Sandia National Laboratories/New Mexico

PROPOSALS FOR NO FURTHER ACTION ENVIRONMENTAL RESTORATION PROJECT

June 1999

Environmental
Restoration
Project

United States Department of Energy
Albuquerque Operations Office

EXECUTIVE SUMMARY

Sandia National Laboratories/New Mexico is proposing a risk-based no further action (NFA) decision for Solid Waste Management Units (SWMU) 65D, 81C, 94D, 61C, and 55. Review and analysis of all relevant data for these SWMUs indicate that concentrations of constituents of concern (COC) at these sites are less than applicable risk assessment action background levels. Thus, these SWMUs are proposed for an NFA decision based upon confirmatory sampling data demonstrating that COCs that could have been released from the SWMUs into the environment pose an acceptable level of risk under current and projected future land use, as set forth by Criterion 5, which states, "The SWMU/AOC [area of concern] has been characterized or remediated in accordance with current applicable state or federal regulations, and the available data indicate that contaminants pose an acceptable level of risk under current and projected future land use" (NMED March 1998). This executive summary briefly describes each of the above-listed SWMUs.

- SWMU 65D (the Near-Field Dispersion Area in Operable Unit [OU] 1333), an inactive subunit of SWMU 65, is the nearest extent (near-field) fragmentation area associated with the open-detonation tests at the Lurance Canyon Explosive Test Site (also referred to as the LCETS). A radiological voluntary corrective action (VCM) was conducted at the site in 1995 and 1996. Point sources and small area sources were removed in 1995. Larger area sources were remediated in 1996. Subsequent sampling analyses revealed residual metals and radionuclides at the SWMU. The site assessment concludes that SWMU 65D does not have the potential to affect human health under a recreational land-use scenario. After considering the uncertainties associated with the available data and modeling assumptions, it was determined that ecological risks associated with SWMU 65D were very low.

- SWMU 81C (the New Aerial Cable Site: Former Burial Location in OU 1333), an inactive subunit of SWMU 81, consists of an east-west trending shallow watercourse located south of the active sled track (SWMU 81A). Debris from testing activities at SWMU 81A was deposited and partially buried in and around SWMU 81C. A VCM was conducted at the site in 1998. Debris consisting of rocket motors, steel cable, and miscellaneous metal was removed from the site. Subsequent sampling analyses yielded the following COCs at the site: metals, radionuclides, high explosives (HE), volatile organic compounds (VOC), and semivolatile organic compounds (SVOC). The site assessment concludes that SWMU 81C does not have the potential to affect human health under a recreational land-use scenario. After considering the uncertainties associated with the available data and modeling assumptions, it was determined that ecological risks associated with SWMU 81C were very low.

- SWMU 94D (the Bomb Burner Discharge Pit in OU 1333), an inactive subunit of SWMU 94, encompasses the area of the discharge pit at the point of entry from the discharge line. The discharge pit received all wastewater from operation of the Bomb Burner Unit. No VCM was conducted at this SWMU. Confirmatory sampling analyses revealed residual metals, radionuclides, and VOCs at the site. The site assessment concludes that SWMU 94D does not have the potential to affect human health under a recreational land-use scenario. After considering the uncertainties associated with the available data and modeling assumptions, it was determined that ecological risks associated with SWMU 94D were very low.

- SWMU 61C (the Schoolhouse Mesa Test Site: Schoolhouse Building in OU 1334), an *inactive site located within the former Area Z explosives testing area, contains an* L-shaped, stucco structure, a soil mound, and the former location of an HE magazine/bunker. No VCM was conducted at this SWMU. Confirmatory sampling analyses yielded the following COCs at the site: metals, radionuclides, HE, VOCs, and SVOCs. The site assessment concludes that SWMU 61C does not have the potential to affect human health under an industrial land-use scenario. After considering the uncertainties associated with the available data and modeling assumptions, it was determined that ecological risks associated with SWMU 61C were low.

- SWMU 55 (the Red Tower in OU 1335), inactive since 1972, is the former location of a tower from which tests involving explosives and depleted uranium (DU) were conducted. The Red Tower was used in a series of tests in which a 50-pound sphere of explosives encased in a lead and DU shell was hoisted to the top of the tower and detonated. A radiological VCM was conducted at the site in 1995 and 1996. The Red Tower itself was removed in 1996. Subsequent sampling analyses revealed residual metals and radionuclides at the SWMU. The site assessment concludes that SWMU 55 does not have the potential to affect human health under an industrial land-use scenario. After considering the uncertainties associated with the available data and modeling assumptions, it was determined that ecological risks associated with SWMU 55 were low.

REFERENCES

New Mexico Environment Department (NMED), March 1998. "RPMP Document Requirement Guide," Hazardous and Radioactive Materials Bureau, RCRA Permits Management Program, New Mexico Environment Department, Santa Fe, New Mexico.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Concluded)

This page intentionally left blank.

LIST OF FIGURES

LIST OF FIGURES (Continued)

Figure **Page**

LIST OF FIGURES (Concluded)

This page intentionally left blank.

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

LIST OF TABLES (Concluded)

LIST OF ANNEXES

Annex

This page intentionally left blank.

ACRONYMS AND ABBREVIATIONS

AOC	area of concern
bgs	below ground surface
BH	borehole
BLM	Bureau of Land Management
C-1	Composition-1 explosive(s)
C-4	Composition-4 explosive(s)
CCTA	Central Coyote Test Area
CEARP	Comprehensive Environmental Assessment and Response Program
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
cm	centimeter(s)
cm^2	square centimeter(s)
COC	constituent of concern
CON-CON	Conical Containment
DOE	U.S. Department of Energy
DOT	Department of Transportation
dpm	disintegration(s) per minute
DU	depleted uranium
EM	electromagnetic
EOD	Explosive Ordnance Disposal
EPA	U.S. Environmental Protection Agency
ER	environmental restoration
ERCL	Environmental Restoration Chemistry Laboratory
g	gram(s)
GR	grab sample
HE	high explosive(s)
HI	hazard index
HMX	1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane
hr	hour(s)
HRMB	Hazardous and Radioactive Materials Bureau
HRS	Hazard Ranking System
HQ	hazard quotient
HSWA	Hazardous and Solid Waste Amendments
ID	identification
JP-4	jet fuel composition 4
KAFB	Kirtland Air Force Base
kg	kilogram(s)
L	liter(s)
LAARC	Light Airtransport Accident Resistant Container
lb	pound(s)
LCBS	Lurance Canyon Burn Site
LCETS	Lurance Canyon Explosive Test Site
LOBP	Large Open Burn Pool
MDA	minimum detectable activity
MDL	method detection limit
mg	milligram(s)

ACRONYMS AND ABBREVIATIONS (Continued)

mrem	millirem(s)
NFA	no further action
NMED	New Mexico Environment Department
OB	Oversight Bureau
OU	operable unit
pCi	picocurie(s)
PPE	personal protective equipment
PQL	practical quantitation limit
PRG	preliminary remediation goals
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
RCRA	Resource Conservation and Recovery Act
RDX	1,3,5-trinitro-1,3,5-triazacyclohexane
RFA	RCRA Facility Assessment
RFI	RCRA facility investigation
RMMA	Radiological Materials Management Area
RPD	relative percent difference(s)
RPO	Radiation Protection Office
RPSD	Radiation Protection Sample Diagnostics
RSI	Request for Supplemental Information
SAP	sampling and analysis plan
SMERF	Smoke Emissions Reduction Facility
SNL/NM	Sandia National Laboratories/New Mexico
SS	soil sample
SVOC	semivolatile organic compound
SVS	soil vapor survey
SWHCP	Site-Wide Hydrogeologic Characterization Project
SWISH	Small Wind-Shielded
SWMU	solid waste management unit
TABS	torch-activated burn system
TNT	2,4,6-trinitrotoluene
TPH	total petroleum hydrocarbon(s)
UXO	unexploded ordnance
VCM	voluntary corrective measure
VOC	volatile organic compound
yr	year
µg	microgram(s)

1.0 INTRODUCTION

Sandia National Laboratories/New Mexico (SNL/NM) is proposing No Further Action (NFA) Proposals for five Environmental Restoration (ER) Solid Waste Management Units (SWMUs). The following SWMUs are listed in the Hazardous and Solid Waste Amendments Module IV of the SNL/NM Resource Conservation and Recovery Act Hazardous Waste Management Facility Permit (NM5890110518) (EPA August 1993). Proposals for each SWMU are located in this document as follows:

Operable Unit 1333

- SWMU 65D, Near-Field Dispersion Area, Lurance Canyon Explosive Test Site (Section 2.0)
- SWMU 81C, Former Burial Location, New Aerial Cable Site (Section 3.0)
- SWMU 94D, Bomb Burner Discharge Pit, Lurance Canyon Burn Site (Section 4.0)

Operable Unit 1334

- SWMU 61C, Schoolhouse Mesa Test Site: Schoolhouse Building (Section 5.0)

Operable Unit 1335

- SWMU 55, Red Tower (Section 6.0)

These proposals each provide a site description, history, summary of investigatory activities, and the rationale for the NFA decision, as determined from assessments predicting acceptable levels of risk under current and projected future land use.

REFERENCES

U.S. Environmental Protection Agency (EPA), August 1993, "Module IV of RCRA Permit No. NM5890110518-1," EPA Region VI, issued to Sandia National Laboratories, Albuquerque, New Mexico.

4.0 SOLID WASTE MANAGEMENT UNIT 94D, BOMB BURNER DISCHARGE PIT, LURANCE CANYON EXPLOSIVES TEST SITE

4.1 Summary

Sandia National Laboratories/New Mexico (SNL/NM) is proposing a risk-based no further action (NFA) decision for Solid Waste Management Unit (SWMU) 94D, Bomb Burner Discharge Pit, Operable Unit (OU) 1333. SWMU 94D encompasses the area of the discharge pit at the point of entry from the discharge line. The discharge pit received all wastewater from operation of the Bomb Burner unit. Constructed in 1982, the Bomb Burner Unit was operated until 1988. During its operation, it had been used for 23 burn tests involving the exposure of weapons (some containing depleted uranium [DU]) and components to abnormal environments (Hooper May 1983, Stevenson December 1985, Hill Date [unk], SNL/NM October 1994). After tests involving radionuclides, wastewater from the Bomb Burner Unit was screened for radiological activity prior to release into the discharge pit (SNL/NM October 1994). As many as 1,500 gallons of wastewater per test may have been discharged into the pit. The Bomb Burner Unit was removed in 1997 under the SNL/NM decontamination and decommissioning program. Review and analysis of all relevant data for SWMU 94D indicate that concentrations of constituents of concern (COC) at this site are less than applicable risk assessment action levels. Thus, SWMU 94D is proposed for an NFA decision based upon confirmatory sampling data demonstrating that COCs that could have been released from the SWMU into the environment pose an acceptable level of risk under current and projected future land uses as set forth by Criterion 5, which states, "The SWMU/AOC [area of concern] has been characterized or remediated in accordance with current applicable state or federal regulations, and the available data indicate that contaminants pose an acceptable level of risk under current and projected future land use" (NMED March 1998).

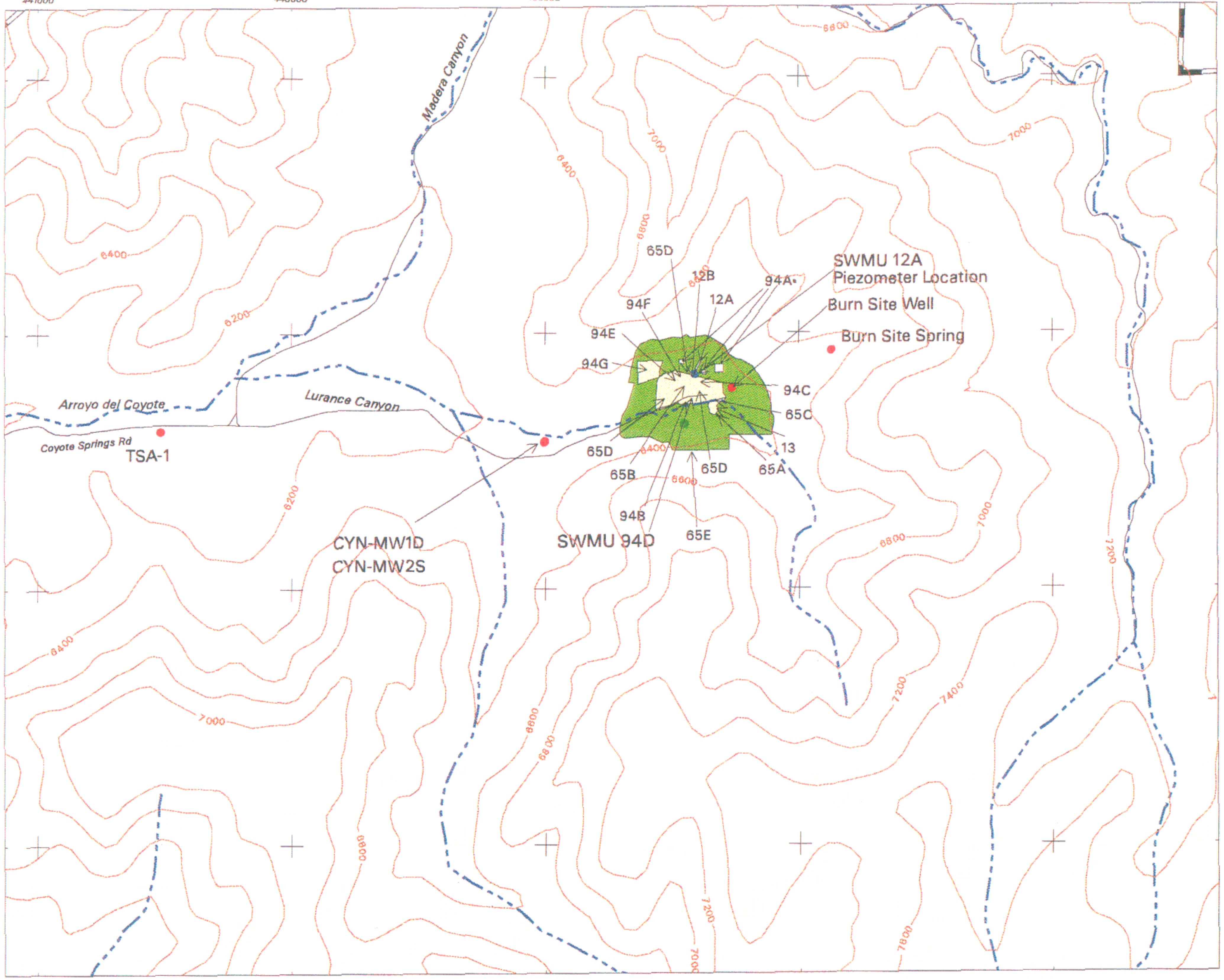
4.2 Description and Operational History

Section 4.2 describes SWMU 94D and discusses its operational history.

