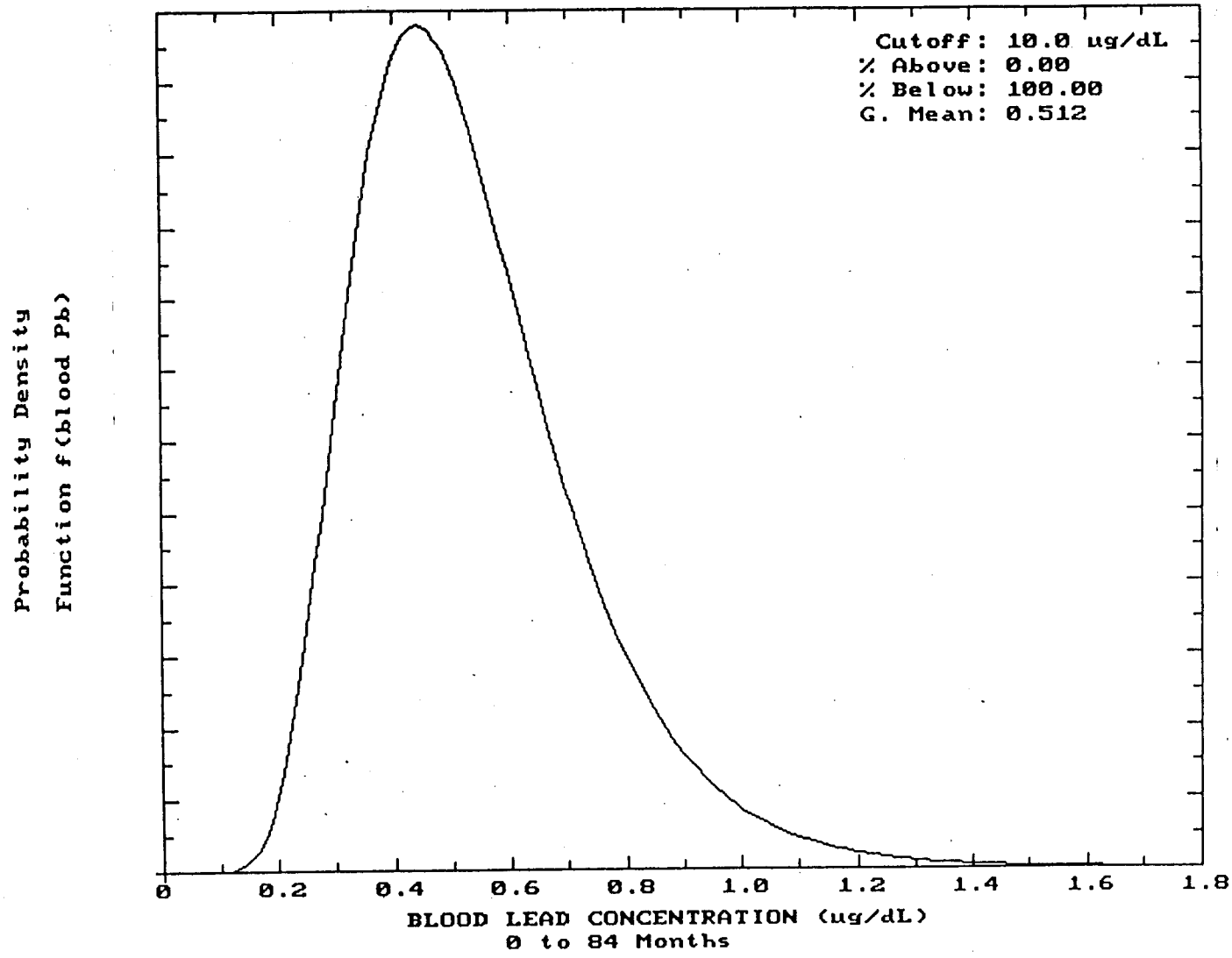
Notes:
(1) Default parameters from Uptake Biokinetic (UBK) Model for child age range 2-3.
(2) Site-specific input values (outdoor air and soil lead concentrations) for Risk Assessment Areas (RAAs) #1 and #3 were obtained from Tables 19-20 and 19-22, respectively. Onsite values were selected for purposes of conservatism.
(3) Indoor air lead concentration assumed 30% of outdoor air lead concentration.
(4) These values were assumed equal to zero in order to calculate blood lead levels due to only site-specific contribution.



Source: Uptake/Biokinetic (UBK) Model Version 0.50. January, 1991.

Probability Density of Blood Lead Concentrations
Assuming UBK Model Default Values
(representative of national background conditions)

FIGURE
19-2

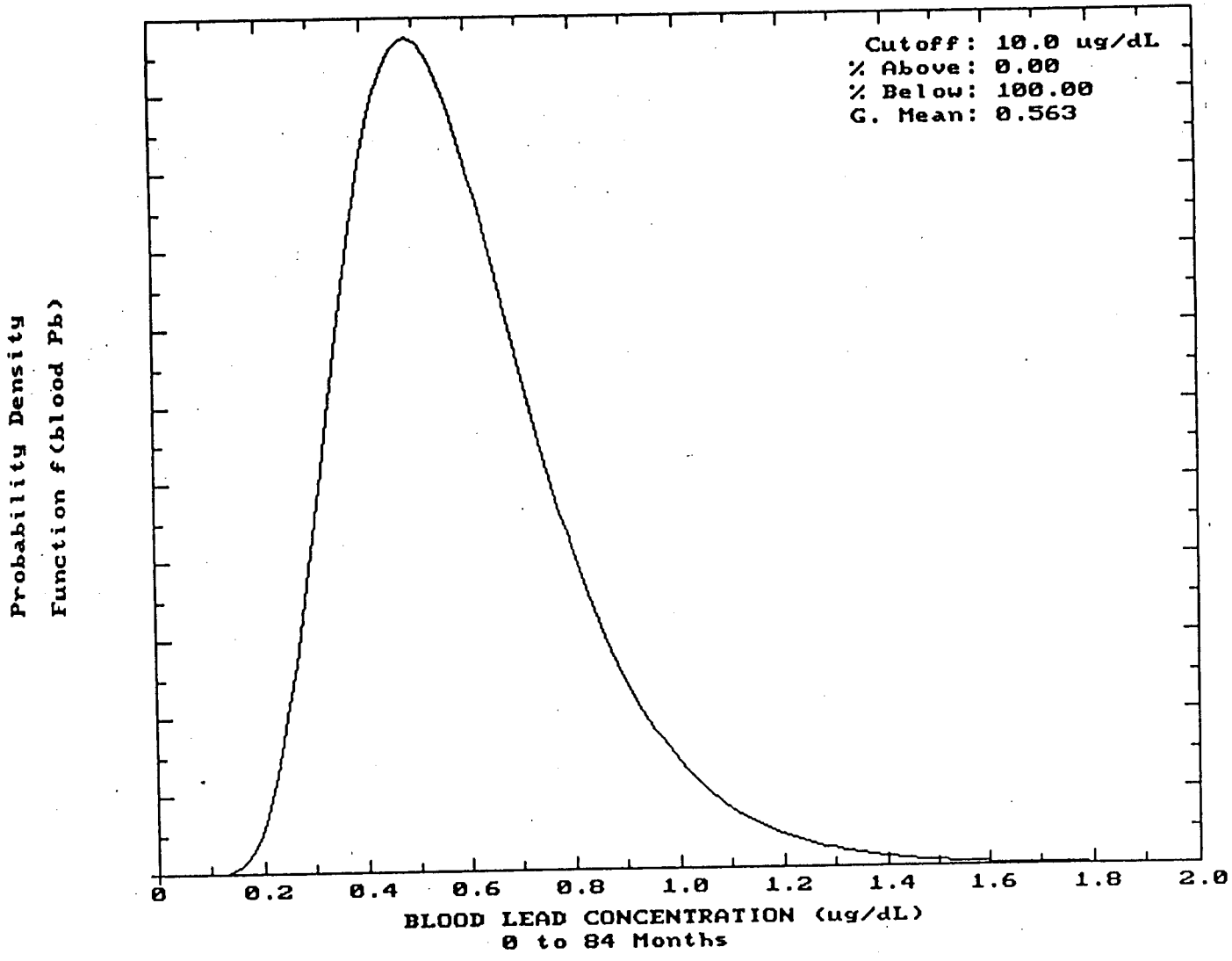


Source: Uptake/Biokinetic (UBK) Model Version 0.50. January, 1991.

Probability Density of Blood Lead Concentrations
UBK Model Results Assuming RAA #1
Site-Specific Media Concentrations

FIGURE

19-3



Source: Uptake/Biokinetic (UBK) Model Version 0.50. January, 1991.

Probability Density of Blood Lead Concentrations
UBK Model Results Assuming RAA #3
Site-Specific Media Concentrations

FIGURE
19-4

19.6 Risk Characterization — Construction Scenario

In Section 19.3.3.4, exposure doses were estimated for each receptor. In Section 19.4, toxicity values were determined for each COC. This section estimates cancer risk and noncancer hazard index for the construction scenario by integrating exposure doses with the toxicity values for each potential receptor.

Because the development of carcinogenic and noncarcinogenic effects are assumed to be caused by different mechanisms of action, different methodologies are used to quantitate these effects. The methods used to estimate cancer risk and noncancer hazard indices are presented in Sections 19.6.1 and 19.6.2, respectively. The cancer and noncancer hazard index results are presented and discussed for each RAA in Section 19.6.3. The results are summarized in Section 19.6.4. A discussion regarding the uncertainties and limitations of the risk characterization for the construction scenario is presented in Section 19.6.5. Finally, because of the lack of EPA-verified toxicity values for lead, cancer risk and noncancer hazard were not quantitated for lead exposure. Also, because the construction scenario encompasses exposures of a short-term (non-chronic) nature, the UBK model could not be used. Therefore, ambient air lead concentrations as a result of construction activities were simply compared to regulatory levels. The results of this comparison are discussed in Section 19.6.6.

19.6.1 Cancer Risk Estimation

In assessing the carcinogenic effects resulting from exposures to COCs, the excess cancer risk due to construction activities, over and above the background cancer risk, was calculated according to the algorithms presented in Section 19.5.1. For the sake of brevity, those algorithms are not presented here. The term "excess cancer risk" refers to the incremental cancer risk above the normal background cancer risk that arises due to exposure to onsite COCs. Excess cancer risk for the construction scenario does not refer to an excess over the excess cancer risk posed by the baseline scenario, but instead represents the excess risk above background. Carcinogenic daily doses under the construction scenario for each RAA were obtained from Tables 19-52 through 19-67. Cancer risks for each COC for each exposure pathway for each RAA/receptor combination were calculated.

19.6.2 Noncancer Hazard Index

In assessing the potential adverse noncarcinogenic effects resulting from exposures to COCs, the hazard index was calculated according to the algorithms presented in Section 19.5.2. For the sake of brevity, those algorithms are not presented here. Noncarcinogenic daily doses under the construction scenario for each RAA were obtained from Tables 19-52 through 19-67. Noncancer hazard indices for each COC for each exposure pathway for each RAA/receptor combination were calculated.

19.6.3 Results and Discussion

For each RAA/receptor combination, carcinogenic risks and noncarcinogenic hazard indices were estimated for each exposure pathway and COC using the exposure doses estimated in Section 19.3.3.4 in conjunction with the risk characterization methods described above. This section summarizes and discusses the results for each of the Risk Assessment Areas.