4.2.1 Site Description

SWMU 94D is a subunit of SWMU 94, which was identified as the Lurance Canyon Burn Site (LCBS) on the RCRA Hazardous and Solid Waste Amendment permit. SWMU 94D is located on U.S. Air Force land withdrawn from the Bureau of Land Management and permitted to the U.S. Department of Energy (DOE) (SNL/NM July 1994a). The site is located on the canyon floor alluvium in the closed upper reaches of the Lurance Canyon drainage. This drainage is surrounded by moderately steep sloping canyon walls, and the immediate topographic relief around the site is over 500 feet (Figure 4.2.1-1). A 25- to 50-foot-wide road is cut on the hillsides as a firebreak and encircles the site (Figure 4.2.1-2). The canyon floor at the site is isolated by the canyon walls except for the western drainage into the Arroyo del Coyote. Coyote Springs Road follows this drainage and is the main access road into the Lurance Canyon (Figure 4.2.1-1).

This page intentionally left blank.



Legend

- SWMU 94D
- Well
- Piezometer Location
- Other SWMU Sites
- Kirtland Air Force Base Boundary
- Surface-Water Features
- 200 Foot Contour Interval

0 2000 4000
Scale in Feet

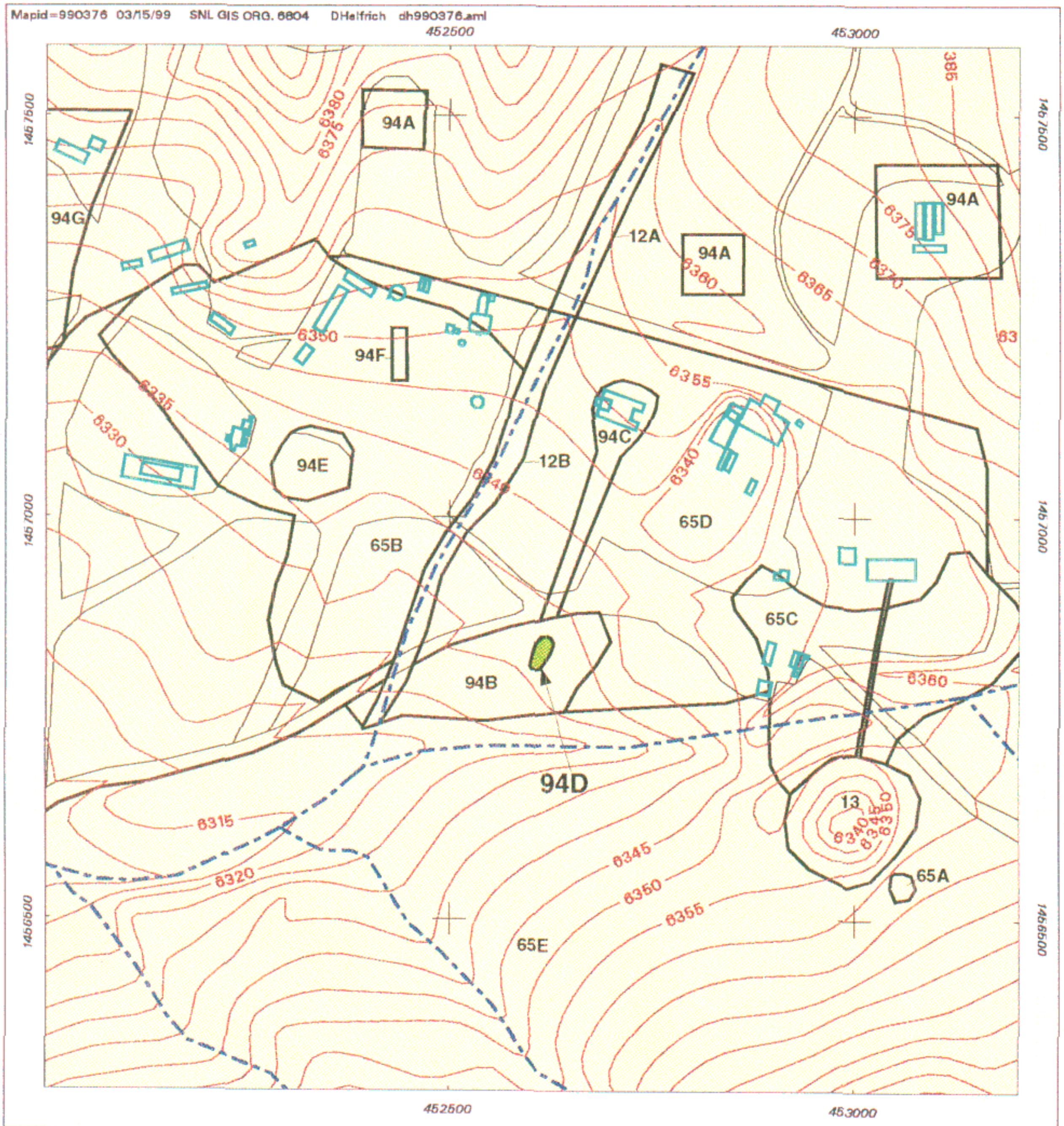
0 480 960
Scale in Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Figure 4.2.1-1
Location of SWMU 94D
Bomb Burner Discharge Pit
within Operable Unit 1333

Transverse Mercator Projection, New Mexico State Plane Coordinate System, Central Zone, 1927 North American Horizontal Datum, 1929 North American Vertical Datum

dr990399b.prl	1:24000	MAPID=980980
Unclassified		SNL GIS ORG. 6804
D Rizor	dr980980.aml	08/28/98



Legend

- Road
- 5 Foot Contour
- Surface Drainage
- Building / Structure
- SWMU 94D
- Other SWMUs

Figure 4.2.1-2
Site Map of SWMU 94D

0 100 200
Scale in Feet

0 24 48
Scale in Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

The LCBS is currently used for testing fire survivability of transportation containers, weapons components, simulated weapons, and satellite components (Author [unk] Date [unk], Martz November 1985, SNL/NM May 1986). Only a few of the permanent engineered structures present at the site are active today. The location of SWMU 94 coincides with SWMU 65, Lurance Canyon Explosives Test Site, an inactive site used for high explosives (HE) tests and for liquid and solid propellant burn tests.

In order to facilitate site characterization, SWMU 94 has been subdivided into seven subunits where hazardous constituents could have been released (Figure 4.2.1-2): SWMU 94A (Aboveground Tanks), SWMU 94B (Debris/Soil Mound Area), SWMU 94C (Bomb Burner Area and Discharge Line), SWMU 94D (Bomb Burner Discharge Pit), SWMU 94E (Small Surface Impoundment), SWMU 94F (Light Airtransport Accident Resistant Container [LAARC] Discharge Pit), and SWMU 94G (Scrap Yard). All of these subunits are inactive except for SWMU 94G (Scrap Yard), and SWMU 94A, which contains both active and inactive tanks. This NFA addresses historical releases from the discharge pit. Table 4.2.1-1 contains the rationale for subunit designation or omission. Each SWMU 94 subunit is addressed in a separate NFA proposal. The NFA proposal for SWMU 94A was submitted in September 1998 (SNL/NM September 1998). SWMUs 94B, 94C, 94E, 94F, and 94G will be addressed in future NFA submittals.

SWMU 94D, which occupies less than 0.1 acre (SNL/NM April 1995), consists of an open pit with no visible surface debris or soil discoloration. The mean elevation of this subunit is 6,333 feet above sea level (SNL/NM April 1995).

Historical published information regarding the hydrogeology of the Lurance Canyon was summarized in the "RCRA Facility Investigation [RFI] Work Plan for the Operable Unit 1333, Canyons Test Area" (SNL/NM September 1995). Since that time, additional bedrock wells and alluvial piezometers have been installed in the Lurance Canyon, and data collected from the new bedrock wells have supported the hydrologic model of semiconfined to confined groundwater conditions at a depth of approximately 222 feet below ground surface (bgs) beneath the Lurance Canyon SWMUs. The data collected from the alluvial piezometers support the absence of alluvial groundwater. Hydrologic data have been based upon the Burn Site Well, CYN-MW1D, 12AUP01 (piezometer), and CYN-MW2S (piezometer). This section summarizes the hydrologic conditions at each monitoring location.

The Burn Site well (located approximately 720 feet northeast of SWMU 94D) was drilled in February 1986 to a total depth of 350 feet bgs (Figure 4.2.1-1). A total of 74 feet of clay, silt, and shale units were encountered overlying the bedrock identified as metamorphic schists and fractured granite. Water-bearing bedrock was encountered at a depth of 222 to 350 feet bgs (New Mexico State Engineers Office Well Record RG-44986 [April 1986]). Following well completion, the water level rose to 68 feet bgs.

A shallow underflow piezometer was installed in November 1996 in SWMU 12A approximately 480 feet north of SWMU 94D (Figure 4.2.1-2). The piezometer was installed in conformance with a document of understanding between SNL/NM and the New Mexico Environment Department (NMED)/DOE Oversight Bureau (OB) (Dawson August 1996). The subsurface geology at the site is comprised of approximately 55 feet of alluvial sand, silt, and gravel overlying metamorphic phyllite to schist bedrock. The piezometer, identified as 12AUP01, was completed to a depth of approximately 58 feet bgs. Moist soil was encountered in the first 5 feet

Table 4.2.1-1
Correlation of Burn Testing Structures and Associated Features to SWMU 94 Subunits

Burn Unit/Structure	Designated Subunit for Site Characterization	Type/Nature of Operational Release	Rationale for Characterization
Portable Pans	None	Detonations (HE, gun propellant, radionuclides)	Nature of operational release covered in sampling plans for SWMUs 65B and 65D
	SWMU 94E	Wastewater	No operational historical releases in most tests; some documented releases to Small Surface Impoundment
Small Surface Impoundment	SWMU 94E	Wastewater (JP-4 fuel and water mixture)	Documented releases and burn test in the Small Surface Impoundment
LOBP (30 x 60 feet)	None	Wastewater (JP-4 fuel and water mixture)	Only operational historical releases to SWMU 13, no documented historical releases from accidental spills
SOBP (20 x 20 feet)	None	Wastewater (JP-4 fuel and water mixture)	No operational historical releases and no documented historical releases from accidental spills
LAARC Unit	None	Wastewater (JP-4 fuel and water mixture)	No documented historical releases within LAARC Unit from accidental spills
LAARC Discharge Pit	SWMU 94F	Wastewater (JP-4 fuel and water mixture)	Operational historical releases to discharge pit
Bomb Burner Unit and Trench	SWMU 94C	Detonations (HE, radionuclides, metals) and wastewater (JP-4 fuel and water mixture) Detonations (HE, radionuclides, metals)	Documented operational historical releases inside and near the Bomb Burner Unit, removed in D&D activities in 1997 Documented detonations in Bomb Burner Unit trench
Bomb Burner Discharger Pit	SWMU 94D	Wastewater (JP-4 fuel and water mixture)	Documented operational historical releases to discharge pit
SWISH Unit	None	None (wastewater recirculated, never disposed of wastewater)	No operational historical releases and no documented historical releases from accidental spills
SMERF	None	None (wastewater recirculated)	No operational historical releases
Bunker 9830	None	None	No operational historical releases outside structure; historical releases within structure covered in future D&D activities
Aboveground Tanks	SWMU 94A	Accidental spills of JP-4 fuel on soil	Documented historical releases from accidental spills
Debris/Soil Mounds	SWMU 94B	Metals or radionuclides leachate	Mounds have no documented history and contain radiological anomalies
Scrap Yard	SWMU 94G	Accidental spills of hydraulic oils on soil	Documented release of hydraulic oil

D&D = Decontamination and decommissioning.
HE = High explosive(s).
JP-4 = Jet fuel composition 4.
LAARC = Light Airtransport Accident Resistant Container.
LOBP = Large Open Burn Pool.
SMERF = Smoke Emission Reduction Facility.
SOBP = Small Open Burn Pool.
SWISH = Small Wind-Shielded.
SWMU = Solid Waste Management Unit.

of alluvium. The remaining 53 feet to bedrock were dry. No groundwater was encountered during drilling. The piezometer was instrumented in February 1997 and has been collecting data since that time. In addition, manual checks have been conducted for the presence of water as a verification procedure. No water has been recorded in the piezometer subsequent to its installation.

The Burn Site Spring (Figure 4.2.1-1) is an ephemeral spring or, more accurately described, a seep, located approximately 2,640 feet northeast of SWMU 94D. The seep discharges small quantities of water from fractures and/or bedding plane permeability within the carbonate rocks (Goodrich [Month Unk.] 1993). It is believed that the source of the water is seasonal recharge of fractures from the surrounding mountain terrain.

A groundwater monitoring well nest was installed in November and December 1997 approximately 3,000 feet west of (downgradient from) the LCBS (Figure 4.2.1-1). The groundwater wells were installed in conformance with the documents of understanding between SNL/NM and the NMED OB (SNL/NM July 1997, SNL/NM September 1997a). The monitoring well nest is comprised of a shallow underflow piezometer (CYN-MW2S) and a deep groundwater well (CYN-MW1D). The subsurface geology at the nest location is characterized by approximately 25 feet of alluvial sand, silt, and gravel, unconformably overlying the Manzanita Gneiss, which is fractured. No water was encountered while drilling activities were conducted in the alluvium, and no water has been recorded at CYN-M2S since its installation. Groundwater was first encountered in CYN-MWD at a depth of 372 feet bgs and the static level rose to 320 feet bgs. This indicated semiconfined to confined groundwater conditions similar to those encountered in the Burn Site Well (Figure 4.2.1-1).

In summary, the groundwater beneath the LCBS occurs at depths of at least 222 feet bgs under semiconfined to confined conditions in fractured metamorphic rock. There has been no record to date of shallow groundwater occurring in the alluvium overlying the bedrock.

For a detailed discussion regarding the local setting at SWMU 94D, refer to the RFI Work Plan for OU 1333 (SNL/NM September 1995).

4.2.2 Operational History

Historical aerial photographs indicate that the transition of testing activities from predominantly open-detonation explosives testing and jet fuel composition 4 (JP-4) fuel fires in excavated pits (SWMU 65) to open burning of test units with JP-4 fuel fires in portable pans (SWMU 94) occurred between 1971 and 1982 (SNL/NM August 1994). Based upon test reports and interviews, open burning with JP-4 fuel fires in portable burn pans began around 1975. By 1980, the first permanent engineered burn unit (LAARC) was constructed on the former location of the Primary Detonation Area (SWMU 65B) and was in operation (Annex 4-A). The scrap yard (SWMU 94G) was established in the northwestern portion of the site within the former location of the Far-Field Dispersion Area (SWMU 65E) (Larson and Palmieri October 1994). The scrap yard has historically been used to store spare materials used in explosives and burn tests and is still in use today for storing nonliquid materials and used equipment.

By 1983, most of SWMU 94 was constructed, with a total of six permanent engineered burn units (the Large Open Burn Pool, the Small Open Burn Pool, the LAARC Unit, the Bomb Burner Unit, the Small Wind-Shielded [SWISH] Unit, and the Conical Container [CON-CON] Unit) placed on the graded area that was formerly the location of the Primary Detonation Area (SWMU 65B) and the Near-Field Dispersion Area (SWMU 65D) (SNL/NM August 1994) (Figure 4.2.2-1). Two of the burn units (the SWISH Unit [and later the Smoke Emissions Reduction Facility (SMERF) Unit]) were constructed to provide testing facilities that would eliminate wind effects and provide accurate temperature control and instrumentation for test monitoring (Palmieri April 1995a). A small surface impoundment (SWMU 94E) is also visible southeast of Bunker 9830. Engineered soil berms had been constructed by 1983 in the southeastern portion of the site for flood protection from the main arroyo in the Lurance Canyon.

By 1992, the site contained all the current permanent engineered burn units (Figure 4.2.2-2). The CON-CON Unit, identified in the 1983 historical aerial photograph, was dismantled prior to 1989, and by 1992 a new burn unit (SMERF) was constructed in the same location (SNL/NM August 1994). Prior to 1992, a debris/soil mound area (SWMU 94B) was created in the southern portion of SWMU 94, directly north of the main arroyo in the Lurance Canyon (Figure 4.2.2-2). This debris/soil mound could be associated with ongoing grading activities at the site. Northeast of the debris/soil mound area (SWMU 94B) is a second soil mound that was created during remediation of a wastewater spill from the SMERF on March 20, 1992 (Figure 4.2.2-2).

Burn testing at the LCBS has always been conducted with JP-4 fuel pool fires in open portable pans or contained within the permanent engineered structures (Jercinovic et al. November 1994). Pool fires provide the closest simulation of accidents involving flammable liquids (Author [unk] Date [unk]). For the tests, the pans are filled with approximately 1 to 2 feet of water, and an average 8-inch layer of JP-4 fuel is placed on the water. A test unit such as a transportation container is placed on a stand above the fuel. The fuel is ignited, and the fire typically burns until the JP-4 fuel is consumed. The length of the test is controlled by the volume (thickness) of the JP-4 fuel layer. After a burn test is completed, test units are retrieved and salvageable materials are collected and stored in the scrap yard located in the northwestern portion of the site (Figure 4.2.2-2). Any test object residue (e.g., metal slag) is recovered with the test unit and is removed from the site by the testing group. It is possible that only small residue particulates were left in the water following the burn test (Larson and Palmieri October 1994). While no testing is currently conducted on components containing radioactive materials, SWMU 94 is classified as a radiological materials management area (RMMA) because of the presence of residual DU in the soil from earlier burn tests (Gaither December 1993) and from former explosives testing activities associated with SWMU 65 (Gaither January 1994). Annex 4-A presents tabulated data from SWMU 94 testing activities documented in test logs since 1979.

The Bomb Burner Unit was constructed in 1982 and it was operated until 1988. During its operation, it was used for 23 burn tests involving the exposure of weapons (some containing DU) and components to abnormal environments (Hopper May 1983, Stevenson December 1985, Hill Date [unk], SNL/NM October 1994). After tests involving radionuclides, wastewater from the Bomb Burner Unit was screened for radiological activity prior to release into the discharge pit (SNL/NM October 1994). As many as 1,500 gallons of wastewater per test may have been discharged into the pit. In 1997, the Bomb Burner Unit was removed from the site under the SNL/NM decontamination and decommissioning program.

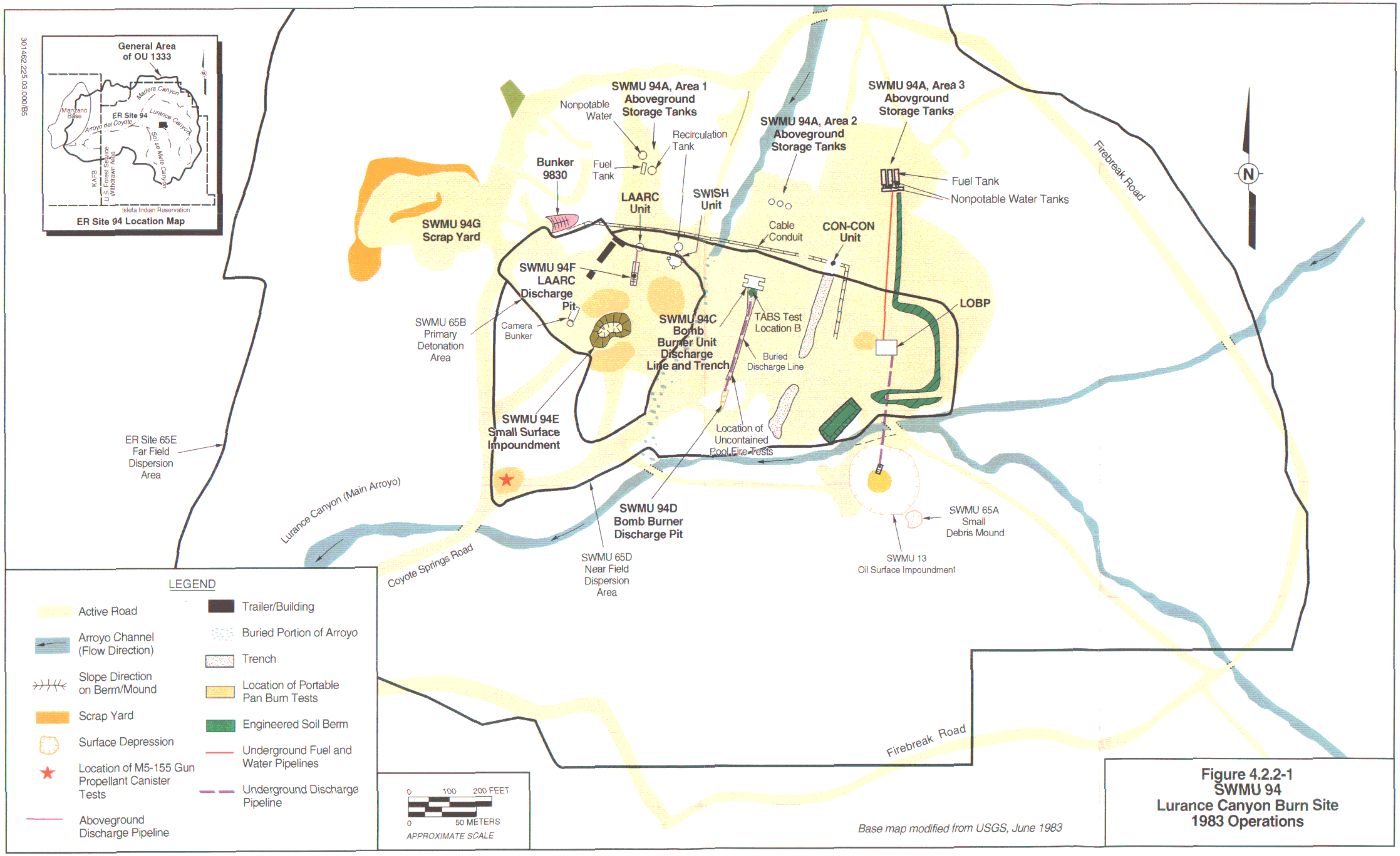


Figure 4.2.2-1
SWMU 94
Lurance Canyon Burn Site
1983 Operations

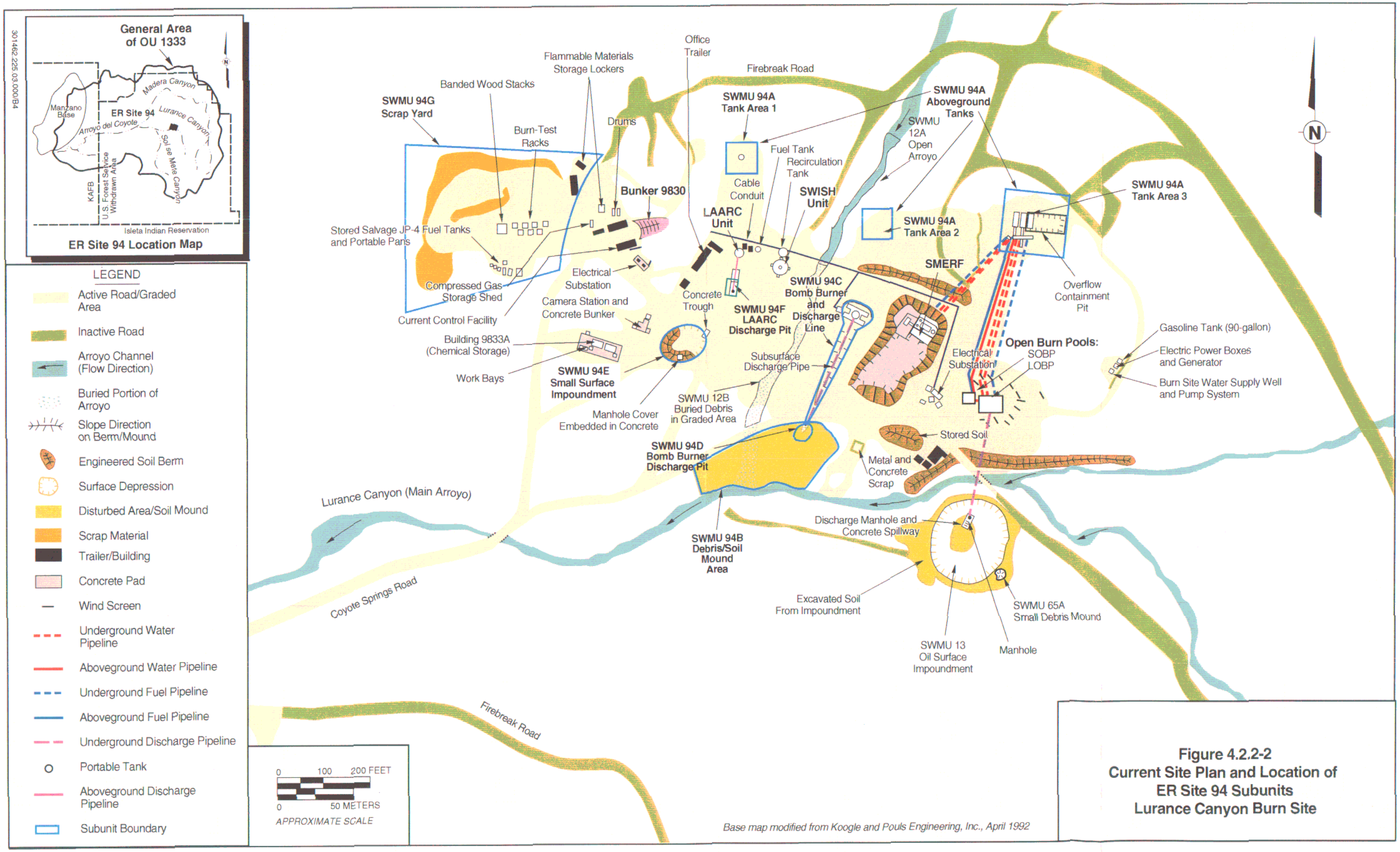


Figure 4.2.2-2
Current Site Plan and Location of ER Site 94 Subunits Lurance Canyon Burn Site

4.3 Land Use

This section discusses the current and future/proposed land uses for SWMU 94D.

4.3.1 Current

SWMU 94D is located within the boundaries of Kirtland Air Force Base (KAFB) (Figure 4.3.1-1) within the active industrial LCBS.

4.3.2 Future/Proposed

The future/proposed land use for SWMU 94D is recreational (DOE et al. October 1995).

4.4 Investigatory Activities

SWMU 94D has been investigated in a series of three investigations. Section 4.4 discusses these investigatory activities.