19.6.3.1 Risk Assessment Area 1

The carcinogenic COCs identified for this RAA were methylene chloride, tetrachloroethene, arsenic, chromium, and nickel. The cancer risks for each of the receptors are presented in Tables 19-96 through 19-99. The carcinogenic risk for each of the receptors evaluated was less than the EPA's target risk range of 10^{-4} to 10^{-6}. Onsite construction workers have the greatest estimated cancer risk among the receptors, at 1×10^{-7}. Onsite workers have a cancer risk of 6×10^{-8}, offsite resident receptors have a cancer risk of 1×10^{-9}, and offsite sensitive receptors have a cancer risk of 6×10^{-9}.

Noncancer hazard indices were calculated for each of the COCs identified: toluene, xylenes, TCA, acetone, methylene chloride, tetrachloroethene, arsenic, barium, chromium, nickel, and silver. The risk characterization for lead is discussed in Section 19.6.6. The hazard indices for each of the receptors are presented in Tables 19-100 through 19-103. The hazard index for each of the receptors evaluated did not exceed EPA's "level of concern" of unity (1.0) for noncarcinogenic effects. Onsite construction workers have the greatest estimated hazard index among the receptors, at 4.0×10^{-2}. Onsite workers have a hazard index of 2.9×10^{-2}, offsite resident receptors have a hazard index of 4.9×10^{-4}, and offsite sensitive receptors have a hazard index of 2.3×10^{-3}.

19.6.3.2 Risk Assessment Area 2

The carcinogenic COCs identified for this RAA were methylene chloride and nickel. The cancer risks for each of the receptors are presented in Tables 19-104 through 19-107. The carcinogenic risk for each of the receptors evaluated was less than the EPA's target risk range of 10^{-4} to 10^{-6}. Onsite construction and general-duty workers have the greatest estimated cancer risk among the receptors, at 7×10^{-8}. Offsite resident receptors have a cancer risk of 2×10^{-11}, while offsite sensitive receptors have a cancer risk of 1×10^{-10}.

Noncancer hazard indices were calculated for each of the COCs identified: toluene, ethylbenzene, xylenes, acetone, methylene chloride, barium, nickel, and vanadium. The hazard indices for each of the receptors are presented in Tables 19-108 through 19-111. The hazard index for two of the receptors evaluated exceeded EPA's "level of concern" of unity (1.0) for noncarcinogenic effects. Specifically, onsite construction workers and general duty workers have an estimated hazard index of 4.0. The greatest contribution to the hazard index for these two receptors was derived from the dust inhalation of barium (4.0). Offsite resident receptors have a hazard index of 1.3×10^{-3}, while offsite sensitive receptors have a hazard index of 5.9×10^{-3}.

Exceeding an HI of unity simply means that the potential for adverse noncarcinogenic health effects may exist. It does not mean that such effects do exist. Also, hazard indices are not statistical probabilities, and the level of concern does not increase linearly as the RfD is approached or exceeded (see Section 19.5.2).

Since the total hazard index for onsite construction workers and general duty workers was greater than one, the results giving rise to the exceedance should be more closely examined, and the type of noncancer health effects and their mechanisms of action should be considered. In this case, exposure to barium through the inhalation pathway caused the HI of unity to be exceeded. Recall, as was discussed in Section 19.2.2, that the prevalence with which barium was identified as a COC suggested that the background concentration of barium used (Table 19-1) may not have been representative of the SWMUs investigated as part of this effort. Thus, the calculated hazard index could be due, either all or in part, to background barium concentrations. It was beyond the scope of this RFI to determine the background metal concentrations at the 15 SWMUs.

Also, it must be emphasized that it was assumed that no mitigation measures would be performed during construction to minimize exposure. Thus, no dust suppression measures were assumed to occur; such measures, if effectively instituted, would eliminate the exposure pathway for all receptors other than construction workers. Similarly, personal protective equipment (PPE) was not assumed to be used by the construction workers; use of PPE would reduce, if not eliminate, their exposure. As a result, the cancer risks and noncancer hazard indices estimated represent the worst-case excess cancer risk and noncancer hazard expected to occur during a hypothetical construction scenario.

19.6.3.3 Risk Assessment Area 3

The carcinogenic COCs identified for this RAA were beryllium and nickel. The cancer risks for each of the receptors are presented in Tables 19-112 through 19-115. The carcinogenic risk for each of the receptors evaluated was less than the EPA's target risk range of 10^{-4} to 10^{-6}. Onsite construction and general-duty workers have the greatest estimated cancer risk among the receptors, at 2×10^{-7}. Offsite resident receptors have a cancer risk of 1×10^{-10}, while offsite sensitive receptors have a cancer risk of 4×10^{-10}.

Noncancer hazard indices were calculated for each of the COCs identified: barium, beryllium, manganese, nickel silver, and zinc. The risk characterization for lead is discussed in Section 19.6.6. The hazard indices for each of the receptors are presented in Tables 19-116 through 19-119. The hazard index for two of the receptors evaluated exceeded EPA's "level of concern" of unity (1.0) for noncarcinogenic effects. Specifically, onsite construction workers and general duty workers have an estimated hazard index of 5.8. The greatest contribution to the hazard index for both types of onsite workers is derived from barium (4.6) and manganese (1.2) exposure through the inhalation pathway. Offsite resident receptors have a hazard index of 2.7×10^{-3}, while offsite sensitive receptors have a hazard index of 1.3×10^{-2}.

Exposure to barium, and to a lesser extent manganese, through the inhalation pathway caused the HI of unity to be exceeded for the onsite construction and general duty workers. As was discussed for these receptors for RAA #2, the calculated hazard index due to barium could be due, either all or in part, to background barium concentrations. It was beyond the scope of this RFI to determine the background metal concentrations of the 15 SWMUs. The HI contribution of manganese through the inhalation pathway (1.2) just exceeds the HI of unity and also may be due, either all or in part, to background concentrations.

The discussion presented for RAA #2 which stated that the noncancer hazards calculated represent a "worst-case" due to an assumed absence of dust mitigation measures and PPE use also applies to the noncancer hazard results for RAA #3.

19.6.3.4 Risk Assessment Area 4

The carcinogenic COCs identified for this RAA included nickel, which was the only COC identified for this RAA. The cancer risk for each of the receptors are presented in Tables 19-120 through 19-123. The carcinogenic risk for each of the receptors evaluated was less than the EPA's target risk range of 10^{-4} to 10^{-6}. Onsite construction and general-duty workers have the greatest estimated cancer risk among the receptors, at 3×10^{-8}. Offsite resident receptors have a cancer risk of 2×10^{-12}, while offsite sensitive receptors have a cancer risk of 1×10^{-11}.

Noncancer hazard indices were calculated for nickel. The hazard indices for each of the receptors are presented in Tables 19-124 through 19-127. The hazard index for each of the receptors evaluated did not exceed EPA's "level of concern" of unity (1.0) for noncarcinogenic effects. Onsite construction workers have the greatest estimated hazard index among the receptors, at 2.3×10^{-4}. Onsite workers have a hazard index of 3.8×10^{-5}, offsite resident receptors have a hazard index of 4.1×10^{-10}, and offsite sensitive receptors have a hazard index of 3.0×10^{-9}.

19.6.4 Summary of Results for the Construction Scenario

A summary of the cancer risk results for the construction scenario, by RAA/receptor combination, is presented below.

Risk Assessment Area	Cancer Risk From All Pathways: Onsite Construction Worker	Onsite General-Duty Worker	Offsite Residential Receptor	Offsite Sensitive Receptor
RAA #1	1×10^{-7}	6×10^{-8}	1×10^{-9}	6×10^{-9}
RAA #2	7×10^{-8}	7×10^{-8}	2×10^{-11}	1×10^{-10}
RAA #3	2×10^{-7}	2×10^{-7}	1×10^{-10}	4×10^{-10}
RAA #4	3×10^{-8}	3×10^{-8}	2×10^{-12}	1×10^{-11}

For regulatory purposes, the acceptable excess cancer risk range is considered to be 10^{-4} to 10^{-6} (see Section 19.5.1). The cancer risks for all RAA/receptor combinations for the construction scenario were lower than 10^{-6}. Therefore, all cancer risks were below the acceptable excess cancer risk range.

A summary of the noncancer hazard index results for the construction scenario, by RAA/receptor combination, is presented below.

Risk Assessment Area	Noncancer Hazard Index From All Pathways: Onsite Construction Worker	Onsite General-Duty Worker	Offsite Residential Receptor	Offsite Sensitive Receptor
RAA #1	4.0×10^{-2}	2.9×10^{-2}	4.9×10^{-4}	2.3×10^{-3}
RAA #2	4.0×10^{0}	4.0×10^{0}	1.3×10^{-3}	5.9×10^{-3}
RAA #3	5.8×10^{0}	5.8×10^{0}	2.7×10^{-3}	1.3×10^{-2}
RAA #4	2.3×10^{-4}	3.8×10^{-5}	4.1×10^{-10}	3.0×10^{-9}

For regulatory purposes, a noncancer hazard index of one or less is considered to be an acceptable noncarcinogenic risk level (see Section 19.5.2). The noncancer hazard indices exceeded this acceptable risk level for RAAs #2 and #3 for onsite construction and general-duty workers. The noncancer hazard indices for all other RAA/receptor combinations were below the acceptable noncarcinogenic risk level.

The greatest contribution to the hazard indices for the onsite RAA #2 and #3 cases is derived from barium exposure through the inhalation pathway. However, the prevalence with which barium was identified as a COC in soils sampled at Cannon AFB (eight out of fifteen SWMUs) suggests that the background concentration of barium used for comparison purposes may not have been representative of the actual background barium concentrations at the SWMUs investigated as part of this effort. Therefore, the hazard indices exceedances may have been due, either wholly or in part, to natural background barium concentrations. It was beyond the scope of this RFI to determine background metal concentrations at the 15 SWMUs.

19.6.5 Uncertainties and Limitations

The uncertainties and limitations associated with the risk characterization of COCs at Cannon AFB under the construction scenario are similar to the uncertainties and limitations associated with the risk characterization under the baseline scenario. However, the cancer risk and noncancer hazard index were estimated using equations based on long-term exposures. Use of these equations to estimate short-term cancer risks and hazard indices leads to unquantifiable uncertainty.

Also, it must be emphasized that it was assumed that no mitigation measures would be performed during construction to minimize exposure. Thus, no dust suppression measures were assumed to occur; such measures, if effectively instituted, would eliminate the exposure pathway for all receptors other than construction workers. Similarly, personal protective equipment (PPE) was not assumed to be used by the construction workers; use of PPE would reduce, if not eliminate, their exposure. As a result, the cancer risks and noncancer hazard indices estimated represent the worst-case excess cancer risk and noncancer hazard expected to occur during a hypothetical construction scenario.

19.6.6 Lead Risk Analysis

For evaluation of lead exposures due to construction activities, an alternative methodology has been applied. The applicability of the UBK Model is restricted to children at residences subject to chronic exposure to lead. However, trenching activities were assumed to last only 30 8-hour days; thus, exposures under the construction scenario are short-term. Therefore, the UBK Model is not appropriate for receptors for the construction scenario. For this HRA, the short-term exposure of adult receptors to airborne particulates containing lead was compared to the Occupational Safety and Health Administration (OSHA) permissible exposure level (PEL) for lead of 5.0×10^{-2} milligrams per cubic meter (mg/m^3). The OSHA PEL is a time weighted average (TWA) concentration that must not be exceeded during any 8-hour work shift of a 40-hour work week.

The concentration of airborne PM_{10} particulates containing lead was estimated using FDM at RAA #1 and RAA #3. Onsite and offsite airborne lead concentrations arising from the site-specific conditions at RAAs #1 and #3 are presented in Table 19-128 and are compared to the OSHA PEL. All airborne lead concentrations are at least two orders of magnitude below the OSHA PEL. However, FDM results are 30-day average concentrations, which are less conservative than the OSHA 8-hour average. Nevertheless, the airborne lead concentrations are significantly (two orders of magnitude) lower than the OSHA PEL, which suggests that the OSHA PEL would not be attained during the construction period.

Table 19-96

CANCER RISK FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #1

ONSITE CONSTRUCTION WORKER

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total Cancer Risk by Chemical (unitless)
	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	
Non-BTEX TCL VOCs										
Methylene Chloride	4.8E-11	7.5E-03	4E-13	3.5E-11	7.5E-03	3E-13	5.1E-08	1.7E-03	9E-11	9E-11
Tetrachloroethene	1.1E-10	5.2E-02	6E-12	8.2E-11	5.2E-02	4E-12	5.3E-08	2.0E-03	1E-10	1E-10
Metals										
Arsenic	3.3E-08	1.8E+00	6E-08	2.4E-09	1.9E+00	5E-09	5.1E-10	1.5E+01	8E-09	7E-08
Chromium	7.2E-08	NA	NA	5.2E-09	NA	NA	1.1E-09	4.1E+01	5E-08	5E-08
Nickel	6.0E-08	NA	NA	4.4E-09	NA	NA	9.4E-10	8.4E-01	8E-10	8E-10
Total Cancer Risk by Pathway (unitless)			6E-08			5E-09			5E-08	**1E-07**

Notes:
(1) Carcinogenic doses were obtained from Table 19-52.
(2) CSFs were obtained from Table 19-69.
(3) Cancer risks calculated using Equation 19-23.
"NA" means CSF not available from EPA sources, therefore the cancer risk was not calculated.

Table 19-97

CANCER RISK FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #1

ONSITE WORKER

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total Cancer Risk by Chemical (unitless)
	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	
Non-BTEX TCL VOCs										
Methylene Chloride	5.0E-12	7.5E-03	4E-14	3.5E-11	7.5E-03	3E-13	5.1E-08	1.7E-03	9E-11	9E-11
Tetrachloroethene	1.2E-11	5.2E-02	6E-13	8.2E-11	5.2E-02	4E-12	5.3E-08	2.0E-03	1E-10	1E-10
Metals										
Arsenic	3.4E-09	1.8E+00	6E-09	2.4E-09	1.9E+00	5E-09	5.1E-10	1.5E+01	8E-09	2E-08
Chromium	7.5E-09	NA	NA	5.2E-09	NA	NA	1.1E-09	4.1E+01	5E-08	5E-08
Nickel	6.3E-09	NA	NA	4.4E-09	NA	NA	9.4E-10	8.4E-01	8E-10	8E-10
Total Cancer Risk by Pathway (unitless)			6E-09			5E-09			5E-08	**6E-08**

Notes:
(1) Carcinogenic doses were obtained from Table 19-53.
(2) CSFs were obtained from Table 19-69.
(3) Cancer risks calculated using Equation 19-23.
"NA" means CSF not available from EPA sources, therefore the cancer risk was not calculated.

Table 19-98

CANCER RISK FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #1

OFFSITE RESIDENTIAL RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total Cancer Risk by Chemical (unitless)
	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	
Metals										
Arsenic	2.4E-11	1.8E+00	4E-11	8.3E-12	1.9E+00	2E-11	1.3E-11	1.5E+01	2E-10	3E-10
Chromium	5.2E-11	NA	NA	1.8E-11	NA	NA	2.8E-11	4.1E+01	1E-09	1E-09
Nickel	4.4E-11	NA	NA	1.5E-11	NA	NA	2.3E-11	8.4E-01	2E-11	2E-11
Total Cancer Risk by Pathway (unitless)			4E-11			2E-11			1E-09	**1E-09**

Notes:
(1) Carcinogenic doses were obtained from Table 19-54.
(2) CSFs were obtained from Table 19-69.
(3) Cancer risks calculated using Equation 19-23.
"NA" means CSF not available from EPA sources, therefore the cancer risk was not calculated.

Table 19-99

CANCER RISK FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #1

OFFSITE SENSITIVE RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total Cancer Risk by Chemical (unitless)
	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	
Metals										
Arsenic	4.4E-11	1.8E+00	8E-11	3.1E-12	1.9E+00	6E-12	6.0E-11	1.5E+01	9E-10	1E-09
Chromium	9.7E-11	NA	NA	6.6E-12	NA	NA	1.3E-10	4.1E+01	5E-09	5E-09
Nickel	8.1E-11	NA	NA	5.6E-12	NA	NA	1.1E-10	8.4E-01	9E-11	9E-11
Total Cancer Risk by Pathway (unitless)			8E-11			6E-12			6E-09	**6E-09**

Notes:
(1) Carcinogenic doses were obtained from Table 19-55.
(2) CSFs were obtained from Table 19-69.
(3) Cancer risks calculated using Equation 19-23.
"NA" means CSF not available from EPA sources, therefore the cancer risk was not calculated.

Table 19-100

NONCANCER HAZARD INDEX FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #1

ONSITE CONSTRUCTION WORKER

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total HI by Chemical (unitless)
	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	
BTEX										
Toluene	2.4E-08	2.0E-01	1.2E-07	1.8E-08	2.0E-01	9.0E-08	5.1E-06	1.1E-01	4.6E-05	4.7E-05
Xylenes	2.9E-08	2.0E+00	1.5E-08	2.1E-08	2.0E+00	1.1E-08	5.2E-06	NA	NA	2.5E-08
Non-BTEX TCL VOCs										
1,1,1-Trichloroethane	4.5E-09	9.0E-02	5.0E-08	3.3E-09	9.0E-02	3.7E-08	1.9E-06	NA	NA	8.7E-08
Acetone	1.4E-07	1.0E-01	1.4E-06	1.0E-07	1.0E-01	1.0E-06	9.9E-05	NA	NA	2.4E-06
Methylene Chloride	3.4E-09	6.0E-02	5.7E-08	2.5E-09	6.0E-02	4.2E-08	3.6E-06	8.6E-01	4.2E-06	4.3E-06
Tetrachloroethene	7.9E-09	1.0E-02	7.9E-07	5.7E-09	1.0E-02	5.7E-07	3.7E-06	NA	NA	1.4E-06
Metals										
Arsenic	2.3E-06	3.0E-04	7.7E-03	1.7E-07	2.8E-04	6.0E-04	3.6E-08	NA	NA	8.3E-03
Barium	1.8E-04	7.0E-02	2.6E-03	1.3E-05	7.0E-02	1.9E-04	2.7E-06	1.4E-04	1.9E-02	2.2E-02
Chromium	5.0E-06	5.0E-03	1.0E-03	3.6E-07	5.0E-05	7.2E-03	7.8E-08	NA	NA	8.2E-03
Lead (4)	6.4E-06	NA	NA	4.6E-07	NA	NA	9.9E-08	NA	NA	NA
Nickel	4.2E-06	2.0E-02	2.1E-04	3.1E-07	2.0E-02	1.6E-05	6.6E-08	NA	NA	2.3E-04
Silver	3.3E-06	5.0E-03	6.6E-04	2.4E-07	5.0E-03	4.8E-05	5.1E-08	NA	NA	7.1E-04
Total HI by Pathway (unitless)			1.2E-02			8.1E-03			1.9E-02	**4.0E-02**

Notes:
(1) Noncarcinogenic doses were obtained from Table 19-52.
(2) RfDs were obtained from Table 19-69
(3) Noncancer hazard indices calculated using Equation 19-27.
(4) Currently, EPA has not recommended an approach for characterization of risk posed by short term lead exposure. Risk characterization for short term lead exposure is thus qualitatively assessed.
"NA" means RfD not available from EPA sources, therefore the hazard index was not calculated.

Table 19-101

NONCANCER HAZARD INDEX FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #1

ONSITE WORKER

Chemical of Concern	Soil Ingestion Pathway Noncarcinogenic Dose (1) (mg/kg/day)	Soil Ingestion Pathway RfD (2) (mg/kg/day)	Soil Ingestion Pathway HI (3) (unitless)	Dermal Absorption Pathway Noncarcinogenic Dose (1) (mg/kg/day)	Dermal Absorption Pathway RfD (2) (mg/kg/day)	Dermal Absorption Pathway HI (3) (unitless)	Inhalation Pathway Noncarcinogenic Dose (1) (mg/kg/day)	Inhalation Pathway RfD (2) (mg/kg/day)	Inhalation Pathway HI (3) (unitless)	Total HI by Chemical (unitless)
BTEX										
Toluene	2.5E-09	2.0E-01	1.3E-08	1.8E-08	2.0E-01	9.0E-08	5.1E-06	1.1E-01	4.6E-05	4.6E-05
Xylenes	3.1E-09	2.0E+00	1.6E-09	2.1E-08	2.0E+00	1.1E-08	5.2E-06	NA	NA	1.2E-08
Non-BTEX TCL VOCs										
1,1,1-Trichloroethane	4.7E-10	9.0E-02	5.2E-09	3.3E-09	9.0E-02	3.7E-08	1.9E-06	NA	NA	4.2E-08
Acetone	1.5E-08	1.0E-01	1.5E-07	1.0E-07	1.0E-01	1.0E-06	9.9E-05	NA	NA	1.2E-06
Methylene Chloride	3.5E-10	6.0E-02	5.8E-09	2.5E-09	6.0E-02	4.2E-08	3.6E-06	8.6E-01	4.2E-06	4.2E-06
Tetrachloroethene	8.2E-10	1.0E-02	8.2E-08	5.7E-09	1.0E-02	5.7E-07	3.7E-06	NA	NA	6.5E-07
Metals										
Arsenic	2.4E-07	3.0E-04	8.0E-04	1.7E-07	2.8E-04	6.0E-04	3.6E-08	NA	NA	1.4E-03
Barium	1.8E-05	7.0E-02	2.6E-04	1.3E-05	7.0E-02	1.9E-04	2.7E-06	1.4E-04	1.9E-02	2.0E-02
Chromium	5.2E-07	5.0E-03	1.0E-04	3.6E-07	5.0E-05	7.2E-03	7.8E-08	NA	NA	7.3E-03
Lead (4)	6.6E-07	NA	NA	4.6E-07	NA	NA	9.9E-08	NA	NA	NA
Nickel	4.4E-07	2.0E-02	2.2E-05	3.1E-07	2.0E-02	1.6E-05	6.6E-08	NA	NA	3.8E-05
Silver	3.4E-07	5.0E-03	6.8E-05	2.4E-07	5.0E-03	4.8E-05	5.1E-08	NA	NA	1.2E-04
Total HI by Pathway (unitless)			1.3E-03			8.1E-03			1.9E-02	**2.9E-02**

Notes:
(1) Noncarcinogenic doses were obtained from Table 19-53.
(2) RfDs were obtained from Table 19-69
(3) Noncancer hazard indices calculated using Equation 19-27.
(4) Currently, EPA has not recommended an approach for characterization of risk posed by short term lead exposure. Risk characterization for short term lead exposure is thus qualitatively assessed.
"NA" means RfD not available from EPA sources, therefore the hazard index was not calculated.

Table 19-102

NONCANCER HAZARD INDEX FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #1

OFFSITE RESIDENTIAL RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total HI by Chemical (unitless)
	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	
Metals										
Arsenic	5.6E-11	3.0E-04	1.9E-07	1.9E-11	2.8E-04	6.7E-08	9.0E-10	NA	NA	2.5E-07
Barium	4.2E-09	7.0E-02	6.0E-08	1.5E-09	7.0E-02	2.1E-08	6.8E-08	1.4E-04	4.9E-04	4.9E-04
Chromium	1.2E-10	5.0E-03	2.4E-08	4.2E-11	5.0E-05	8.4E-07	1.9E-09	NA	NA	8.6E-07
Lead (4)	1.5E-10	NA	NA	5.3E-11	NA	NA	2.5E-09	NA	NA	NA
Nickel	1.0E-10	2.0E-02	5.0E-09	3.5E-11	2.0E-02	1.8E-09	1.6E-09	NA	NA	6.8E-09
Silver	7.9E-11	5.0E-03	1.6E-08	2.7E-11	5.0E-03	5.4E-09	1.3E-09	NA	NA	2.1E-08
Total HI by Pathway (unitless)			2.9E-07			9.4E-07			4.9E-04	**4.9E-04**

Notes:
(1) Noncarcinogenic doses were obtained from Table 19-54.
(2) RfDs were obtained from Table 19-69
(3) Noncancer hazard indices calculated using Equation 19-27.
(4) Currently, EPA has not recommended an approach for characterization of risk posed by short term lead exposure. Risk characterization for short term lead exposure is thus qualitatively assessed.
"NA" means RfD not available from EPA sources, therefore the hazard index was not calculated.