4.4.1 Summary

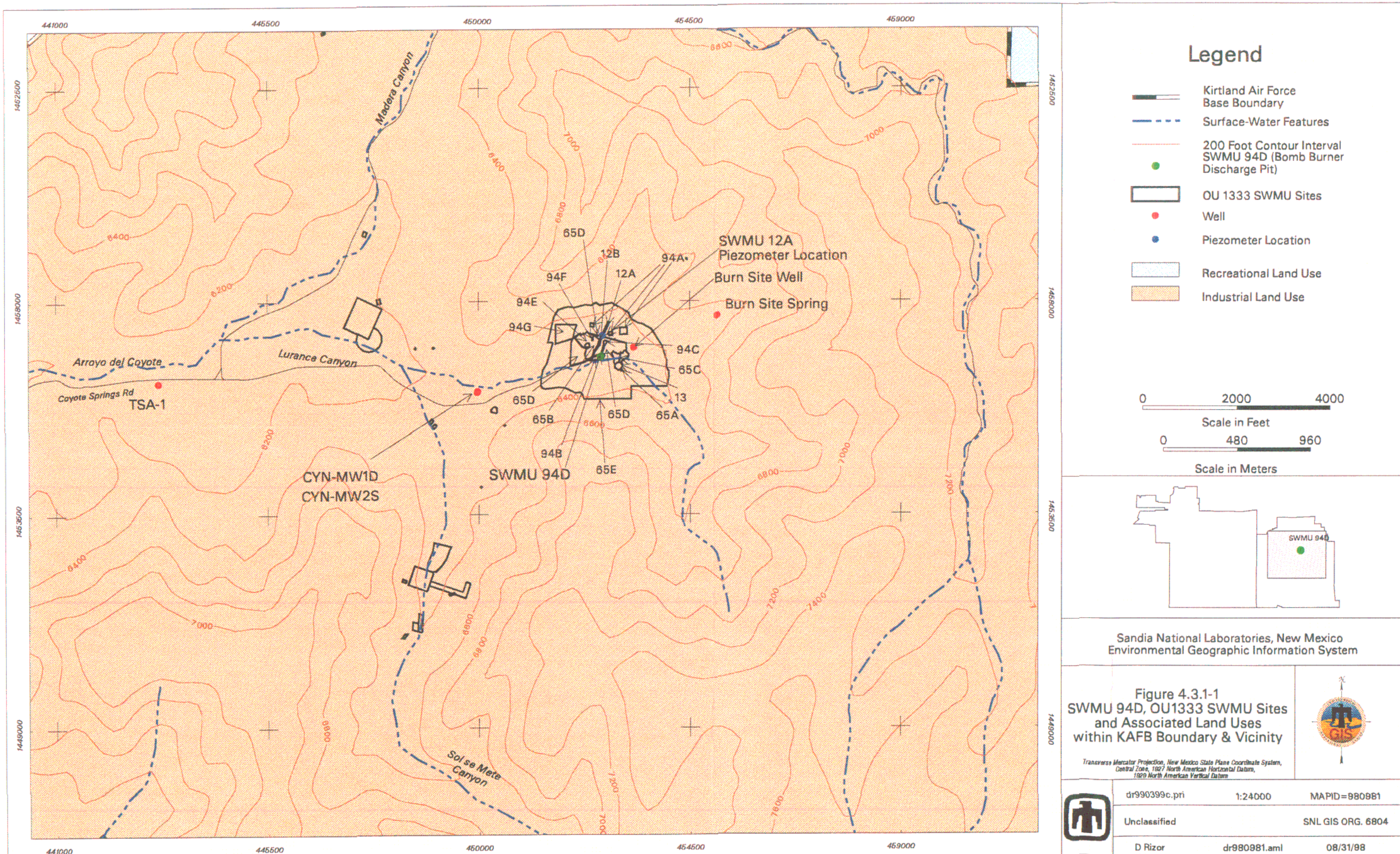
SWMU 94D was originally investigated under the DOE Comprehensive Environmental Assessment and Response Program (CEARP) in the mid-1980s (Investigation #1) in conformance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). In 1993 preliminary investigations began that included background information reviews, interviewing, field surveys, and scoping sampling (Investigation #2). In 1998 a passive soil vapor survey (SVS) and confirmatory soil sampling were conducted (Investigation #3).

4.4.2 Investigation #1—CEARP and RCRA Facility Assessment

4.4.2.1 Nonsampling Data Collection

SWMU 94 was evaluated during investigations conducted under the CEARP (DOE September 1987) and the RCRA Facility Assessment (RFA) (EPA April 1987). The CEARP Phase I report stated that SWMU 94 was constructed in the late 1970s and is currently used for studying the effects of fire on a variety of test units (e.g., weapons components and transportation containers). JP-4 is the standard fuel burned, but propellants and nitromethane were also used. Current test activities may release metallic particulates and other materials into the environment.

The RFA report (EPA April 1987) noted only that scrap metal, old equipment, empty drums, and empty tanks used in impact experiments are contained in a 3- to 5-acre area (SWMU 94G [Scrap Yard]). The storage of liquids was not noted during the visual site inspection.



Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Figure 4.3.1-1
SWMU 94D, OU1333 SWMU Sites and Associated Land Uses within KAFB Boundary & Vicinity

Transverse Mercator Projection, New Mexico State Plane Coordinate System, Central Zone, 1927 North American Horizontal Datum, 1929 North American Vertical Datum

dr990399c.pri	1:24000	MAPID=980981
Unclassified		SNL GIS ORG. 6804
D Rizor	dr980981.aml	08/31/98

4.4.2.2 Sampling Data Collection

No sampling activities were conducted at SWMU 94D as part of the CEARP.

4.4.2.3 Data Gaps

Insufficient information was available to calculate a hazard ranking system (HRS) and modified HRS migration mode scores.

4.4.2.4 Results and Conclusions

The CERCLA finding under the CEARP was uncertain for RCRA-regulated hazardous waste.

4.4.3 Investigation #2—SNL/NM Environmental Restoration Preliminary Investigations

4.4.3.1 Nonsampling Data Collection

This section describes the nonsampling data collected at SWMU 94D.

4.4.3.1.1 Background Review

A background review was conducted in order to collect available and relevant information regarding SWMU 94D. Background information sources included interviews with SNL/NM staff and contractors familiar with the site's operational history and reviews of existing historical site records and reports. The study was documented completely and has provided traceable references that sustain the integrity of the NFA proposal. Table 4.4.3-1 lists the information sources that were used to assist in evaluating SWMU 94D.

4.4.3.1.2 UXO/HE Survey

In October 1993, KAFB Explosive Ordnance Disposal personnel conducted a visual survey for the presence of unexploded ordnance (UXO)/HE on the ground surface at SWMU 94 in conjunction with SWMUs 65, 12, and 13. The survey identified one trip flare as live ordnance and one slap flare and one rifle-propelled illuminator round as ordnance debris. The survey report also documented that metal fragments were found in the hills surrounding these sites (Young September 1994).

Table 4.4.3-1
Summary of Background Information Review for SWMU 94D

Information Source	Reference	
Technical test reports and project log books	Hill [Date unk.] Kervin April 1981 Moore September 1981 Moore June 1982 Gill November 1982 Moore and Luna February 1983 Luna March 1983	Hooper May 1983 Luna and Moore June 1983 Mata December 1983 Cocke May 1984 Stevenson December 1985 SNL/NM November 1994
Engineering drawings "Burn Site" (Drawing Number T95597)	SNL/NM 1983	
Site inspections (field notes, aerial photograph review, site photographs, radiological, UXO/HE, biological, and cultural resource surveys)	Gaither [Date unk.] Luna October 1985 Gaither October 1992 Oldewage May 1993 Karas June 1993	Oldewage December 1993a Oldewage December 1993b Oldewage February 1994 SNL/NM August 1994 Young September 1994
Employee interviews, 24 interviews with 11 facility personnel (current and retired)	Martz September 1985 Martz November 1985 Brouillard June 1994 Larson and Palmieri August 1994a Palmieri September 1994a Palmieri September 1994b Palmieri and Larson October 1994 Jercinovic et al. November 1994 Palmieri November 1994a Palmieri November 1994b	Hickox and Abitz December 1994 Palmieri December 1994a Palmieri December 1994b Palmieri December 1994c Palmieri January 1995 Palmieri March 1995 Jercinovic April 1995 Palmieri April 1995a Palmieri April 1995b Palmieri August 1995

HE = High explosive(s).
SWMU = Solid Waste Management Unit.
UXO = Unexploded ordnance.

4.4.3.1.3 Radiological Survey(s)

SWMU 94 is classified as a RMMA because it is co-located with the SWMU 65 RMMA (SNL/NM November 1994). On April 30 and May 4, 1993, the SNL/NM Radiation Protection Office personnel conducted contamination surveys of several sections of road in the Coyote Canyon area. Adhesive swipes that had been placed on the underside of the vehicle collected samples of air from behind the vehicle as it was moving. Analysis yielded no contamination, nor was airborne radioactivity detected in the dust kicked up by the vehicle (Oldewage May 1993).

During November and December 1993 and January 1994, RUST Geotech Inc. conducted a surface gamma radiation survey of SWMU 94 in conjunction with SWMUs 65, 12, and 13. The gamma scan survey was performed at 6-foot centers (100-percent coverage) over the surface of the graded portion of the site (SWMU 65D) which included the area of SWMU 94D. No surface gamma radiation anomalies were detected within the boundaries of SWMU 94D (SNL/NM September 1997b).

4.4.3.1.4 *Cultural-Resources Survey*

A cultural-resources survey of SWMU 94 was conducted as part of the assessment of the LCBS. Seven cultural-resources sites were identified at the LCBS (Hoagland and Dello-Russo February 1995). However, none of the cultural-resource sites are within 100 feet of the SWMU 94D boundaries, and SWMU 94D sampling activities have not affected the cultural resources.

4.4.3.1.5 *Sensitive-Species Survey*

A sensitive-species survey was conducted as part of a biological assessment of the LCBS (Biggs May 1991). No sensitive species were found during this survey (IT February 1995). The site is active and no undisturbed habitat remains in the graded portion of the LCBS.

4.4.3.1.6 *Geophysical Survey(s)*

No geophysical surveys were performed in the vicinity of SWMU 94D.

4.4.3.2 *Sampling Data Collection*

In July 1995, SWMU 94D was investigated as part of a sitewide scoping sampling program. The purpose of this effort was to obtain preliminary analytical data to support the Environmental Restoration (ER) Project site ranking and prioritization. Two sampling locations were selected within the boundary of SWMU 94D. A surface sample (0 to 6 inches) and a subsurface sample (1.5 to 2 feet) were collected at each location. The SNL/NM ER Chemistry Laboratory analyzed the four environmental samples for RCRA metals (plus beryllium) using modified EPA Method 6010 (EPA November 1986), for total petroleum hydrocarbons (TPH) using an immunoassay method, and for HE using high-performance liquid chromatography. In addition, the Radiation Protection Sample Diagnostics (RPSD) Laboratory analyzed the samples for gamma-emitting radionuclides using gamma spectroscopy.

4.4.3.3 *Data Gaps*

Information gathered through process knowledge, reviewing historical files, and interviewing personnel aided in identifying the most likely COCs at SWMU 94D and in selecting types of analyses to be performed on soil samples. However, the preliminary scoping data are not adequate to define organic COCs or support a risk screening assessment.

4.4.3.4 *Results and Conclusions*

No TPH concentrations were detected in any of the samples at the method detection limit (MDL) of 10 parts per million. Only barium, mercury, lead, and selenium were detected in the soil samples. Barium concentrations were below the background limit of 246 milligrams (mg)/kilogram (kg). Mercury was detected in two samples ranging from 0.07 J mg/kg to 0.24 mg/kg, above the background limit of 0.055 mg/kg. Lead concentrations were all estimated and ranged between 13 J mg/kg and 20 J mg/kg, and two of the four samples exceeded the background limit of 18.9 mg/kg. Selenium was detected in one sample at a concentration of 34 J mg/kg, above the background limit of 3.0 mg/kg. Arsenic, cadmium, chromium, and silver were not detected. The MDL ranged from 0.2 mg/kg (for mercury) to 50 mg/kg (for arsenic and selenium) and exceeded the background limits. No HE compounds were detected in any of the soil samples at MDLs ranging from 150 to 750 micrograms/kg. No duplicate samples were analyzed.

Uranium-235 was not detected in any scoping samples above the minimum detectable activity (MDA). However, the MDA for all uranium-235 analyses exceeded the background activity limit of 0.16 picocuries (pCi)/gram (g). Uranium-238 was detected above the MDA and the background activity limit of 2.31 pCi/g in two samples (CY94D-GR-002-0-SS and CY94D-GR-001-1.5-S) with activities of 2.86 and 3.81 pCi/g respectively. In three of the samples, the uranium-238 MDA exceeded the background activity limit of 2.31 pCi/g. Thorium-232 was not detected in any samples at levels above the background activity limit of 1.03 pCi/g. Cesium-137 was not detected in any samples above the background activity limit of 0.515. (Scoping data not included in Annex 4-B.)

4.4.4 Investigation #3—SNL/NM ER Passive SVS and Confirmatory Sampling

4.4.4.1 Nonsampling Data Collection

No nonsampling data collection activities were associated with Investigation #3 of SWMU 94D.

4.4.4.2 Sampling Data Collection

This section discusses the passive SVS and confirmatory soil sampling at SWMU 94D.

4.4.4.2.1 Passive SVS

SNL/NM conducted a passive SVS of the entire LCBS in February 1998. All SVS activities were implemented in accordance with the rationale and procedures described in the sampling and analysis plan (SAP) for "Soil Vapor Surveys at the Lurance Canyon Burn Site" (SNL/NM February 1998a). The SAP combined the investigation activities proposed in the RFI Work Plan for OU 1333 (SNL/NM September 1995) with the comment responses to the request for supplemental information relating to the OU 1333 RFI Work Plan (SNL/NM December 1997). In addition, the SAP was reviewed by the NMED and includes SNL/NM and NMED/DOE OB agreed-upon recommendations. SVS samplers were installed approximately 18 to 36 inches bgs. The samplers were retrieved after approximately 16 days. The manufacturer-recommended installation depth and residence time are 18 inches bgs minimum and 14 days minimum, respectively.

Within the boundaries of SWMU 94D, the survey was designed to determine the presence of volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs) associated with historical discharges to the pit. Passive soil vapor samplers were installed approximately 40 feet apart at two locations. After approximately 16 days residence time, the samplers were retrieved for off-site analysis at W.L. Gore & Associates, Inc., in Elkton, Maryland. The samplers were analyzed for target VOCs (benzene, toluene, ethylbenzene, and xylene) using a modified EPA Method 8260 (EPA November 1986) and for target SVOCs using a modified EPA Method 8270 (EPA November 1986). These modified analytical methods involve thermal desorption, gas chromatography, and mass selective detection.

No detection above the reporting limits were seen at the two sampling locations. The reporting limits are based upon the maximum contaminant level observed in the field on trip blanks. The results of the passive SVS are summarized in a separate report previously submitted to the NMED (SNL/NM February 1998a).

4.4.4.2.2 Confirmatory Sampling

SNL/NM conducted confirmatory soil sampling at SWMU 94D in March and April 1998 to determine whether potential COCs were present at levels exceeding background limits at the site and/or were sufficient to pose a risk to human health or the environment. All sampling activities were performed in accordance with the rationale and procedures described in the OU 1333 RFI Work Plan (SNL/NM September 1995) and the associated Field Implementation Plan addendum to the work plan (SNL/NM March 1998), as reviewed by NMED. SNL/NM chain-of-custody and sample documentation procedures were followed for all samples collected. Figure 4.4.4-1 shows the confirmatory sample locations associated with SWMU 94D.