Table 19-103

NONCANCER HAZARD INDEX FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #1

OFFSITE SENSITIVE RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total HI by Chemical (unitless)
	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	
Metals										
Arsenic	5.2E-10	3.0E-04	1.7E-06	3.6E-11	2.8E-04	1.3E-07	4.2E-09	NA	NA	1.9E-06
Barium	3.9E-09	7.0E-02	5.6E-08	2.7E-09	7.0E-02	3.9E-08	3.2E-07	1.4E-04	2.3E-03	2.3E-03
Chromium	1.1E-09	5.0E-03	2.2E-07	7.8E-11	5.0E-05	1.6E-06	9.1E-09	NA	NA	1.8E-06
Lead (4)	1.4E-09	NA	NA	9.8E-11	NA	NA	1.2E-08	NA	NA	NA
Nickel	9.5E-10	2.0E-02	4.8E-08	6.5E-11	2.0E-02	3.3E-09	7.7E-09	NA	NA	5.1E-08
Silver	7.3E-10	5.0E-03	1.5E-07	5.1E-11	5.0E-03	1.0E-08	5.9E-09	NA	NA	1.6E-07
Total HI by Pathway (unitless)			2.2E-06			1.7E-06			2.3E-03	**2.3E-03**

Notes:
(1) Noncarcinogenic doses were obtained from Table 19-55.
(2) RfDs were obtained from Table 19-69
(3) Noncancer hazard indices calculated using Equation 19-27.
(4) Currently, EPA has not recommended an approach for characterization of risk posed by short term lead exposure. Risk characterization for short term lead exposure is thus qualitatively assessed.
"NA" means RfD not available from EPA sources, therefore the hazard index was not calculated.

Table 19-104

CANCER RISK FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #2

ONSITE CONSTRUCTION WORKER

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total Cancer Risk by Chemical (unitless)
	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	
Non-BTEX TCL VOCs										
Methylene Chloride	1.2E-09	7.5E-03	9E-12	8.8E-10	7.5E-03	7E-12	7.5E-07	1.7E-03	1E-09	1E-09
Metals										
Nickel	6.4E-08	NA	NA	4.6E-09	NA	NA	8.2E-08	8.4E-01	7E-08	7E-08
Total Cancer Risk by Pathway (unitless)			9E-12			7E-12			7E-08	**7E-08**

Notes:
(1) Carcinogenic doses were obtained from Table 19-56.
(2) CSFs were obtained from Table 19-69.
(3) Cancer risks calculated using Equation 19-23.
"NA" means CSF not available from EPA sources, therefore the cancer risk was not calculated.

Table 19-105

CANCER RISK FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #2

ONSITE WORKER

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total Cancer Risk by Chemical (unitless)
	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	
Non-BTEX TCL VOCs										
Methylene Chloride	1.3E-10	7.5E-03	1E-12	8.8E-10	7.5E-03	7E-12	7.5E-07	1.7E-03	1E-09	1E-09
Metals										
Nickel	6.6E-09	NA	NA	4.6E-09	NA	NA	8.2E-08	8.4E-01	7E-08	7E-08
Total Cancer Risk by Pathway (unitless)			1E-12			7E-12			7E-08	**7E-08**

Notes:
(1) Carcinogenic doses were obtained from Table 19-57.
(2) CSFs were obtained from Table 19-69.
(3) Cancer risks calculated using Equation 19-23.
"NA" means CSF not available from EPA sources, therefore the cancer risk was not calculated.

Table 19-106

CANCER RISK FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #2

OFFSITE RESIDENTIAL RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total Cancer Risk by Chemical (unitless)
	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	
Metals										
Nickel	4.9E-11	NA	NA	1.7E-11	NA	NA	2.6E-11	8.4E-01	2E-11	2E-11
Total Cancer Risk by Pathway (unitless)			0E+00			0E+00			2E-11	**2E-11**

Notes:
(1) Carcinogenic doses were obtained from Table 19-58.
(2) CSFs were obtained from Table 19-69.
(3) Cancer risks calculated using Equation 19-23.
"NA" means CSF not available from EPA sources, therefore the cancer risk was not calculated.

Table 19-107

CANCER RISK FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #2

OFFSITE SENSITIVE RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total Cancer Risk by Chemical (unitless)
	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	
Metals										
Nickel	9.2E-11	NA	NA	6.3E-12	NA	NA	1.2E-10	8.4E-01	1E-10	1E-10
Total Cancer Risk by Pathway (unitless)			0E+00			0E+00			1E-10	**1E-10**

Notes:
(1) Carcinogenic doses were obtained from Table 19-59.
(2) CSFs were obtained from Table 19-69.
(3) Cancer risks calculated using Equation 19-23.
"NA" means CSF not available from EPA sources, therefore the cancer risk was not calculated.

Table 19-108

NONCANCER HAZARD INDEX FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #2

ONSITE CONSTRUCTION WORKER

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total HI by Chemical (unitless)
	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	
BTEX										
Toluene	6.8E-07	2.0E-01	3.4E-06	4.9E-07	2.0E-01	2.5E-06	8.4E-05	1.1E-01	7.6E-04	7.7E-04
Ethylbenzene	2.4E-06	1.0E-01	2.4E-05	1.7E-06	1.0E-01	1.7E-05	1.6E-04	2.9E-01	5.5E-04	5.9E-04
Xylenes	1.8E-05	2.0E+00	9.0E-06	1.3E-05	2.0E+00	6.5E-06	1.9E-03	NA	NA	1.6E-05
Non-BTEX TCL VOCs										
Acetone	6.2E-08	1.0E-01	6.2E-07	4.5E-08	1.0E-01	4.5E-07	2.6E-05	NA	NA	1.1E-06
Methylene Chloride	8.5E-08	6.0E-02	1.4E-06	6.1E-08	6.0E-02	1.0E-06	5.3E-05	8.6E-01	6.2E-05	6.4E-05
Metals										
Barium	4.3E-04	7.0E-02	6.1E-03	3.1E-05	7.0E-02	4.4E-04	5.6E-04	1.4E-04	4.0E+00	4.0E+00
Nickel	4.5E-06	2.0E-02	2.3E-04	3.2E-07	2.0E-02	1.6E-05	5.7E-06	NA	NA	2.4E-04
Vanadium	8.2E-06	7.0E-03	1.2E-03	6.0E-07	7.0E-03	8.6E-05	1.1E-05	NA	NA	1.3E-03
Total HI by Pathway (unitless)			7.6E-03			5.7E-04			4.0E+00	**4.0E+00**

Notes:
(1) Noncarcinogenic doses were obtained from Table 19-56.
(2) RfDs were obtained from Table 19-69
(3) Noncancer hazard indices calculated using Equation 19-27.
"NA" means RfD not available from EPA sources, therefore the hazard index was not calculated.

Table 19-109

NONCANCER HAZARD INDEX FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #2

ONSITE WORKER

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total HI by Chemical (unitless)
	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	
BTEX										
Toluene	7.0E-08	2.0E-01	3.5E-07	4.9E-07	2.0E-01	2.5E-06	8.4E-05	1.1E-01	7.6E-04	7.7E-04
Ethylbenzene	2.5E-07	1.0E-01	2.5E-06	1.7E-06	1.0E-01	1.7E-05	1.6E-04	2.9E-01	5.5E-04	5.7E-04
Xylenes	1.9E-06	2.0E+00	9.5E-07	1.3E-05	2.0E+00	6.5E-06	1.9E-03	NA	NA	7.5E-06
Non-BTEX TCL VOCs										
Acetone	6.5E-09	1.0E-01	6.5E-08	4.5E-08	1.0E-01	4.5E-07	2.6E-05	NA	NA	5.2E-07
Methylene Chloride	8.8E-09	6.0E-02	1.5E-07	6.1E-08	6.0E-02	1.0E-06	5.3E-05	8.6E-01	6.2E-05	6.3E-05
Metals										
Barium	4.5E-05	7.0E-02	6.4E-04	3.1E-05	7.0E-02	4.4E-04	5.6E-04	1.4E-04	4.0E+00	4.0E+00
Nickel	4.6E-07	2.0E-02	2.3E-05	3.2E-07	2.0E-02	1.6E-05	5.7E-06	NA	NA	3.9E-05
Vanadium	8.6E-07	7.0E-03	1.2E-04	6.0E-07	7.0E-03	8.6E-05	1.1E-05	NA	NA	2.1E-04
Total HI by Pathway (unitless)			7.9E-04			5.7E-04			4.0E+00	**4.0E+00**

Notes:
(1) Noncarcinogenic doses were obtained from Table 19-57.
(2) RfDs were obtained from Table 19-69
(3) Noncancer hazard indices calculated using Equation 19-27.
"NA" means RfD not available from EPA sources, therefore the hazard index was not calculated.

Table 19-110

NONCANCER HAZARD INDEX FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #2

OFFSITE RESIDENTIAL RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total HI by Chemical (unitless)
	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	
Metals										
Barium	1.1E-08	7.0E-02	1.6E-07	3.9E-09	7.0E-02	5.6E-08	1.8E-07	1.4E-04	1.3E-03	1.3E-03
Nickel	1.1E-10	2.0E-02	5.5E-09	4.0E-11	2.0E-02	2.0E-09	1.8E-09	NA	NA	7.5E-09
Vanadium	2.1E-10	7.0E-03	3.0E-08	7.4E-11	7.0E-03	1.1E-08	3.4E-09	NA	NA	4.1E-08
Total HI by Pathway (unitless)			1.9E-07			6.8E-08			1.3E-03	**1.3E-03**

Notes:
(1) Noncarcinogenic doses were obtained from Table 19-58.
(2) RfDs were obtained from Table 19-69
(3) Noncancer hazard indices calculated using Equation 19-27.
"NA" means RfD not available from EPA sources, therefore the hazard index was not calculated.

Table 19-111

NONCANCER HAZARD INDEX FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #2

OFFSITE SENSITIVE RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total HI by Chemical (unitless)
	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	
Metals										
Barium	1.0E-07	7.0E-02	1.4E-06	7.2E-09	7.0E-02	1.0E-07	8.3E-07	1.4E-04	5.9E-03	5.9E-03
Nickel	1.1E-09	2.0E-02	5.5E-08	7.4E-11	2.0E-02	3.7E-09	8.6E-09	NA	NA	5.9E-08
Vanadium	2.0E-09	7.0E-03	2.9E-07	1.4E-10	7.0E-03	2.0E-08	1.6E-08	NA	NA	3.1E-07
Total HI by Pathway (unitless)			1.8E-06			1.3E-07			5.9E-03	**5.9E-03**

Notes:
(1) Noncarcinogenic doses were obtained from Table 19-59.
(2) RfDs were obtained from Table 19-69
(3) Noncancer hazard indices calculated using Equation 19-27.
"NA" means RfD not available from EPA sources, therefore the hazard index was not calculated.