In March and April 1998, surface soil samples were collected from three locations within the Bomb Burner Discharge Pit. In addition, three subsurface samples were collected from a single soil boring located near the lowest point in the Bomb Burner Discharge Pit. The subsurface samples were collected at 5-foot intervals as the borehole was advanced to a total depth of 16 feet below ground surface (bgs). Quality assurance (QA)/quality control (QC) samples included one duplicate subsurface soil sample, one equipment blank, and two trip blanks. All soil samples and the equipment blank were analyzed off site for RCRA metals plus beryllium, HE, and VOCs. The soil samples from the borehole were also analyzed off site for SVOCs. In addition, two surface and two subsurface samples were analyzed off site for gross alpha and gross beta activity. The two trip blanks were analyzed off site for VOCs only. Core Laboratories Inc. of Denver, Colorado, analyzed the samples for RCRA metals plus beryllium using EPA Methods 6010/7000 (EPA November 1986); for HE using EPA Method 8330 (EPA November 1986); for VOCs using EPA Method 8260 (EPA November 1986); for SVOCs using EPA Method 8270 (EPA November 1986); and for gross alpha and gross beta activities using EPA Method 900.0 (EPA November 1986). SNL/NM Department 7713, RPSD Laboratory, analyzed two samples for radionuclides using gamma spectroscopy to permit the off-site transport of samples to Core Laboratories Inc.

4.4.4.3 Data Gaps

Information gathered through process knowledge, review of historical site files, and personal interviews aided in identifying the most likely COCs at SWMU 94D and in the selection of the types of analyses performed on soil samples. Analytical data from confirmatory sampling are sufficient to characterize the nature and extent of historical releases of COCs at the site. There are no further data gaps regarding characterization of the SWMU 94D.

This page intentionally left blank.

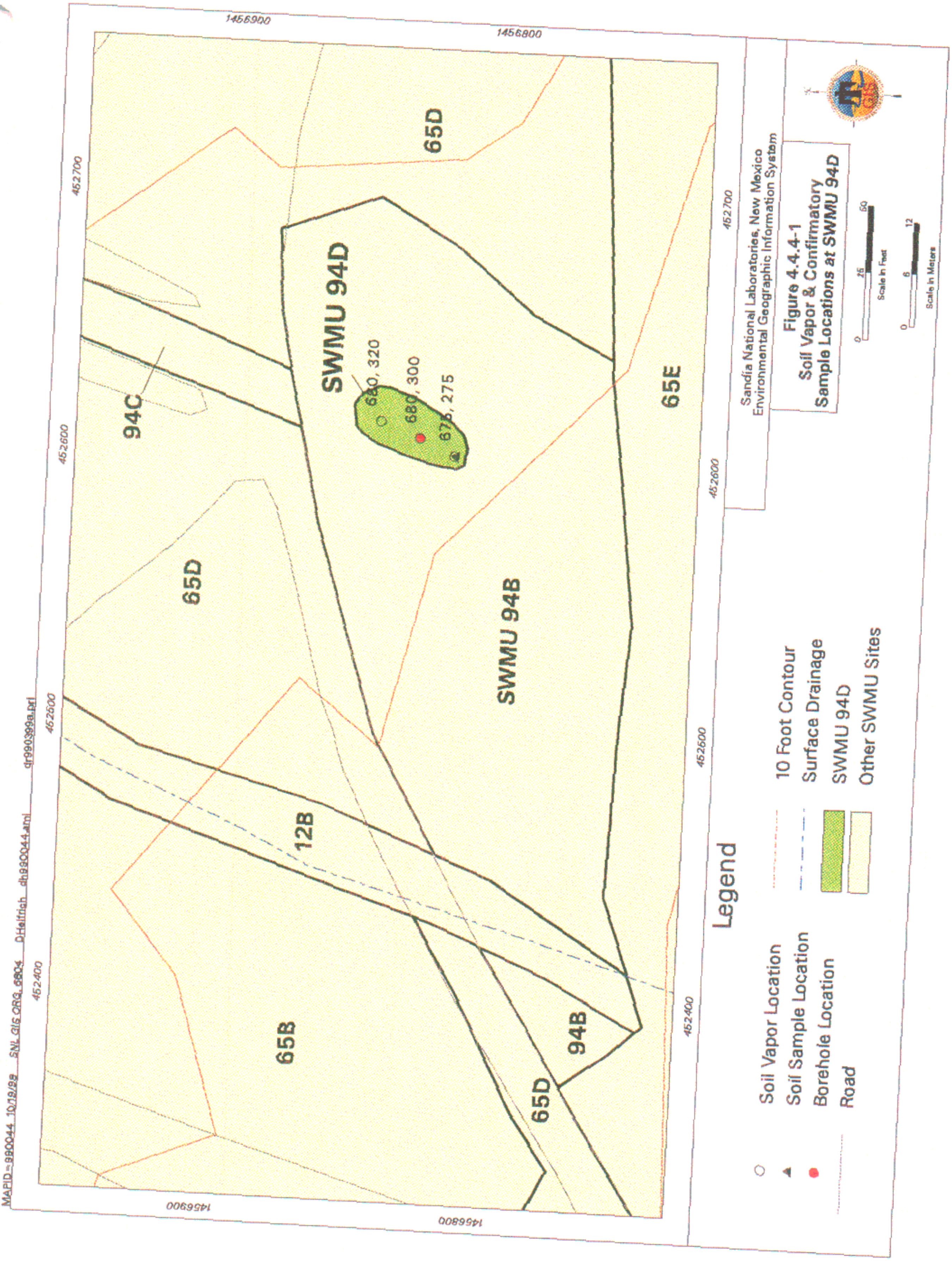


Figure 4.4.4-1
Soil Vapor & Confirmatory
Sample Locations at SWMU 94D

4.4.4.4 *Results and Conclusions*

In March and April 1998 representative soil samples were collected from three locations on the surface and from three locations within the subsurface of the Bomb Burner Discharge Pit. Tables 4.4.4-1, 4.4.4-2, 4.4.4-3, 4.4.4-4, 4.4.4-5, 4.4.4-6, and 4.4.4-7 summarize the metals, HE, VOCs, SVOCs, and radionuclide (i.e., gamma spectroscopy, and gross alpha and gross beta) analytical results, respectively, for all of the confirmatory soil samples collected at SWMU 94D. Annex 4-B contains complete results for the gamma spectroscopy analyses.

An example sample identification (ID) in the ER Sample ID column of the data summary tables is CY94D-BH-680,300-5-6-S. This ID refers to a sample collected from SWMU 94D within the Canyons Test Area of SNL/NM (CY94D). The sample was collected from a borehole (BH) located at the Lurance Canyon sample grid location 680,300. The sample depth was 5 to 6 feet bgs, which implies a subsurface sample type (S). This section briefly describes the results of confirmatory sampling at SWMU 94D.

Metals

Table 4.4.4-1 presents a summary of the off-site metals analysis results for the three surface soil samples, three subsurface soil samples, and the one duplicate subsurface soil sample from the Bomb Burner Discharge Pit at SWMU 94D. Although sample CY94D-BH-680,300-15-15.5-SQ is identified as a matrix spike/matrix spike duplicate, the results presented are from a prespike analysis conducted by the laboratory. As a result, this sample represents the subsurface conditions at the bottom of the 15-foot borehole. No metals, with the exception of silver, were detected above the background concentration limits in the samples collected at SWMU 94D. The background concentration limit for silver has not been quantified. All silver concentrations in the soil samples were reported as nondetectable at the MDL of 0.002914 mg/kg.

HE

Because there are no applicable background concentrations for HE compounds in soil, any detectable HE compounds in the samples collected at SWMU 94D can be considered an indication of contamination. However, no HE compounds were detected in any of the surface or subsurface soil samples collected at SWMU 94D. Table 4.4.4-2 summarizes the MDL used for analyzing HE compounds by the off-site laboratory.

VOCs

Table 4.4.4-3 presents a summary of the off-site VOC analysis results for the three surface soil samples, three subsurface soil samples, and one duplicate subsurface soil sample collected from the Bomb Burner Discharge Pit at SWMU 94D. As described above, the results presented for sample CY94D-BH-680,300-15.5-16-SQ are from a prespike analysis conducted by the laboratory. This sample, therefore, represents the subsurface conditions at the bottom of the 15-foot borehole.

Table 4.4.4-1
Summary of SWMU 94D Confirmatory Soil Sampling Metals Analytical Results, March—April 1998
(Off-Site Laboratory)

Sample Attributes			Metals (EPA 6010/7000[a]) (mg/kg)								
Record Number[b]	ER Sample ID (Figure 4.4.4-1)	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
600091	CY94D-BH-680,300-0-1-SS	0–1.0	2.16	156	0.527	ND (0.002453)	10.2	9.00	0.0172	0.182 J (0.5)	ND (0.002914)
600091	CY94D-BH-680,300-5-6-S	5.0–6.0	1.42	73.7	0.283 J (0.5)	ND (0.002453)	6.25	3.98	ND (0.000047)	ND (0.000891)	ND (0.002914)
600091	CY94D-BH-680,300-11-12-S	11.0–12.0	2.67	98.8	0.339 J (0.5)	ND (0.002453)	12.7	8.05	ND (0.000047)	0.118 J (0.5)	ND (0.002914)
600091	CY94D-BH-680,300-11-12-DU	11.0–12.0	2.62	90.6	0.356 J (0.5)	0.247 J (0.5)	7.67	0.0653	0.00881 J (0.10)	0.101 J (0.5)	ND (0.002914)
600091	CY94D-BH-680,300-15-15.5-SQ	15.0–15.5	2.76	83.1	0.413 J (0.5)	ND (0.002453)	10.9	7.05	0.00959 J (0.10)	0.118 J (0.5)	ND (0.002914)
600054	CY94D-680,310-GR-SS	0–0.5	1.74	113	0.367 J (0.5)	0.257 J (0.5)	7.50	6.08 B	ND (0.000047)	ND (0.000891)	ND (0.002914)
600054	CY94D-680,320-GR-SS	0–0.5	2.08	121	0.513	0.277 J (0.5)	9.12	6.88 B	0.0149 J (0.10)	ND (0.000891)	ND (0.002914)
Background Soil Concentrations, Canyon Area[c]			9.8	246	0.75	0.64	18.8	18.9	0.055	3.0	<0.5
Quality Assurance/Quality Control Sample (mg/L)											
600091	CY94D-GR-01-EB	NA	ND (0.000827)	ND (0.001709)	ND (0.001811)	0.00299 J (0.005)	ND (0.003826)	0.00169 J (0.005)	ND (0.000047)	ND (0.000891)	ND (0.002914)

[a]EPA November 1986.
[b]Analysis request/chain of custody
[c]SNL/NM December 1997.

B = Analyte was detected in an associated blank.
BH = Borehole.
CY = Canyon.
DU = Duplicate sample.
EB = Equipment blank.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
J ( ) = The reported value is greater than or equal to the method detection limit (MDL) but is less than the practical quantitation limit, shown in parenthesis.

mg/kg = Milligram(s) per kilogram.
mg/L = Milligram(s) per liter.
NA = Not applicable.
ND ( ) = Not detected above the MDL, shown in parenthesis.
S = Subsurface soil sample.
SNL/NM = Sandia National Laboratories/New Mexico.
SQ = Quality control sample (matrix spike/matrix spike duplicate).
SS = Surface soil sample.
SWMU = Solid Waste Management Unit.

Table 4.4.4-2
Summary of HE Analysis Detection Limits
Used for SWMU 94D Confirmatory Soil Sampling, March—April 1998

Compounds	Off-Site Analyses Using EPA Method 8330[a] (µg/kg)
1,3,5-trinitrobenzene	32
1,3-dinitrobenzene	16
2,4,6-trinitrotoluene	19
2,4-dinitrotoluene	17
2,6-dinitrotoluene	17
2-amino-4,6-dinitrotoluene	17
2-nitrotoluene	41
3-nitrotoluene	30
4-amino-2,6-dinitrotoluene	79
4-nitrotoluene	31
HMX	24
Nitrobenzene	9.0
Pentaerythritol tetranitrate	NA
RDX	31
Tetryl	94

[a]EPA November 1986.
EPA = U.S. Environmental Protection Agency.
HE = High explosive(s).
HMX = 1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane.
µg/kg = Microgram(s) per kilogram.
RDX = 1,3,5-trinitro-1,3,5-triazacyclohexane.
SWMU = Solid Waste Management Unit.

Table 4.4.4-3
Summary of SWMU 94D Confirmatory Soil Sampling VOC
Analytical Results, March—April 1998
(Off-Site Laboratory)

Sample Attributes			VOCs (EPA 8260)[a] (µg/kg)	
Record Number[b]	ER Sample ID (Figure 4.4.4-1)	Sample Depth (ft)	Methylene Chloride	Toluene
600091	CY94D-BH-680,300-0-1-SS	0-1.0	ND (5)	ND (5)
600091	CY94D-BH-680,300-7-7.5-S	7.0-7.5	ND (5)	ND (5)
600091	CY94D-GR-680,300-10-11-S	10.0-11.0	ND (5)	ND (5)
600091	CY94D-BH-680,300-10-11-DU	11.0-12.0	ND (5)	ND (5)
600091	CY94D-BH-680,300-15.5-16-SQ	15.5-16.0	ND (5)	ND (0.66)
600054	CY94D-680,310-GR-SS	0-0.5	**1.2 J (5)**	ND (0.66)
600054	CY94D-680,320-GR-SS	0-0.5	**1.2 J (5)**	ND (0.66)
Quality Assurance/Quality Control Sample (µg/L)				
600091	CY94D-01-TB	NA	ND (2.0)	ND (2.0)
600091	CY94D-04-EB	NA	ND (2.0)	ND (2.0)
600054	CY94D-01-TB	NA	ND (2.0)	ND (2.0)

Note: Numbers in **bold** represent detected values.
[a]EPA November 1986.
[b]Analysis request/chain of custody
BH = Borehole.
CY = Canyon.
DU = Duplicate sample.
EB = Equipment blank.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
J ( ) = The reported value is greater than or equal to the method detection limit (MDL) but is less than the practical quantitation limit, shown in parenthesis.
µg/kg = Microgram(s) per kilogram.
µg/L = Microgram(s) per liter.
NA = Not applicable.
ND ( ) = Not detected above the method detection limit, shown in parenthesis.
S = Subsurface soil sample.
SQ = Quality control sample (matrix spike/matrix spike duplicate).
SS = Surface soil sample.
SWMU = Solid Waste Management Unit.
TB = Trip blank.
VOC = Volatile Organic Compound.