Table 19-112

CANCER RISK FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #3

ONSITE CONSTRUCTION WORKER

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total Cancer Risk by Chemical (unitless)
	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	
Metals										
Beryllium	4.9E-09	4.3E+00	2E-08	3.6E-10	4.3E+00	2E-09	7.6E-09	8.4E+00	6E-08	9E-08
Nickel	7.4E-08	NA	NA	5.4E-09	NA	NA	1.1E-07	8.4E-01	9E-08	9E-08
Total Cancer Risk by Pathway (unitless)			2E-08			2E-09			2E-07	**2E-07**

Notes:
(1) Carcinogenic doses were obtained from Table 19-60.
(2) CSFs were obtained from Table 19-69.
(3) Cancer risks calculated using Equation 19-23.
"NA" means CSF not available from EPA sources, therefore the cancer risk was not calculated.

Table 19-113

CANCER RISK FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #3

ONSITE WORKER

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total Cancer Risk by Chemical (unitless)
	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	
Metals										
Beryllium	5.1E-10	4.3E+00	2E-09	3.6E-10	4.3E+00	2E-09	7.6E-09	8.4E+00	6E-08	7E-08
Nickel	7.7E-09	NA	NA	5.4E-09	NA	NA	1.1E-07	8.4E-01	9E-08	9E-08
Total Cancer Risk by Pathway (unitless)			2E-09			2E-09			2E-07	**2E-07**

Notes:
(1) Carcinogenic doses were obtained from Table 19-61.
(2) CSFs were obtained from Table 19-69.
(3) Cancer risks calculated using Equation 19-23.
"NA" means CSF not available from EPA sources, therefore the cancer risk was not calculated.

Table 19-114

CANCER RISK FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #3

OFFSITE RESIDENTIAL RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total Cancer Risk by Chemical (unitless)
	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	
Metals										
Beryllium	6.6E-12	4.3E+00	3E-11	2.3E-12	4.3E+00	1E-11	3.6E-12	8.4E+00	3E-11	7E-11
Nickel	9.9E-11	NA	NA	3.4E-11	NA	NA	5.4E-11	8.4E-01	5E-11	5E-11
Total Cancer Risk by Pathway (unitless)			3E-11			1E-11			8E-11	**1E-10**

Notes:
(1) Carcinogenic doses were obtained from Table 19-62.
(2) CSFs were obtained from Table 19-69.
(3) Cancer risks calculated using Equation 19-23.
"NA" means CSF not available from EPA sources, therefore the cancer risk was not calculated.

Table 19-115

CANCER RISK FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #3

OFFSITE SENSITIVE RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total Cancer Risk by Chemical (unitless)
	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	
Metals										
Beryllium	1.2E-11	4.3E+00	5E-11	8.4E-13	4.3E+00	4E-12	1.7E-11	8.4E+00	1E-10	2E-10
Nickel	1.8E-10	NA	NA	1.3E-11	NA	NA	2.5E-10	8.4E-01	2E-10	2E-10
Total Cancer Risk by Pathway (unitless)			5E-11			4E-12			4E-10	**4E-10**

Notes:
(1) Carcinogenic doses were obtained from Table 19-63.
(2) CSFs were obtained from Table 19-69.
(3) Cancer risks calculated using Equation 19-23.
"NA" means CSF not available from EPA sources, therefore the cancer risk was not calculated.

Table 19-116

NONCANCER HAZARD INDEX FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #3

ONSITE CONSTRUCTION WORKER

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total HI by Chemical (unitless)
	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	
Metals										
Barium	4.2E-04	7.0E-02	6.0E-03	3.0E-05	7.0E-02	4.3E-04	6.5E-04	1.4E-04	4.6E+00	4.6E+00
Beryllium	3.4E-07	5.0E-03	6.8E-05	2.5E-08	5.0E-03	5.0E-06	5.3E-07	NA	NA	7.3E-05
Lead (4)	8.1E-06	NA	NA	5.9E-07	NA	NA	1.3E-05	NA	NA	NA
Manganese	8.4E-05	1.4E-01	6.0E-04	6.1E-06	5.6E-03	1.1E-03	1.3E-04	1.1E-04	1.2E+00	1.2E+00
Nickel	5.2E-06	2.0E-02	2.6E-04	3.8E-07	2.0E-02	1.9E-05	8.0E-06	NA	NA	2.8E-04
Silver	1.9E-06	5.0E-03	3.8E-04	1.4E-07	5.0E-03	2.8E-05	3.0E-06	NA	NA	4.1E-04
Zinc	7.7E-05	3.0E-01	2.6E-04	5.6E-06	9.0E-02	6.2E-05	1.2E-04	NA	NA	3.2E-04
Total HI by Pathway (unitless)			7.6E-03			1.6E-03			5.8E+00	**5.8E+00**

Notes:
(1) Noncarcinogenic doses were obtained from Table 19-60.
(2) RfDs were obtained from Table 19-69
(3) Noncancer hazard indices calculated using Equation 19-27.
(4) Currently, EPA has not recommended an approach for characterization of risk posed by short term lead exposure. Risk characterization for short term lead exposure is thus qualitatively assessed.
"NA" means RfD not available from EPA sources, therefore the hazard index was not calculated.

Table 19-117

NONCANCER HAZARD INDEX FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #3

ONSITE WORKER

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total HI by Chemical (unitless)
	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	
Metals										
Barium	4.4E-05	7.0E-02	6.3E-04	3.0E-05	7.0E-02	4.3E-04	6.5E-04	1.4E-04	4.6E+00	4.6E+00
Beryllium	3.6E-08	5.0E-03	7.2E-06	2.5E-08	5.0E-03	5.0E-06	5.3E-07	NA	NA	1.2E-05
Lead (4)	8.5E-07	NA	NA	5.9E-07	NA	NA	1.3E-05	NA	NA	NA
Manganese	8.7E-06	1.4E-01	6.2E-05	6.1E-06	5.6E-03	1.1E-03	1.3E-04	1.1E-04	1.2E+00	1.2E+00
Nickel	5.4E-07	2.0E-02	2.7E-05	3.8E-07	2.0E-02	1.9E-05	8.0E-06	NA	NA	4.6E-05
Silver	2.0E-07	5.0E-03	4.0E-05	1.4E-07	5.0E-03	2.8E-05	3.0E-06	NA	NA	6.8E-05
Zinc	8.0E-06	3.0E-01	2.7E-05	5.6E-06	9.0E-02	6.2E-05	1.2E-04	NA	NA	8.9E-05
Total HI by Pathway (unitless)			7.9E-04			1.6E-03			5.8E+00	**5.8E+00**

Notes:
(1) Noncarcinogenic doses were obtained from Table 19-61.
(2) RfDs were obtained from Table 19-69
(3) Noncancer hazard indices calculated using Equation 19-27.
(4) Currently, EPA has not recommended an approach for characterization of risk posed by short term lead exposure. Risk characterization for short term lead exposure is thus qualitatively assessed.
"NA" means RfD not available from EPA sources, therefore the hazard index was not calculated.

Table 19-118

NONCANCER HAZARD INDEX FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #3

OFFSITE RESIDENTIAL RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total HI by Chemical (unitless)
	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	
Metals										
Barium	1.9E-08	7.0E-02	2.7E-07	6.5E-09	7.0E-02	9.3E-08	3.0E-07	1.4E-04	2.1E-03	2.1E-03
Beryllium	1.5E-11	5.0E-03	3.0E-09	5.3E-12	5.0E-03	1.1E-09	2.5E-10	NA	NA	4.1E-09
Lead (4)	3.6E-10	NA	NA	1.3E-10	NA	NA	5.9E-09	NA	NA	NA
Manganese	3.7E-09	1.4E-01	2.6E-08	1.3E-09	5.6E-03	2.3E-07	6.0E-08	1.1E-04	5.5E-04	5.5E-04
Nickel	2.3E-10	2.0E-02	1.2E-08	8.0E-11	2.0E-02	4.0E-09	3.7E-09	NA	NA	1.6E-08
Silver	8.5E-11	5.0E-03	1.7E-08	3.0E-11	5.0E-03	6.0E-09	1.4E-09	NA	NA	2.3E-08
Zinc	3.4E-09	3.0E-01	1.1E-08	1.2E-09	9.0E-02	1.3E-08	5.6E-08	NA	NA	2.5E-08
Total HI by Pathway (unitless)			3.4E-07			3.5E-07			2.7E-03	**2.7E-03**

Notes:
(1) Noncarcinogenic doses were obtained from Table 19-62.
(2) RfDs were obtained from Table 19-69
(3) Noncancer hazard indices calculated using Equation 19-27.
(4) Currently, EPA has not recommended an approach for characterization of risk posed by short term lead exposure. Risk characterization for short term lead exposure is thus qualitatively assessed.
"NA" means RfD not available from EPA sources, therefore the hazard index was not calculated.

Table 19-119

NONCANCER HAZARD INDEX FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #3

OFFSITE SENSITIVE RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total HI by Chemical (unitless)
	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	
Metals										
Barium	1.7E-07	7.0E-02	2.4E-06	1.2E-08	7.0E-02	1.7E-07	1.4E-06	1.4E-04	1.0E-02	1.0E-02
Beryllium	1.4E-10	5.0E-03	2.8E-08	9.8E-12	5.0E-03	2.0E-09	1.2E-09	NA	NA	3.0E-08
Lead (4)	3.4E-09	NA	NA	2.3E-10	NA	NA	2.7E-08	NA	NA	NA
Manganese	3.5E-08	1.4E-01	2.5E-07	2.4E-09	5.6E-03	4.3E-07	2.8E-07	1.1E-04	2.5E-03	2.5E-03
Nickel	2.2E-09	2.0E-02	1.1E-07	1.5E-10	2.0E-02	7.5E-09	1.7E-08	NA	NA	1.2E-07
Silver	8.0E-10	5.0E-03	1.6E-07	5.5E-11	5.0E-03	1.1E-08	6.5E-09	NA	NA	1.7E-07
Zinc	3.2E-08	3.0E-01	1.1E-07	2.2E-09	9.0E-02	2.4E-08	2.6E-07	NA	NA	1.3E-07
Total HI by Pathway (unitless)			3.1E-06			6.4E-07			1.3E-02	**1.3E-02**

Notes:
(1) Noncarcinogenic doses were obtained from Table 19-63.
(2) RfDs were obtained from Table 19-69
(3) Noncancer hazard indices calculated using Equation 19-27.
(4) Currently, EPA has not recommended an approach for characterization of risk posed by short term lead exposure. Risk characterization for short term lead exposure is thus qualitatively assessed.
"NA" means RfD not available from EPA sources, therefore the hazard index was not calculated.

Table 19-120

CANCER RISK FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #4

ONSITE CONSTRUCTION WORKER

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total Cancer Risk by Chemical (unitless)
	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	
Metals										
Nickel	6.1E-08	NA	NA	4.4E-09	NA	NA	3.0E-08	8.4E-01	3E-08	3E-08
Total Cancer Risk by Pathway (unitless)			0E+00			0E+00			3E-08	**3E-08**

Notes:
(1) Carcinogenic doses were obtained from Table 19-64.
(2) CSFs were obtained from Table 19-69.
(3) Cancer risks calculated using Equation 19-23.
"NA" means CSF not available from EPA sources, therefore the cancer risk was not calculated.

Table 19-121

CANCER RISK FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #4

ONSITE WORKER

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total Cancer Risk by Chemical (unitless)
	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	
Metals										
Nickel	6.4E-09	NA	NA	4.4E-09	NA	NA	3.0E-08	8.4E-01	3E-08	3E-08
Total Cancer Risk by Pathway (unitless)			0E+00			0E+00			3E-08	**3E-08**

Notes:
(1) Carcinogenic doses were obtained from Table 19-65.
(2) CSFs were obtained from Table 19-69.
(3) Cancer risks calculated using Equation 19-23.
"NA" means CSF not available from EPA sources, therefore the cancer risk was not calculated.