Table 4.4.4-4
Summary of Volatile Organic Compound Analytical Detection Limits
Used for SWMU 94D Confirmatory Soil Sampling, March—April 1998
(Off-Site Laboratory)

Analyte	Method Detection Limit (µg/kg)
Benzene	0.96
Bromobenzene	0.83
Bromochloromethane	0.80
Bromodichloromethane	0.64
Bromoform	0.65
Bromomethane	1–2.1
n-butylbenzene	0.67
sec-butylbenzene	0.62
tert-butylbenzene	0.52
Carbon Tetrachloride	0.69
Chlorobenzene	0.54
Chloroethane	0.86
Chloroform	0.72
Chloromethane	1.2
2-chlorotoluene	0.58
4-chlorotoluene	0.73
Dibromochloromethane	0.55
1,2-dibromo-3-chloropropane	0.84
1,2-dibromoethane	0.5
Dibromomethane	0.52
1,2-dichlorobenzene	0.63
1,3-dichlorobenzene	0.71
1,4-dichlorobenzene	0.64
Dichlorodifluoromethane	1.2
1,1-dichloroethane	0.78
1,2-dichloroethane	0.64–5
1,1-dichloroethene	0.77–25
cis-1,2-dichloroethene	1.1
trans-1,2-dichloroethene	0.73
1,1-dichloropropane	0.81
1,2-dichloropropane	0.76
1,3-dichloropropane	0.79
2,2-dichloropropane	0.61
Ethylbenzene	0.61
Hexachlorobutadiene	0.84
Isopropylbenzene	0.68
p-isopropyltoluene	0.57

Refer to footnotes at end of table.

Table 4.4.4-4 (Concluded)
Summary of Volatile Organic Compound Analytical Detection Limits
Used for SWMU 94D Confirmatory Soil Sampling, March—April 1998
(Off-Site Laboratory)

Analyte	Method Detection Limit (µg/kg)
Methylene Chloride	0.48
Naphthalene	0.43
n-propylbenzene	0.56
Styrene	0.47
1,1,1,2-tetrachloroethane	0.55
1,1,2,2-tetrachloroethane	0.38
Tetrachloroethene	1.1
Toluene	0.66
1,2,3-trichlorobenzene	0.42
1,2,4-trichlorobenzene	1.2
1,1,1-trichloroethane	0.74
1,1,2-trichloroethane	0.39
Trichloroethene	0.56
Trichlorofluoromethane	5.0
1,2,3-trichloropropane	0.96
1,2,4-trimethylbenzene	0.64
1,3,5-trimethylbenzene	0.59
Vinyl Chloride	1.1
Xylenes (total)	3.1

µg/kg = Microgram(s) per kilogram.
SWMU = Solid Waste Management Unit.

Table 4.4.4-5
Summary of Semivolatile Organic Compound Analytical Detection Limits
Used for SWMU 94D Confirmatory Soil Sampling, March—April 1998
(Off-Site Laboratory)

Analyte	Method Detection Limit (µg/kg)
1,2,4-trichlorobenzene	0.5
1,2-dichlorobenzene	0.5
1,3-dichlorobenzene	0.5
1,4-dichlorobenzene	0.6
2,4,5-trichlorphenol	0.8
2,4,6-trichlorophenol	0.6
2,4-dichlorophenol	0.3
2,4-dimethylphenol	0.5
2,4-dinitrophenol	1.1
2,4-dinitrotoluene	0.7
2,6-dinitrotoluene	0.6
2-chloronaphthalene	0.7
2-chlorophenol	0.4
2-methyl-4,6-dinitrophenol	0.7
2-methylnaphthalene	0.5
2-methylphenol	0.5
o-nitroaniline (2)	0.6
2-nitrophenol	0.5
3,3-dichlorobenzidine	0.7
m-nitroaniline (3)	0.6
4-bromophenyl phenyl ether	0.6
4-chloro-3-methylphenol	0.5
4-chloroaniline	0.5
4-chlorophenyl phenyl ether	0.6
4-methylphenol	0.6
p-nitroaniline (4)	0.6
4-nitrophenol	0.6
Acenaphthene	0.6
Acenaphthylene	0.5
Anthracene	0.6
Benzidine	0.4
Benzo(a)anthracene	0.5
Benzo(a)pyrene	0.7
Benzo(b)fluoranthene	0.9
Benzo(g,h,i)perylene	1.6
Benzo(k)fluoranthene	0.8
Benzoic acid	0.5
Benzyl alcohol	0.6
Bis(2-chloroethoxy) methane	0.3
Bis(2-chloroethyl) ether	0.6

Refer to footnotes at end of table.

Table 4.4.4-5 (Concluded)
Summary of Semivolatile Organic Compound Analytical Detection Limits
Used for SWMU 94D Confirmatory Soil Sampling, March – April 1998
(Off-Site Laboratory)

Analyte	Method Detection Limit (µg/kg)
Bis(2-chloroisopropyl) ether	0.6
Bis(2-ethylhexyl)phthalate	0.6
Butylbenzylphthalate	0.5
Chrysene	0.5
Dibenzo(a,h)anthracene	1.8
Dibenzofuran	0.5
Diethylphthalate	0.7
Dimethylphthalate	0.5
Di-n-butylphthalate	0.5
Di-n-octylphthalate	0.6
Fluoranthene	0.6
Fluorene	0.7
Hexachlorobenzene	0.5
Hexachlorobutadiene	0.5
Hexachlorocyclopentadiene	2.0
Hexachloroethane	0.8
Indeno(1,2,3-cd)pyrene	1.7
Isophorone	0.5
Naphthalene	0.5
Nitrobenzene	0.5
N-nitrosodi-n-propylamine	0.7
N-nitrosodiphenylamine	0.6
Pentachlorophenol	2.3
Phenanthrene	0.6
Phenol	0.5
Pyrene	0.6

µg/kg = Microgram(s) per kilogram.
SWMU = Solid Waste Management Unit.

Table 4.4.4-6
Summary of SWMU 94D Confirmatory Soil Sampling Gamma Spectroscopy Analytical Results, March – April 1998 (On-Site Laboratory)

Sample Attributes			Gamma Spectroscopy Activity (pCi/g)							
			Uranium-238		Thorium-232		Uranium-235		Cesium-137	
Record Number[a]	ER Sample ID (Figure 4.4.4-1)	Sample Depth (ft)	Results	Error[b]	Results	Error[b]	Results	Error[b]	Results	Error[b]
600057	CY94D-680,320-GR-SS	0.0-0.5	ND (1.17E+00)	--	5.72E-01	1.06E+00	ND (2.13E-01)	--	8.66E-02	3.07E-02
600092	CY94D-BH-680,300-0-1-SS	0.0-1.0	1.23E+00	1.01E+00	4.80E-01	2.71E-01	ND (1.80E-01)	--	4.36E-02	2.56E-02
Background Soil Concentrations, Upper Canyon[c]			2.31	NA	1.03	NA	0.16	NA	0.515	NA

[a]Analysis request/chain of custody.
[b]Two standard deviations above the mean detected activity.
[c]Dinwiddie September 1997.

BH = Borehole.
CY = Canyon.
ER = Environmental Restoration.
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
NA = Not applicable.
ND = Not detected above the minimum detectable activity, shown in parenthesis.
pCi/g = Picocurie(s) per gram.
SS = Surface soil sample.
SWMU = Solid Waste Management Unit.
-- = Error not calculated for nondectable results.

Table 4.4.4-7
Summary of SWMU 94D Confirmatory Soil Sampling Gross Alpha and Gross Beta Analytical Results, March—April 1998
(Off-Site Laboratory)

Sample Attributes			Gross Alpha/Gross Beta Activity (pCi/g)			
Record Number[a]	ER Sample ID (Figure 4.4.4-1)	Sample Depth (ft)	Gross Alpha		Gross Beta	
			Results	Error[b]	Results	Error[b]
600054	CY94D-680,310-GR-SS	0-0.5	7.52	2.88	24.4	2.31
600054	CY94D-680,320-GR-SS	0-0.5	11.1	3.06	39.8	2.56
600091	CY94D-GR-680,300-7.5-8-S	7.5-8.0	7.84	4.94	21.0	3.80
600091	CY94D-GR-680,300-11-12-S	11.0-12.0	6.60	4.85	25.4	3.90
Background Soil Concentrations, Canyon Area[c]			18.3	NA	52.7	NA

[a]Analysis request/chain of custody

[b]Two standard deviations above the mean detected activity.

[c]Tharp July 1998.

CY = Canyon.
ER = Environmental Restoration.
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
NA = Not applicable.
pCi/g = Picocurie(s) per gram.
S = Surface soil sample.
SS = Subsurface soil sample.
SWMU = Solid Waste Management Unit.

Because there are no applicable background concentrations for VOC compounds in soil, any detectable VOC compounds in the samples collected at SWMU 94D can be considered an indication of contamination. One VOC was detected in the surface soil samples. Methylene chloride was detected at estimated concentrations in two of the three surface soil samples (CY94D-680, 310-GR-SS and CY94D-680,320-GR-SS). Table 4.4.4-4 contains a summary of the VOCs analyzed and the associated MDLs used in the off-site analysis.

SVOCs

No SVOCs were detected in the soil samples collected at SWMU 94D. Table 4.4.4-5 contains a summary of the SVOCs analyzed and the associated MDLs used in the off-site analysis.

Radionuclides

Table 4.4.4-6 includes a summary of the on-site gamma spectroscopy analysis results for two surface soil samples collected from the Bomb Burner Discharge Pit at SWMU 94D. The gamma spectroscopy results indicated that no gamma activity was detected above the background concentration limits in the two samples analyzed. However, the MDA used for the analysis of uranium-235 exceeded the background limit. Although this situation inhibits any comparison to background, uranium-235 can be compared to uranium-238 because both coexist in DU. As a result, any elevated uranium-235 activity would be accompanied by corresponding elevation in uranium-238 activity. Using this comparison, the nondetectable results obtained for uranium-235 that have MDAs above background in the samples do not show corresponding elevated activities in the results for uranium-238.

Gross Alpha and Gross Beta

Table 4.4.4-7 contains a summary of the off-site gross alpha and gross beta analysis results for two surface soil samples and two subsurface samples from the Bomb Burner Discharge Pit at SWMU 94D. The results indicate that no gross alpha and gross beta activity was detected above the background concentration limits in the four samples analyzed.

QA/QC Results

Table 4.4.4-1 presents results of the analysis of metals QA/QC samples collected during the confirmatory sampling program at SWMU 94D. The QA/QC samples consisted of one equipment blank and one duplicate soil sample. Both QA/QC samples were analyzed off site for metals. Detectable concentrations of both cadmium and lead were reported for the equipment blank (sample CY94D-GR-01-EB). However, because both cadmium and lead were detected above the MDLs but below the practical quantitation limits (PQLs), the reported values are estimated.

Minor differences in the reported concentrations of several metals are noted between the sample pair CY94D-BH-680,300-11-12-S and CY94D-BH-680,300-11-12-DU. Although cadmium and mercury were not detected above the MDLs in the primary sample, estimated concentrations were reported for the duplicate. In addition, the lead concentration reported for the primary sample was significantly higher than the lead concentration estimated in the duplicate sample.

To assess the laboratory precision, one soil sample was collected and analyzed for metals in replicate off site. Relative percent differences (RPD) were calculated from the data and are included in Table 4.4.4-8. Because many of results for the sample pairs are nondetect, RPDs could only be calculated for arsenic, barium, and chromium. The corresponding RPDs ranges were 1.9 percent for arsenic, 8.8 percent for barium, and 49.4 percent for chromium in the sample duplicate pair. In general, the results obtained for the sample duplicate pair are in agreement for a soil matrix.

HE analysis results were not tabulated because no HE was detected in the soil samples. However, the QA/QC samples collected for HE analysis consisted of one equipment blank and one duplicate soil sample. Both QA/QC samples were analyzed off site for HE compounds. Detectable concentrations of 1,3,5-trinitrobenzene and 1,3,5,7-tetranitro-1,3,5,7-tetrazaciyclooctane (HMX) were reported for the equipment blank (sample CY94D-GR-02-EB). Because HMX was detected above the MDL but below the PQL, the reported value is an estimation. The reported concentration of 1,3,5-trinitrobenzene is not an estimated value. Identical results were obtained for the sample pair CY94D-BH-680,300-11-12-S and CY94D-BH-680,300-11-12-DU. The presence of 1,3,5-trinitrobenzene and 1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane (HMX) in the equipment blank and not in the soil samples is the result of laboratory QA problems.

Table 4.4.4-8
Summary of SWMU 94D Field Duplicate Relative Percent Differences

Sample Attributes			Relative Percent Difference								
Record Number[a]	ER Sample ID (Figure 4.4.4-1)	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
600091	CY94D-BH-680,300-11-12-S CY94D-BH-680,300-11-12-DU (off-site laboratory)	11-12	1.9	8.8	NC	NC	49.4	NC	NC	NC	NC

[a]Analysis request/chain of custody
BH = Borehole.
CY = Canyon.
DU = Duplicate sample.
ER = Environmental Restoration.
ft = Foot (feet).
ID = Identification.
NC = Not calculated for estimated values or nondetected results.
S = Subsurface soil sample.
SWMU = Solid Waste Management Unit.

Table 4.4.4-3 contains results of the analysis of VOC QA/QC samples collected during the confirmatory sampling program at SWMU 94D. The QA/QC samples collected consist of one equipment blank, two trip blanks, and one duplicate soil sample. All QA/QC samples were analyzed off site for VOCs. No VOCs were detected in the equipment blank or trip blanks. Comparable results were obtained for the sample pair CY94D-BH-680,300-11-12-S and CY94D-BH-680,300-11-12-DU.

SVOC analysis results were not tabulated because no SVOCs were detected in the soil samples. However, the QA/QC samples collected for SVOC analysis consisted of one equipment blank and one duplicate soil sample. A single SVOC, bis(2-ethylhexyl)phthalate, was detected in the equipment blank at 1.7 mg/liter (L). Because the contaminant was detected above the MDL but below the PQL, the reported value is estimated. The presence of bis(2-ethylhexyl)phthalate in the equipment blank and not in the soil samples could result from laboratory contamination, or the sampler could have been used to collect the SVOC samples. Identical results were obtained for the sample pair CY94D-BH-680,300-11-12-S and CY94D-BH-680,300-11-12-DU.

No QA/QC samples were collected for radionuclide analysis.

4.4.4.5 Data Validation

All off-site laboratory results were reviewed and verified/validated according to "Data Verification/Validation Level 3—DV-3" in Attachment C of the Technical Operating Procedure 94-03, Rev. 0 (SNL/NM July 1994b). In addition, all gamma spectroscopy results were reviewed by SNL/NM Department 7713 (RPSD Laboratory) according to "Laboratory Data Review Guidelines," Procedure No. RPSD-02-11, Issue No. 2 (SNL/NM July 1996). Annex 4-C contains a summary of the off-site data validation results. The verification/validation process confirmed that the data are acceptable for use in this NFA proposal for SWMU 94D.

4.5 Site Conceptual Model

The site conceptual model for SWMU 94D is based upon the residual COCs identified in the soil samples from the surface and subsurface of the Bomb Burner Discharge Pit. This section summarizes the nature and extent of contamination and the environmental fate of COCs.

4.5.1 Nature and Extent of Contamination

The COCs at SWMU 94D, Bomb Burner Discharge Pit, are methylene chloride, uranium-235, and silver. The wastewater discharged to the pit was generated from fuel-fire tests conducted on weapons and devices containing HE and DU at the Bomb Burner Unit. The fuel used in the tests was JP-4.

Since methylene chloride is not a component of JP-4 and the detected concentrations were so low, the presence of methylene chloride is likely the result of laboratory contamination. However, for purposes of the risk screening assessment, methylene chloride is considered a VOC COC. The VOC COC was determined on the basis of detectable concentrations of one

VOC in any soil sample. Because background concentrations for these constituents are not applicable, any detectable VOCs are considered potential contamination. Conversely, nondetect results are not considered for evaluating potential COCs at SWMU 94D. As a result, the VOC COC was methylene chloride. Low concentrations of one VOC was found in two surface soil samples at SWMU 94D. The concentration of methylene chloride is constant in two of the three surface soil samples. All laboratory results for methylene chloride detected in the samples collected at SWMU 94D were J-qualified.

Radionuclide COCs were determined by comparing sample results to background activities established for the Canyons Area (Dinwiddie September 1997, Zamorski December 1997). Any radionuclide found to exceed background in any sample is considered a potential COC for the site. Because the MDAs for uranium-235 analyses exceed background activity limits (see Section 4.4.4.4), nondetect sample results are also considered in identifying potential COCs. In the case of radionuclides, the MDA is used for comparison to background. In addition, all wastewater was screened for radioactivity prior to release into the discharge pit, and subsequent radiological surveys (Section 4.4.3.1.3) and confirmatory sampling results (Section 4.4.4.4) verified that no radiological activity is present above the MDAs. Uranium-235 is the only radionuclide COC.

Although metals were also associated with the tests conducted at the Bomb Burner Unit, none of these constituents were identified at the Bomber Burner Discharge Pit. Results of the confirmatory sampling indicated that no metals, with the exception of silver, were detected above the background concentration limits in the surface or subsurface of the discharge pit. Since the background limit for silver has not been quantified, no background comparisons are possible. Although silver concentrations were not detected at the MDL in all samples, silver is considered a COC because the background is nonquantified (Section 4.4.4.4). Table 4.5.1-1 includes summaries of the COCs for SWMU 94D.

4.5.2 Environmental Fate

The primary source of the COCs for SWMU 94D is wastewater generated from fuel-fire tests of weapons and devices containing HE and DU conducted at the Bomb Burner Unit (Figure 4.5.2-1). The primary release mechanism of COCs is the discharge of the wastewater directly into the discharge pit. Although metals HE and DU were involved with the tests conducted at the Bomb Burner Unit, HE and DU were not present at SWMU 94D. In addition, all wastewater was screened for radioactivity prior to release into the discharge pit, and subsequent radiological surveys (Section 4.4.3.1.3) and confirmatory sampling results (Section 4.4.4.4) verified that no radiological activity is present above the MDAs. Results of the confirmatory sampling indicated that no metals, with the exception of silver (nonquantified background), were detected in the surface or subsurface soil of the discharge pit above the background concentration limits (Section 4.4.4.4).

Table 4.5.1-1 contains a summary of the potential COCs for SWMU 94D. Based upon the nature and extent of contamination at the site (Section 4.5.1), methylene chloride, uranium-235, and silver occurred at very low concentrations in two surface soil samples from the discharge pit. No distinct horizontal distribution of contamination is present. All potential COCs were retained in the conceptual model and evaluated in the human health and ecological risk assessments.

Table 4.5.1-1
Summary of COCs for SWMU 94D

COC Type	Number of Samples	COCs Detected in Soil Samples	Maximum Concentration (µg/kg)	Average Concentration[a] (µg/kg)	Sampling Locations Where COCs are Detected
Metals	7 environmental	Silver	ND (0.002914)	ND (0.002914)	All samples reported because there is no quantifiable background value for silver
Radionuclides	2 environmental	U-235	0.23 pCi/g	Not calculated. All MDAs above maximum background concentration	All sample locations
VOCs	2 environmental	Methylene chloride	1.2 J (5)	1.2	CY94D-680,320-GR-SS CY94D-680,310-GR-SS

[a]Average concentration includes all samples, duplicates, and splits. For nondetectable results, the detection limit is used to calculate the average.

COC = Constituent of concern.
CY = Canyon.
GR = Grab sample.
J ( ) = The reported value is greater than or equal to the method detection limit but is less than the practical quantitation limit, shown in parenthesis.
µg/kg = Microgram(s) per kilogram.
MDA = Minimum detectable activity.
pCi/g = Picocurie(s) per gram.
SS = Surface soil sample.
SWMU = Solid Waste Management Unit.
VOC = Volatile organic compound.

This page intentionally left blank.

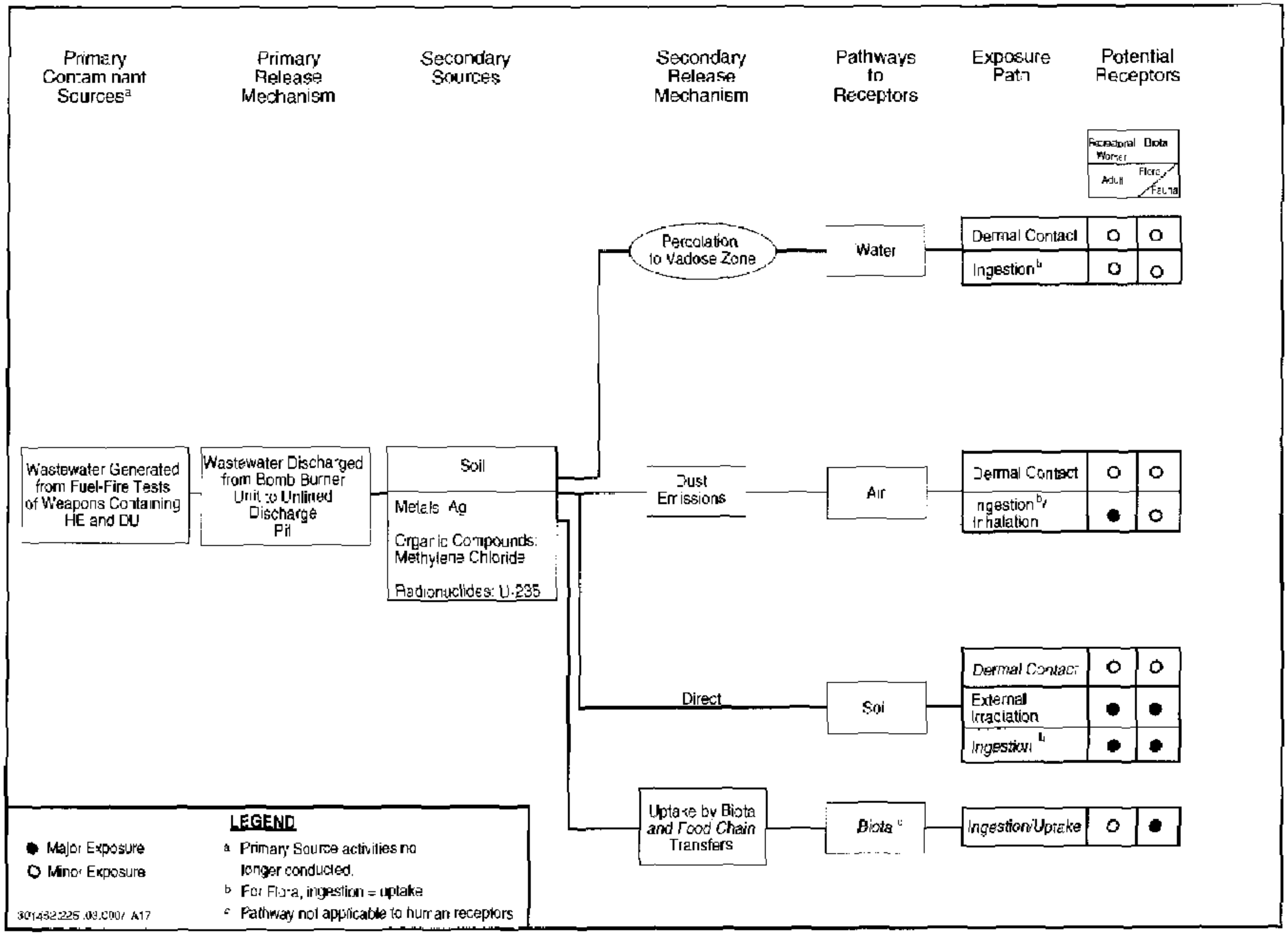


Figure 4.5.2-1

Conceptual Model Flow Diagram for SWMU 94D, Bomb Burner Discharge Pit

Because wastewater from the Bomb Burner Unit is no longer generated, only secondary sources of COCs remain at the site in the surface and subsurface soil at the discharge pit. The secondary release mechanisms at SWMU 94D are the suspension and/or dissolution of the COCs in surface-water runon and percolation to the vadose zone, VOC vapor emanations, dust emissions, and the uptake of the COCs in the soil by biota (Figure 4.5.2-1). However, the depth to groundwater at the site at approximately 222 feet bgs precludes the migration of the COCs to the aquifer. In addition, high partitioning coefficients and low mobility in the transporting medium would enhance dilution of the already low COC concentrations. The pathways to receptors are surface water (within the discharge pit), soil water, air, and soil. Biota are also a pathway through food chain transfers. Annex 4-D, Section V, provides additional discussion of the fate and transport of the COCs at SWMU 94D.

The current land use for SWMU 94D is industrial. However, since the future/proposed land use for SWMU 94D is designated recreational (DOE et al. October 1995), the potential human receptor is considered a recreational user of the site. For all applicable pathways, the exposure route for the recreational user is dermal contact and ingestion/inhalation. Only ingestion of soil is considered a major exposure route for the recreational user. Potential biota receptors include flora and fauna at the site. Similar to the recreational user, direct ingestion of soil is considered the major exposure route for biota, in addition to the ingestion of the COCs through food chain transfers or the direct uptake of the COCs. Annex 4-D, Section V, provides additional discussion of the exposure routes and receptors at SWMU 94D.

4.6 Site Assessments

The site assessment process for SWMU 94D includes risk screening assessments followed by risk baseline assessments (as required) for both human health and ecological risk. This section summarizes the site assessment results. Annex 4-D provides details of the site assessment.

4.6.1 Summary

The site assessment concludes that SWMU 94D does not have potential to affect human health under a recreational land-use scenario. After considering the uncertainties associated with the available data and modeling assumptions, ecological risks associated with SWMU 94D were found to be extremely low. Section 4.6.2 briefly describes and Annex 4-D provides details of the site screening assessments.

4.6.2 Screening Assessments

Risk screening assessments were performed for both human health risk and ecological risk for SWMU 94D. This section briefly summarizes the risk screening assessments.

4.6.2.1 Human Health

SWMU 94D has been recommended for recreational land-use (DOE et al. October 1995). Annex 4-D provides a complete discussion of the risk assessment process, results, and uncertainties. Because the COCs were present in concentrations or activities greater than background levels, it was necessary to perform a health risk assessment analysis for the site. This assessment included any VOCs detected above their reporting limits and any radionuclide compounds detected either above background levels and/or MDAs. The risk assessment process provides a quantitative evaluation of the potential adverse human health effects caused by constituents in soil at the site. The Risk Screening Assessment Report calculated the hazard index (HI) and excess cancer risk for a recreational land-use setting. The excess cancer risk from nonradiological COCs and the radiological COCs is not additive (EPA 1989).

In summary, the HI calculated for SWMU 94D nonradiological COCs is 0.00 for a recreational land-use setting, which is less than the numerical standard of 1.0 suggested by risk assessment guidance (EPA 1989). Incremental risk is determined by subtracting risk associated with background from potential nonradiological COC risk. The incremental HI is 0.00. The excess cancer risk for SWMU 94D nonradiological COCs is 5E-12 for a recreational land-use setting. Guidance from the NMED indicates that excess lifetime risk of developing cancer by an individual must be less than 1E-6 for Class A and B carcinogens and less than 1E-5 for Class C carcinogens (NMED March 1998). Thus, the excess cancer risk for this site is below the suggested acceptable risk value of 1E-6. The incremental excess cancer risk is 5E-12.

The incremental total effective dose equivalent for radionuclides for a recreational land-use setting for SWMU 94D is 8.6E-4 millirems (mrem)/year (yr), which is well below the recommended dose limit of 15 mrem/yr found in EPA's OSWER Directive No. 9200.4-18 and reflected in a document entitled "Sandia National Laboratories/New Mexico Environmental Restoration Project—RESRAD Input Parameter Assumptions and Justification" (SNL/NM February 1998b). The incremental excess cancer risk for radionuclides is 9.2E-9 for the recreational land-use scenario, which is much less than risk values calculated from naturally occurring radiation and from intakes considered background concentration values.