Table 19-122

CANCER RISK FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #4

OFFSITE RESIDENTIAL RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total Cancer Risk by Chemical (unitless)
	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	
Metals										
Nickel	2.6E-12	NA	NA	9.0E-13	NA	NA	2.6E-12	8.4E-01	2E-12	2E-12
Total Cancer Risk by Pathway (unitless)			0E+00			0E+00			2E-12	**2E-12**

Notes:
(1) Carcinogenic doses were obtained from Table 19-66.
(2) CSFs were obtained from Table 19-69.
(3) Cancer risks calculated using Equation 19-23.
"NA" means CSF not available from EPA sources, therefore the cancer risk was not calculated.

Table 19-123

CANCER RISK FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #4

OFFSITE SENSITIVE RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total Cancer Risk by Chemical (unitless)
	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	Carcinogenic Dose (1) (mg/kg/day)	CSF (2) 1/(mg/kg/day)	Cancer Risk (3) (unitless)	
Metals										
Nickel	4.8E-12	NA	NA	3.3E-13	NA	NA	1.2E-11	8.4E-01	1E-11	1E-11
Total Cancer Risk by Pathway (unitless)			0E+00			0E+00			1E-11	**1E-11**

Notes:
(1) Carcinogenic doses were obtained from Table 19-67.
(2) CSFs were obtained from Table 19-69.
(3) Cancer risks calculated using Equation 19-23.
"NA" means CSF not available from EPA sources, therefore the cancer risk was not calculated.

Table 19-124

NONCANCER HAZARD INDEX FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #4

ONSITE CONSTRUCTION WORKER

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total HI by Chemical (unitless)
	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	
Metals										
Nickel	4.3E-06	2.0E-02	2.2E-04	3.1E-07	2.0E-02	1.6E-05	2.1E-06	NA	NA	2.3E-04
Total HI by Pathway (unitless)			2.2E-04			1.6E-05			0.0E+00	2.3E-04

Notes:
(1) Noncarcinogenic doses were obtained from Table 19-64.
(2) RfDs were obtained from Table 19-69
(3) Noncancer hazard indices calculated using Equation 19-27.
"NA" means RfD not available from EPA sources, therefore the hazard index was not calculated.

Table 19-125

NONCANCER HAZARD INDEX FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #4

ONSITE WORKER

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total HI by Chemical (unitless)
	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	
Metals										
Nickel	4.5E-07	2.0E-02	2.3E-05	3.1E-07	2.0E-02	1.6E-05	2.1E-06	NA	NA	3.8E-05
Total HI by Pathway (unitless)			2.3E-05			1.6E-05			0.0E+00	**3.8E-05**

Notes:
(1) Noncarcinogenic doses were obtained from Table 19-65.
(2) RfDs were obtained from Table 19-69
(3) Noncancer hazard indices calculated using Equation 19-27.
"NA" means RfD not available from EPA sources, therefore the hazard index was not calculated.

Table 19-126

NONCANCER HAZARD INDEX FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #4

OFFSITE RESIDENTIAL RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total HI by Chemical (unitless)
	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	
Metals										
Nickel	6.1E-12	2.0E-02	3.1E-10	2.1E-12	2.0E-02	1.1E-10	1.9E-10	NA	NA	4.1E-10
Total HI by Pathway (unitless)			3.1E-10			1.1E-10			0.0E+00	**4.1E-10**

Notes:

(1) Noncarcinogenic doses were obtained from Table 19-66.

(2) RfDs were obtained from Table 19-69

(3) Noncancer hazard indices calculated using Equation 19-27.

"NA" means RfD not available from EPA sources, therefore the hazard index was not calculated.

Table 19-127

NONCANCER HAZARD INDEX FROM ALL PATHWAYS

CONSTRUCTION SCENARIO
RAA #4

OFFSITE SENSITIVE RECEPTOR

Chemical of Concern	Soil Ingestion Pathway			Dermal Absorption Pathway			Inhalation Pathway			Total HI by Chemical (unitless)
	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	Noncarcinogenic Dose (1) (mg/kg/day)	RfD (2) (mg/kg/day)	HI (3) (unitless)	
Metals										
Nickel	5.7E-11	2.0E-02	2.9E-09	3.9E-12	2.0E-02	2.0E-10	8.7E-10	NA	NA	3.0E-09
Total HI by Pathway (unitless)			2.9E-09			2.0E-10			0.0E+00	**3.0E-09**

Notes:
(1) Noncarcinogenic doses were obtained from Table 19-67.
(2) RfDs were obtained from Table 19-69
(3) Noncancer hazard indices calculated using Equation 19-27.
"NA" means RfD not available from EPA sources, therefore the hazard index was not calculated.

Table 19-128

AIRBORNE LEAD CONCENTRATIONS AND PERMISSIBLE REGULATORY LEVELS

CONSTRUCTION SCENARIO

	Airborne Lead Concentration (mg/m3)		Permissible Regulatory Level (mg/m3) (3)
	RAA #1 (1)	RAA #3 (2)	
Onsite Dust	4.2E-06	5.3E-04	5.0E-02
Offsite Dust	1.1E-07	2.5E-07	5.0E-02

Notes:
(1) Concentrations were obtained from Table 19-47.
(2) Concentrations were obtained from Table 19-49.
(3) Value shown is the OSHA PEL, the Occupational Safety and Health Administration Permissible Exposure Level for lead. The OSHA PEL is a time-weighted average concentration that must not be exceeded during any 8-hour work shift or 40-hour work week.

20.0 ECOLOGICAL RISK ASSESSMENT

20.1 Introduction

An ecological risk assessment (ERA) was conducted in order to evaluate the potential for adverse effects to the environment from identified chemicals of concern (COCs) at the Solid Waste Management Units (SWMUs). The ERA uses both qualitative and quantitative information in order to characterize the risk to the environment. It was designed to be screening in nature and was not based on site-specific biological field investigations. From the information gathered, a recommendation can be made for no further action or for further study, including the gathering of field biological data.

The approach employed is similar to that used for the human health risk assessment (HRA). First, COCs were selected and exposure point concentrations for soils were derived based on criteria determined in the HRA (Section 20.2). Next, potential ecological receptor(s) and pathway(s) of exposure were identified, and exposure concentrations for all complete pathway(s) were calculated (Section 20.3). A toxicity assessment based on the ecological receptor(s) was then conducted (Section 20.4). Finally, a risk characterization was performed by comparing the results of the exposure assessment with the toxicity assessment (Section 20.5). In general, the ecological risk assessment follows the guidelines presented in the "Risk Assessment Guidance for Superfund: Volume II Environmental Evaluation Manual" (RAGS, Vol. II), (EPA, 1989d).

20.2 Data Evaluation

The data evaluation for the ERA followed the same process as that for the HRA. A summary of the process is given below. For a detailed description of data evaluation, see Section 19.2.

20.2.1 Identification of Chemicals of Concern

The results from sample analysis were first validated using the United States Environmental Protection Agency (EPA) Laboratory Data Validation Functional Guidelines (EPA, 1988b, EPA, 1991g) in order to determine the useability of the data. The data were reviewed with respect to the overall quality of the data, the quantitation limits achieved in the analysis, and the laboratory quality assurance/quality control (QA/QC) practices, including precision, accuracy, representativeness, completeness, and comparability. The data were either accepted, rejected, or accepted with qualifications. All rejected data were eliminated from further consideration.

The COCs for each SWMU were then identified by eliminating chemicals that were not detected in any environmental sample, eliminating chemicals that were conclusively identified in data validation as laboratory contaminants, eliminating metals in which the maximum detected concentration was less than its background soil concentration at Cannon AFB (see Section 19.2.1 for a discussion of background metal concentrations), and eliminating chemicals, except lead, for which there are no EPA-verified toxicity data. The metals excluded due to the lack of EPA-verified toxicity data have low mammalian toxicities and include aluminum, calcium, cobalt, copper, iron, magnesium, and potassium. Although there could be organisms in the environment that are more sensitive to a chemical than mammals are, the ecological receptor of concern

identified is a mammal, and thus the chemicals with low mammalian toxicities were nevertheless eliminated. (See Section 20.3.1.3 for a description of the identification of potential ecological receptors.) The remaining chemicals constitute the list of COCs.

For the HRA, the SWMUs were divided into Risk Assessment Areas (RAAs), and the subsequent calculations and risk analysis were performed for each RAA. In the ERA, there is no division according to RAA, and the list of COCs is a composite list of the COCs from all of the RAAs. The composite list of COCs for the 15 SWMUs includes the following: arsenic, barium, beryllium, chromium, lead, manganese, nickel, silver, vanadium, zinc, acetone, ethylbenzene, methylene chloride, tetrachloroethylene, 1,1,1-trichloroethane, toluene, and xylene.

20.2.2 Reasonable Maximum Exposure Concentrations for Soil

The reasonable maximum exposure (RME) concentration is the maximum exposure concentration that is reasonably expected to occur at a site. RMEs are designed to be conservative estimates of exposure, that is, they are greater than the average exposure, while still remaining within the range of possible exposures. RMEs for this site were developed based on the collection of analytical data from the source and any chemical transport and environmental fate modeling used for a given exposure pathway. The development of soil RME concentrations, also called exposure point concentrations for onsite soils, does not involve fate and transport modeling performed. These values are based directly on analytical sampling data collected at the source.

In most cases, the exposure point concentrations for soil are the same as the values for the 95 percent upper confidence limit on the arithmetic average (95% UCL) of the analytical data. In some cases, however, based on professional judgement, the maximum value for a chemical concentration was used. A full description of the development of the RME concentrations for soil is provided in Section 19.2.4.

As with the development of the list of COCs, the RME concentrations for soil were calculated for each RAA in the HRA. For the ERA, a composite of RMEs for soil is used. This composite was developed by using the highest value RME for any of the RAAs. This is a conservative approach for deriving RME values for the ERA, since it uses the exposure concentrations for a chemical for the potentially most highly contaminated RAA, and is in keeping with the screening nature of this ERA. Other RAAs would have a lower exposure concentration, and thus a lower risk. The composite list of COCs and their associated RME concentrations for soil are presented in Table 20-1.

20.3 Exposure Assessment

In the exposure assessment, the type and magnitude of exposures to the environment from the identified COCs are identified, and where feasible, quantified. Because of the complexity of the ecological habitats and the scarcity of reliable toxicity and transport data, the exposure assessment for the ERA must necessarily limit the quantification of exposures to one or a few scenarios. In some cases, the data can only be analyzed qualitatively. The scenario(s) selected

for quantification are those that are generally considered to be the most conservative, that is, the pathways and routes of exposure that are most likely to be followed, and the receptor(s) most sensitive or most likely to be impacted by contamination.

20.3.1 Current and Future Exposure Scenarios

This section presents current and future exposure scenarios based on potential ecological receptors and potential transport mechanisms and routes of exposure.

At the time of sampling, 11 of the 15 SWMUs were covered with asphalt or concrete. Three of the remaining SWMUs (#8, #16, and #83) were at disturbed sites adjacent to buildings where the vegetation is mowed to a fairly short height. The third remaining SWMU (#108), used for training in explosive ordnance disposal, is maintained free of significant vegetation by grading every few months. The conditions of the SWMUs that are paved over severely limit the possible transport mechanisms, and thus complete exposure pathways, for current exposure scenarios for those SWMUs.

The future land use of the SWMUs is defined to be industrial/commercial (see Section 19.3.1.1). Although the SWMUs will likely remained paved over, there could be some SWMUs that are uncovered, with subsequent growth of limited vegetation. It is conservatively assumed that for the future scenario all of the SWMUs will be uncovered and have limited vegetative growth. In any case, however, the SWMUs will not be returned to their original habitat, and will remain surrounded by buildings and the flight line.

For conservative purposes, the exposure assessment is based on the conditions under the potential future land use scenario, that is, that all of the SWMUs are uncovered and have limited vegetative growth. This is conservative since some of the RME concentrations used were derived from RAAs where all of the SWMUs are covered, and indeed, may remain so in the future.

20.3.1.1 Identification of Potential Ecological Receptors

It is not feasible to evaluate, even qualitatively, the effects of contaminants on all of the species in an entire ecosystem. Instead, as is described in RAGS, Volume II (EPA, 1989d), ecologists will often use professional judgement to select an "indicator species" that is thought to be representative of the success of other species that could be impacted in a given habitat. The indicator species, also called the ecological receptor, is selected based on one or more of the following attributes: 1) the species' susceptibility to contaminants or other environmental changes; 2) the importance of the species to the entire habitat, e.g., whether the species occurs frequently in the area or is a central part of the food chain; 3) whether the species is likely to be exposed to the identified contaminants; and 4) the availability of toxicity data on the species. In this section, the general ecology of the area is evaluated with respect to the SWMUs, potential ecological receptors are identified, and one ecological receptor is selected to represent the habitat and to be used for the exposure scenarios.

A description of the ecology of the area is provided in Section 1.4.3.8. The natural High Plains grassland is dominated primarily by blue grama grass, with galleta grass a subdominant species. The natural grassland habitat on Cannon Air Force Base (AFB) has been highly modified, however, by industrial and other uses. This is particularly true for the SWMUs as they presently exist, where they are either covered over or are surrounded by paved areas. The only exception is SWMU 108, the explosive ordnance disposal training area, which is surrounded by disturbed, weedy grassland. Nevertheless, many of the native species are in the general vicinity of the SWMUs.

The only water bodies in the area are the sewage treatment lagoons and the playa lakes. The sewage treatment lagoons are located next to and empty into the playa lakes. These water bodies are important to the area's wildlife because they provide drinking water, resting areas, and nesting sites with an increased food supply. None of the SWMUs have habitats that include water bodies, and all of them are situated away from the sewage treatment lagoons and the playa lakes (see Figure 1-2 for locations of the SWMUs and the sewage lagoons).

The wildlife of the area consists of large and small mammals, reptiles and amphibians, waterfowl, shorebirds, raptors, and passerine birds. A complete listing of mammals, reptiles, and birds of the area is provided in Section 1.4.3.8. For reasons outlined later in Section 20.3.1.2, however, this ERA will not consider transport mechanisms from the SWMUs to other sites. Therefore, only terrestrial receptors that could be exposed to chemicals at the actual site of the SWMUs will be considered as potential ecological receptors.

Potential terrestrial receptors include small mammals such as the deer mouse and the plains pocket gopher, insects, raptors, and other birds. There are no threatened or endangered species listed by the United States Fish and Wildlife Service or by the State of New Mexico known to exist on the Cannon AFB.

Of the potential terrestrial receptors, the deer mouse was considered to be the most appropriate receptor for evaluating these SWMUs for several reasons. First, even if the SWMUs are uncovered in the future, all of the SWMUs, with the exception of SWMU 108, will nevertheless be surrounded by buildings and industrial areas and will remain near the flight line. The habitat of the SWMUs would only be conducive to invertebrates, insects, small mammals such as the deer mouse, and possible raptors. Second, there is a large data base of toxicity studies on laboratory mice because of their widespread use for human health assessment. Comparing toxicity data for laboratory mice to wild deer mice has a lower uncertainty than comparing the same toxicity data to a less closely related species such as the plains pocket gopher, invertebrates, or insects. Third, although there will not likely be high raptor activity around the SWMUs due to their location, the deer mouse does serve as prey for raptors in the area.

20.3.1.2 Identification of Potential Transport Mechanisms

An evaluation of potential transport mechanisms is presented in Section 19.3.1.3. Air transport was the only reasonable transport mechanism identified at the site. The air transport mechanism includes both the volatization of organics and the transport of metals and organics by wind. Under the future scenario where the SWMUs are uncovered, wind transport could potentially

carry COCs to an offsite terrestrial habitat or to an aquatic habitat (the sewage lagoons and the playa lakes). For the ecological risk assessment, however, the air transport mechanism has been determined not to be a significant pathway for the following reasons.

Unlike in the HRA, where the onsite and offsite receptors can vary considerably, the potential receptor would be the same in the case of the terrestrial habitat. The potential exposure concentrations of the COCs would be reduced by the wind transport mechanism, however. Therefore, evaluating the exposures at the actual site of the SWMUs indicates the greatest potential risk to the terrestrial habitat.

In the case of the aquatic habitat, there would be a different ecological receptor chosen. However, the sewage lagoons, which empty into Playa Lake, have already been evaluated based on actual sampling data at the lagoons under the Remedial Investigation performed by Woodward-Clyde Consultants in 1991-1992 (Woodward-Clyde, 1992). Further, Playa Lake is a SWMU and will be investigated in the future. The adverse ecological effects of the wind transport of COCs from these SWMUs would be far less than the direct effects from the sewage effluent. Moreover, risk assessment information generated from actual sampling of the aquatic environment is far more reliable than that generated from modeling.

20.3.1.3 Identification of Potential Routes of Exposure

Of the three potential routes of exposure, inhalation, ingestion, and dermal contact, the only one considered here is ingestion. Most animal toxicity studies, including those for laboratory mice and rats, are based on ingestion and/or injection. There are not sufficient data to estimate the toxicity from inhalation or dermal absorption of the COCs.

Direct ingestion of soil by the deer mouse is the main route of exposure considered in this ERA. This direct ingestion would occur as incidental to ingestion of other biota. Indirect ingestion, through the ingestion of plants, is not considered because plants do not tend to bioaccumulate high levels of metals (Woodward-Clyde, 1992).

20.3.2 Summary of Exposure Assumptions

The following assumptions are used in calculating the exposure.

1. There was only one complete exposure pathway evaluated: the direct onsite incidental ingestion of COCs in the soil by the deer mouse.

2. Although 11 of the 15 SWMUs are currently paved over, all of the SWMUs were conservatively assessed as if they were uncovered, in order to estimate any potential future exposures.

3. A mouse weight of 0.025 kg was used (Woodward-Clyde, 1992).

4. A food intake for the mouse of 0.003 kg/day was used (Woodward-Clyde, 1992).

5. An estimated incidental soil ingestion value of 2% of food intake, or 6.0E-05 kg, was used (Woodward-Clyde, 1992).

6. The exposure concentrations of COCs used were the highest value of the RME concentration for soil at any one of the RAAs.

20.3.3 Exposure Assessment Results

The estimated daily dose values of a COC to the deer mouse are calculated as follows:

$$DV_i = \frac{SI \times RME_i}{BW} \qquad (20\text{-}1)$$

where:

DV_i	=	The daily dose value to the deer mouse for COC i (in mg/kg-day)
SI	=	The daily soil ingestion of the deer mouse
	=	6.0E-05 kg/day
RME_i	=	The reasonable maximum exposure concentration in soil to the deer mouse for COC i (in mg/kg)
BW	=	The average weight of a deer mouse
	=	0.025 kg

The daily dose values for each of the COCs are presented in Table 20-1.

20.4 Toxicity Assessment

In order to assess the potential for adverse effects to environmental receptors present on the Cannon AFB site, an indicator species, the deer mouse, was identified that is representative of the wildlife potentially present onsite (see Section 20.3.1.1 for a discussion of the selection of the indicator species). It is assumed for the screening purposes of this report that potential adverse effects to the selected indicator species will represent the potential for hazards to the environment encompassing Cannon AFB.

The toxicity values used to evaluate the potential for adverse effects to the deer mouse were based on laboratory studies of mice or rats orally exposed to the COCs. From these studies, No-Observed-Adverse-Effects-Levels (NOAELs) in mg-COC/kg-mouse weight were identified, representing levels of exposure above which there may be adverse effects to the indicator species. An uncertainty factor for extrapolation from laboratory mice and rat studies to wild deer mice of 10 was incorporated into the values used to assess potential hazards.

There were no available studies that calculated a NOAEL for barium or that have been able to demonstrate conclusive signs of barium toxicity. There were studies that detected no effects at various exposure levels. One of these values, 100 ppm in drinking water, divided by an uncertainty factor of 10, was used as a surrogate NOAEL. Although the NOAEL could in fact be much higher, the use of this value allows quantification of risk based on a known safe level

of barium. No information regarding the potential effects of 1,1,1-trichloroethane on animals has been identified for this study, therefore no further quantitative evaluation of the ecological effects is possible for this COC.

Table 20-2 presents ecotoxicity values identified for the indicator species of concern, including the mouse NOAEL, the rat NOAEL, and the selected toxicity values for each of the COCs.

20.5 Risk Characterization

There is no specified formal method for quantitatively characterizing the risk to the environment. The risk to the environment was therefore characterized by following a similar process for noncarcinogens as that outlined for the HRA described in RAGS, Volume I (EPA, 1989a). In the HRA, a Hazard Quotient (HQ) was determined for the noncarcinogenic risk for each COC from all of the complete pathways of exposure for that RAA (e.g., onsite inhalation, offsite inhalation, etc.). This HQ was determined by dividing the estimated pathway-specific daily intake of the COC by the reference dose for that COC.

The characterization of risk to the environment was conducted in an analogous fashion. An HQ was determined for the risk from each COC, for the RAA with the highest RME for that COC. For the ERA, there was only one complete pathway considered, for reasons outlined in Section 20.3.1. The HQ was determined by dividing the estimated daily intake of the COC by the ecological receptor, by the selected toxicity value for the ecological receptor, as follows:

$$HQ_i = \frac{DV_i}{TV_i} \qquad (20\text{-}2)$$

where

HQ_i = The Hazard Quotient for COC i
DV_i = The daily dose value for the deer mouse for COC i
TV_i = The selected toxicity value for the deer mouse for COC i

The HQ is used to assess the potential hazards posed to indicator species by comparing the daily dose values with the toxicity values. If the daily dose values are less than the toxicity values, meaning that the HQ is less than one, then it is expected that the deer mice will not suffer harmful effects. If the daily dose value exceeds the toxicity value, meaning that the HQ is more than one, then the potential exists that the deer mouse could be exposed to higher levels of the COC than it can tolerate without harmful effects. It is assumed that the risks for adverse effects posed to the deer mouse is indicative to the risks for adverse effects posed to the ecosystem at Cannon AFB in general.

The values for the HQ for each COC were calculated and are presented in Table 20-1. For chromium, the toxicity value for chromium VI was used to calculate the HQ; chromium VI is more toxic than chromium III, so it was conservatively assumed that all chromium detected was chromium VI. The HQ for each COC listed in Table 20-1 represents the highest possible HQ for that COC for any of the RAAs, since the calculations are based on the highest RME value at any of the RAAs. All of the HQ values are below one. The only HQ value that approaches

one, thus indicating that there could be potential harmful effects to the deer mouse, is for manganese. Manganese is a COC only in RAA #3, which is comprised solely of SWMU #83. The daily dose value is .36 mg/kg, while the selected toxicity value is 0.5 mg/kg. In order to exceed the toxicity value based on the exposure assumptions described in Section 20.3.2, the concentration of manganese in the soil would have to exceed 208 mg/kg. All samples except one have concentrations of manganese below 208 mg/kg, further indicating that it is not expected that manganese will cause adverse effects in the deer mouse.

20.6 Summary and Conclusions

The purpose of this ERA was to evaluate the potential for adverse effects to the environment from the 15 SWMUs investigated at Cannon AFB. The ERA was performed using guidelines presented in RAGS, Volume II (EPA, 1989d), and employed an approach similar to that used in the HRA. Assumptions made throughout the ERA were generally conservative, and therefore tend to overestimate the actual risk.

Because of the complexity of ecosystems and the interrelationships between species, it was not feasible to assess the potential risk to all species. The ERA evaluated the risk to the environment by using a surrogate receptor that was considered to be the most representative of terrestrial habitats in the area. The deer mouse was selected as the ecological receptor because of its abundance (particularly in disturbed areas such as is the case for the 15 SWMUs), the abundance of toxicological data on mice, and because of its centrality in the food chain. Aquatic habitats were not considered because the significance of the COCs from these SWMUs is much less than from other SWMUs under investigation that actually contain the aquatic environments in question. There was only one complete exposure pathway identified, which was the direct onsite incidental ingestion of COCs in the soil by the deer mouse.

The COCs identified at the 15 SWMUs were arsenic, barium, beryllium, chromium, lead, manganese, nickel, silver, vanadium, zinc, acetone, ethylbenzene, methylene chloride, tetrachloroethylene, 1,1,1-trichloroethane, toluene, and xylene. Concentrations in the soil of each of these COCs were calculated by taking the highest RME for that COC from any of the RAAs identified in the HRA. A daily dose value of each COC to the deer mouse was then calculated based on the incidental ingestion of the COC from soil. These values were compared with estimated safe dose levels derived from the toxicity assessment.

For each of the COCs identified at the 15 SWMUs, the estimated daily dose value to the deer mouse was below the estimated safe level. This indicates that the potential for adverse effects from the 15 SWMUs to the deer mouse is not significant. Because the ERA was designed to be screening in nature and capture the receptor with the highest likelihood of exposure, the potential for adverse effects from the 15 SWMUs to the environment at Cannon AFB is also not significant.

20.7 Uncertainties and Limitations

This section discusses the uncertainties and limitations associated with the performance of the ERA. In general, the assumptions made in this risk assessment were conservative wherever possible. The overall result is that risk estimates presented in this ERA are much more likely to overestimate the potential risk rather than to underestimate it. Although this approach could lead to an overly conservative assessment of the risk, it is generally preferable for the purposes of protecting the environment. The sources of uncertainty associated with the assumptions made in the ERA and an assessment of their effect on risk are presented below.

Data Evaluation

The selection of the COCs and their associated RMEs were derived directly from the HRA. A discussion of the uncertainties associated with this process is presented in Section 19.2.5. Because of the screening nature of the ERA, the highest RME concentration in any of the RAAs for a given COC was used for calculating the daily dose and ultimately the risk values. The end result is that the final risk estimates represent the risk from a COC at the RAA with the highest concentration of that COC; the risk at other RAAs would be lower.

In the selection of the COCs, chemicals for which there is no EPA-verified toxicity values were excluded. These COCs, which include aluminum, calcium, cobalt, copper, iron, magnesium, and potassium, also have low mammalian toxicities, and would not adversely affect the deer mouse. It is possible, though unlikely, that there is another type of species in the ecosystem that may be susceptible to one of these COCs, and the risk would be underestimated for that species.

Exposure Assessment

The deer mouse was selected as the indicator species because of its abundance, its greater likelihood than other species to inhabit the disturbed habitats present on the SWMUs, the availability of toxicity data on mice and rats, and the centrality of the deer mouse in the area ecosystem. It is assumed, then, that other species in the area would be less susceptible to the COCs present at the SWMUs, and thus the use of the deer mouse in the ERA would tend to overestimate the risk to other species and to the environment in general. There could be other species, however, that are more susceptible to the COCs present at the SWMUs, in which case the risk would be underestimated for those species.

In the development of this ERA, only one complete pathway of exposure was evaluated, that of onsite ingestion of soil by the deer mouse. Offsite transport by wind was eliminated from further consideration. For potential terrestrial receptors, the receptor chosen would not change between onsite and offsite. Since wind transportation would reduce the exposure concentrations and thus the risk, the risk from onsite exposure represents the greatest risk to the deer mouse. Risks to offsite receptors would be less, and thus the risk factors calculated are an overestimation of risk to offsite terrestrial receptors. For potential aquatic receptors at the sewage lagoons and playa lakes it was determined that these two SWMUs are under current investigation using direct sampling data, which is more reliable than data generated from transport modeling. In a future scenario where some or all of the 15 SWMUs are bare, there could be some small

additional risk from wind transport from the 15 SWMUs. Any additional risk would nevertheless be insignificant with respect to the direct risk from the SWMUs that contain the aquatic environments.

Onsite inhalation and dermal absorption were not considered in the exposure assessment because of a lack of toxicity data on those routes of entry. Although these routes of entry are probably not as significant as that of ingestion, particularly for metals, the lack of consideration of these routes of entry could represent a small underestimation of risk.
The calculations of the intake of the COCs by the deer mouse, or daily dose value, did not take into account the effects of the soil matrix. In general, the soil matrix will lessen the bioavailability of chemicals present, or reduce the actual amounts of a chemical absorbed by the deer mouse. The lack of taking this into account represents an unquantifiable overestimation of the actual risk.

Toxicity Assessment

A general discussion of the uncertainties associated with the toxicity assessment is presented in Section 19.4.4. A souce of uncertainty involves the potential for cumulative effects posed by exposures to multiple chemicals. Synergistic effects are those in which the net effect of the simultaneous action of two or more COCs is greater than the sum of their individual effects. Antagonistic effects are those in which the net effect of exposure to two or more COCs is less than the sum of their individual effects. Data concerning combined effects of complex mixtures of chemicals are generally limited. There could be potential synergism or antagonism as a result of exposures to multiple chemicals to the deer mouse, which could either underestimate or overestimate the risk.

For toxicity values used for the ERA for barium, there were no studies found that calculated a NOAEL. There were studies that showed no effects to mice or rats at two concentration levels. The higher of these two was selected as a surrogate NOAEL from which the toxicity value was derived. The actual NOAEL could in fact be much higher, since no studies were found that showed any adverse effects. Thus the toxicity value used for barium is probably an unquantifiable overestimation of risk.

The studies on mice and rats reviewed in the literature were performed on laboratory-raised animals. Sometimes risk assessments assume that laboratory-raised animals are more sensitive to chemicals than wild animals, and thus do not use an uncertainty factor to extrapolate from laboratory-raised animals to wild animals (see Woodward-Clyde, 1992). Although unlikely, there is the possibility that the wild deer mouse is more sensitive to one or more of the COCs than a laboratory-raised mouse or rat, therefore in this risk assessment an uncertainty factor of 10 was used to extrapolate between species to ensure that the risk is not underestimated. This probably generates a large overestimation of risk.

Risk Characterization

In the risk characterization, the toxicity values for chromium VI were used to represent all of the chromium detected because chromium VI is more toxic then chromium III and thus presents a greater risk. It is unlikely that all of the chromium present is chromium VI, however, particularly given the alkaline soil. This probably represents an unquantifiable overestimation of risk.

As noted before, the exposure concentrations for a COC that were used in the risk characterization were the highest at any of the RAAs. Thus the risk calculated for each COC is the highest it could be at any of the RAAs. An ecological receptor would not be exposed to all of these risk levels however, since a receptor would not be at all of the SWMUs at all times to received the highest dose.

Moreover, all of the exposure calculations, and thus the risk characterization, are based on the presumption that all of the SWMUs will be uncovered. Only four of the SWMUs are uncovered at present, and it is unlikely under the future scenario of commercial/industrial use that many of the SWMUs will be uncovered.

Table 20-1. Summary of Results for the Ecological Risk Assessment

Chemical	Reasonable Maximum Exposure (mg/kg)	Daily Dose Value (mg/kg/day)	Selected Toxicity Value (mg/kg/day)	Hazard Quotient
METALS				
Arsenic	4.1	.0098	6.0	1.6×10^{-3}
Barium	$7.7 \times 10^{+2}$	1.8	$1.0 \times 10^{+1}$	1.8×10^{-1}
Beryllium	6.1×10^{-1}	1.5×10^{-3}	1.0×10^{-1}	1.5×10^{-2}
Chromium	8.9	2.1×10^{-2}	2.4×10^{-1}	8.8×10^{-2}
Lead	$1.4 \times 10^{+1}$	3.4×10^{-2}	3.9	8.7×10^{-3}
Manganese	$1.5 \times 10^{+2}$	3.6×10^{-1}	5.0×10^{-1}	7.2×10^{-1}
Nickel	9.2	2.2×10^{-2}	5.0×10^{-1}	4.4×10^{-2}
Silver	5.8	1.4×10^{-2}	$1.4 \times 10^{+1}$	1.0×10^{-3}
Vanadium	$1.5 \times 10^{+1}$	3.6×10^{-2}	5.0×10^{-1}	7.2×10^{-2}
Zinc	$1.4 \times 10^{+2}$	3.4×10^{-1}	7.7	4.4×10^{-2}
ORGANICS				
Acetone	2.5×10^{-1}	6.0×10^{-4}	$4.85 \times 10^{+2}$	1.2×10^{-6}
Ethylbenzene	4.2	1.0×10^{-2}	$1.36 \times 10^{+1}$	$7.4\ 10^{-4}$
Methylene Chloride	1.5×10^{-1}	3.6×10^{-4}	6.0×10^{-1}	6.0×10^{-4}
Tetrachloroethene	1.4×10^{-2}	3.4×10^{-5}	2.0	1.7×10^{-5}
1,1,1-Trichloroethane	8.0×10^{-3}	1.9×10^{-5}	N/A	N/A
Toluene	1.2	2.9×10^{-3}	5.0×10^{-1}	5.8×10^{-3}
Xylenes	$3.2 \times 10^{+1}$	7.7×10^{-2}	$1.75 \times 10^{+1}$	4.4×10^{-3}

N/A = Not Available

Table 20-2. Ecotoxicity Values for Cannon AFB Chemicals of Concern[a]

Chemical	Mouse NOAEL (mg/kg/day)	Rat NOAEL (mg/kg/day)	Toxicity value selected for Indicator Sprecies[b] (mg/kg/day)
METALS			
Arsenic	$6.0 \times 10^{+1}$		6.0
Barium	5.0	$1.0 \times 10^{+2}$	$1.0 \times 10^{+1}$
Beryllium	9.5×10^{-1}		1.0×10^{-1}
Chromium (III)		$1.4 \times 10^{+3}$	$1.4 \times 10^{+2}$
Chromium (VI)		2.4	2.4×10^{-1}
Lead	$3.9 \times 10^{+1}$		3.9
Manganese		5.0	5.0×10^{-1}
Nickel		5.0	5.0×10^{-1}
Silver		$1.4 \times 10^{+2}$	$1.4 \times 10^{+1}$
Vanadium		5.0	5.0×10^{-1}
Zinc	$7.69 \times 10^{+1}$		7.7
ORGANICS			
Acetone	$4.85 \times 10^{+3}$	$1.0 \times 10^{+2}$	$4.85 \times 10^{+2}$
Ethylbenzene		$1.36 \times 10^{+2}$	$1.36 \times 10^{+1}$
Methylene Chloride		5.85	6.0×10^{-1}
Tetrachloroethene	$2.0 \times 10^{+1}$		2.0
1,1,1-Trichloroethane			N/A
Toluene	5.0	$3.12 \times 10^{+2}$	5.0×10^{-1}
Xylenes	$1.75 \times 10^{+2}$	$2.5 \times 10^{+2}$	$1.75 \times 10^{+1}$

[a] References for ecotoxicity values are included in Appendix G.

[b] An uncertainty factor of 10 has been applied to the toxicity values to account for intraspecies extrapolation from laboratory mice and rats to wild deer mice. See Appendix G for an explanation of the selection of the toxicity value for each chemical of concern.

N/A Not Available

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