The residential land-use scenarios for this site are provided only for comparison in the Risk Screening Assessment Report (Annex 4-D). The report concludes that SWMU 94D does not have potential to affect human health under a recreational land-use scenario.

4.6.2.2 Ecological

An ecological screening assessment that corresponds with the screening procedures (NMED March 1998) in the EPA's Ecological Risk Assessment Guidance for Superfund (EPA 1997) was performed as set forth by the NMED Risk-Based Decision Tree. An early step in the evaluation is comparing COC concentrations and identifying potentially bioaccumulative constituents (see Annex 4-D, Sections V, VI, VII.2, and VII.3). This methodology also requires developing a site conceptual model and a food web model as well as selecting ecological receptors. Each of these items is presented in the "Predictive Ecological Risk Assessment Methodology" for the SNL/NM ER Program (IT July 1998) and will not be duplicated here. The screening also includes the estimation of exposure and ecological risk.

Tables 16, 17, and 18 of Annex 4-D present the results of the ecological risk assessment screen. Site-specific information was incorporated into the screening assessment when such data were available. No risks (as indicated by hazard quotient (HQ) and HI values exceeding unity) were predicted for any of the ecological receptors. Risks are not expected in those cases where HQs would not be determined because of insufficient toxicity information. Based upon an evaluation of these uncertainties, ecological risks associated with this site are expected to be extremely low.

4.6.3 Baseline Risk Assessments

This section discusses the baseline risk assessments for human health and ecological risk.

4.6.3.1 Human Health

Based upon the fact that human health results of the screening assessment summarized in Section 4.6.2.1 indicate that SWMU 94D does not have potential to affect human health under a recreational land-use setting, a baseline human health risk assessment is not required for SWMU 94D.

4.6.3.2 Ecological

Based upon the fact that ecological results of the screening assessment summarized in Section 4.6.2.2 indicate that SWMU 94D has very low ecological risk, a baseline ecological risk assessment is not required for SWMU 94D.

4.6.4 Other Applicable Assessments

No other applicable assessments have been conducted at SWMU 94D.

4.7 No Further Action Proposal

4.7.1 Rationale

Based upon field investigation data and the human health risk assessment analysis, an NFA is being recommended for SWMU 94D for the following reason: No COCs (particularly metals VOCs, or radionuclides) were present in concentrations considered hazardous to human health for a recreational land-use scenario.

4.7.2 Criterion

Based upon the evidence provided above, SWMU 94D is proposed for an NFA decision in conformance with Criterion 5 (NMED March 1998), which states, "The SWMU/AOC has been characterized or remediated in accordance with current applicable state or federal regulations, and that available data indicate that contaminants pose an acceptable level of risk under current and projected future land use."

REFERENCES

Author [unk], Date [unk]. Notes collected for SWMU 65, Sandia National Laboratories, Notes (unpublished), Albuquerque, New Mexico.

Biggs, J., May 1991. "Sensitive Species Survey for Sandia National Laboratories Burn Site, Kirtland Air Force Base, New Mexico," CGI Report *#8067AF*, The Chambers Group, Inc., Albuquerque, New Mexico.

Brouillard, L. Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-021, Sandia National Laboratories, Albuquerque, New Mexico. June 29, 1994.

Cocke, W.J., May 1984. "Executive Test Report, Results of AB61-Navy Shielded Cradle Fire Test Series (R802995)," SAND84-1027, Sandia National Laboratories, Albuquerque, New Mexico

Dawson, L. (Sandia National Laboratories/New Mexico). Memorandum to Distribution, "Record of Verbal Communication for the NMED/DOE OB and SNL/NM ER Project Meetings on Lurance Canyon Burn Site Groundwater Issues Rounds 1 and 2," Sandia National Laboratories/New Mexico. August 15, 1996.

Dinwiddie, R.S. (New Mexico Environment Department). Letter to M.J. Zamorski (U.S. Department of Energy), "Request for Supplemental Information: Background Concentrations Report, SNL/KAFB." September 24, 1997.

DOE, see U.S. Department of Energy.

EPA, see U.S. Environmental Protection Agency.

Gaither, K. (Sandia National Laboratories/New Mexico). Memorandum to K. Karp (Sandia National Laboratories/New Mexico), "Lurance Canyon, Geotech Rad [sic] Survey," Sandia National Laboratories, Albuquerque, New Mexico. October 28, 1992.

Gaither, K. (Sandia National Laboratories/New Mexico), Date [unk]. "Environmental Restoration Sites on Forest Service Withdrawn Land," Sandia National Laboratories, Albuquerque, New Mexico.

Gaither, K. (Sandia National Laboratories/New Mexico). Memorandum to R.E. Fate (Sandia National Laboratories/New Mexico), Sandia National Laboratories, Albuquerque, New Mexico. December 20, 1993.

Gaither, K. (Sandia National Laboratories/New Mexico). Memorandum to D. Bleakley (Sandia National Laboratories/New Mexico), Sandia National Laboratories, Albuquerque, New Mexico. January 5, 1994.

Gill, W., November 1982. "Propellant Canister Fire Tests Environmental Test Report," Sandia National Laboratories, Albuquerque, New Mexico.

Goodrich, M. (IT Corporation). Personal Communication with M. Crawley (IT Corporation), Albuquerque, New Mexico. [Month Unk] 1993.

Hickox, J, and R. Abitz (IT Corporation). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/065/INT/95-030, Sandia National Laboratories, Albuquerque, New Mexico. December 1, 1994.

Hill, T.K., Date [unk]. "W80 Abnormal Environment Fuel Fire Test (U), Sandia National Laboratories, Albuquerque, New Mexico.

Hoagland, S. and R. Dello-Russo, February 1995. "Cultural Resources Investigation for Sandia National Laboratories/New Mexico, Environmental Restoration Program, Kirtland Air Force Base, New Mexico," Butler Service Group, Albuquerque, New Mexico.

Hooper, P.R., May 1983. "W69 Fuel Fire Test (U)," SAND82-2920, Sandia National Laboratories/New Mexico, Albuquerque, New Mexico.

IT, see IT Corporation.

IT Corporation (IT), February 1995. "Sensitive Species Survey Results, Environmental Restoration Project, Sandia National Laboratories/New Mexico," IT Corporation, Albuquerque, New Mexico.

IT Corporation, July 1998. "Predictive Ecological Risk Assessment Methodology, Environmental Restoration Program, Sandia National Laboratories, New Mexico," IT Corporation, Albuquerque, New Mexico.

Jercinovic, D. (IT Corporation). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-035, Sandia National Laboratories, Albuquerque, New Mexico. April 24, 1995.

Jercinovic, D., E. Larson, L. Brouillard, and D. Palmieri (IT Corporation and Sandia National Laboratories/New Mexico). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/065/INT/95-020, Sandia National Laboratories, Albuquerque, New Mexico. November 14, 1994.

Karas, P., June 1983. Notes relating to Site 94 for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), Sandia National Laboratories, Albuquerque, New Mexico.

Kervin, J.E., April 1981. "Fire Test of the W84 (U)," Sandia National Laboratories, Albuquerque, New Mexico.

Larson, E., and D. Palmieri (Sandia National Laboratories/New Mexico and IT Corporation). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/065/INT/95-018, Sandia National Laboratories, Albuquerque, New Mexico. August 30, 1994a.

Larson, E., and D. Palmieri (Sandia National Laboratories/New Mexico and IT Corporation). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/065/INT/95-023, Sandia National Laboratories, Albuquerque, New Mexico. August 16, 1994b.

Larson, E., and D. Palmieri (Sandia National Laboratories/New Mexico and IT Corporation). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/065/INT/95-022, Sandia National Laboratories, Albuquerque, New Mexico. August 24, 1994c.

Larson, E., and D. Palmieri (Sandia National Laboratories/New Mexico and IT Corporation). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-016, Sandia National Laboratories, Albuquerque, New Mexico. October 26, 1994.

Luna, D.A., March 1983. "Data Report on the W80 WTE08-01 Fuel Fire Test (Abnormal Environment)," R716200, Sandia National Laboratories, Albuquerque, New Mexico.

Luna, D.A. Memorandum to R. Mata (Sandia National Laboratories/New Mexico), "Slow Heat Tests Conducted at Lurance Canyon Burn Site, CTF (R803877), August 20–27, 1985," Sandia National Laboratories, Albuquerque, New Mexico. October 1, 1985.

Luna, D.A., and J.W. Moore, June 1983. "Report on B-61 Shielded Cradle Fire Tests Conducted in Lurance Canyon Coyote Test Field," R802995, Sandia National Laboratories, Albuquerque, New Mexico

Martz, M.K. Memorandum to Sandia National Laboratories CEARP File regarding Personal Interview (unpublished), ER7585/1333/065/INT/95-015, Sandia National Laboratories, Albuquerque, New Mexico. September 24, 1985.

Martz, M.K. Memorandum to Sandia National Laboratories CEARP File regarding Personal Interview (unpublished), ER7585/1333/065/INT/95-014, Sandia National Laboratories, Albuquerque, New Mexico. November 1985.

Mata, Jr., R., December 1983. "Report on the Vented Slow Heat Fire Test, Environment Test Report," R803059, Sandia National Laboratories, Albuquerque, New Mexico.

Moore, J.W., September 1981. "Uncontained Pool Fire Tests Conducted in Lurance Canyon," R802358, Sandia National Laboratories, Albuquerque New Mexico

Moore, J.W., June 1982. "CTF Test Conducted at Lurance Canyon Burn Site," Sandia National Laboratories, Albuquerque, New Mexico

Moore, J.W., and D.A. Luna, February 1983. "Report on Fire Tests for the TRUPACT Shipping Container Program, December 1981—July 1982," Environmental Test Report, Sandia National Laboratories, Albuquerque, New Mexico.

Nash, S.J. (Environmental Control Technology Corporation). Letter to W. Booher (IT Corporation), Albuquerque, New Mexico. June 4, 1990.

New Mexico Environment Department (NMED), March 1998. "RPMP Document Requirement Guide," RCRA Permits Management Program, Hazardous and Radioactive Materials Bureau, New Mexico Environment Department, Santa Fe, New Mexico.

NMED, see New Mexico Environment Department.

Oldewage, H. (Sandia National Laboratories/New Mexico). Memorandum to K. Gaither (Sandia National Laboratories/New Mexico), Albuquerque, New Mexico. May 17, 1993.

Oldewage, H. (Sandia National Laboratories/New Mexico). Memorandum to K. Gaither (Sandia National Laboratories/New Mexico), Albuquerque, New Mexico. December 21, 1993a.

Oldewage, H. (Sandia National Laboratories/New Mexico). Memorandum to K. Gaither (Sandia National Laboratories/New Mexico), Albuquerque, New Mexico, December 23, 1993b.

Oldewage, H. (Sandia National Laboratories/New Mexico). Memorandum to K. Gaither (Sandia National Laboratories/New Mexico), Albuquerque, New Mexico. February 7, 1994.

Palmieri, D. (IT Corporation). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-011, Sandia National Laboratories, Albuquerque, New Mexico. September 22, 1994a.

Palmieri, D. (IT Corporation). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-012, Sandia National Laboratories, Albuquerque, New Mexico. September 22, 1994b.

Palmieri, D. (IT Corporation). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-024, Sandia National Laboratories, Albuquerque, New Mexico. November 28, 1994a.

Palmieri, D. (IT Corporation). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-023, Sandia National Laboratories, Albuquerque, New Mexico. November 23, 1994b.

Palmieri, D. (IT Corporation). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-025, Sandia National Laboratories, Albuquerque, New Mexico. December 9, 1994a.

Palmieri, D. (IT Corporation). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-028, Sandia National Laboratories, Albuquerque, New Mexico. December 16, 1994b.

Palmieri, D. (IT Corporation). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-026, Sandia National Laboratories, Albuquerque, New Mexico. December 15, 1994c.

Palmieri, D. (IT Corporation). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-029, Sandia National Laboratories, Albuquerque, New Mexico. January 6, 1995.

Palmieri, D. (IT Corporation). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-031, Sandia National Laboratories, Albuquerque, New Mexico. March 30, 1995.

Palmieri, D. (IT Corporation). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-033, Sandia National Laboratories, Albuquerque, New Mexico. April 19, 1995a.

Palmieri, D. (IT Corporation). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-034, Sandia National Laboratories, Albuquerque, New Mexico. April 19, 1995b.

Palmieri, D. (IT Corporation). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-036, Sandia National Laboratories, Albuquerque, New Mexico. August 21, 1995.

Palmieri, D., and E. Larson (IT Corporation and Sandia National Laboratories/New Mexico). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-015, Sandia National Laboratories, Albuquerque, New Mexico. October 26, 1994.

Sandia National Laboratories/New Mexico (SNL/NM), 1983. "Burn Site," Dwg. No. T95597, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), May 1986. "CEARP Phase I, Draft," Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), July 1994a. "Ownership (Land Use), Canyons Test Area—ADS 1333," GIS Group, Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), July 1994b. "Verification and Validation of Chemical and Radiological Data," Technical Operating Procedure (TOP) 94-03, Rev. 0, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), August 1994. "Historical Aerial Photo Interpretation of the Canyons Test Area, OU 1333," Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), October 1994. "RCRA Facility Investigation Work Plan for Operable Unit 1334, Central Coyote Test Area," Environmental Restoration Project, Sandia National Laboratories/New Mexico, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), November 1994. "Project Log Book, Tests Conducted at SNL/NM Lurance Canyon Burn Site," October 9, 1981, through November 9, 1994, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), April 1995. "Acreage and Mean Elevations for SNL Environmental Restoration Sites," GIS Group, Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), September 1995. "RCRA Facility Investigation Work Plan for Operable Unit 1333, Canyons Test Area," Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), July 1996. "Laboratory Data Review Guidelines," Radiation Protection Sample Diagnostics Procedure No. RPSD-02-11, Issue 02, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), July 1997. "Bullets of Understanding for Nitrate Assessment at the Lurance Canyon Explosive Test Site (ER Site 65) OU 1333, Canyons Test Area, July 1, 1997," Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), September 1997a. "Bullets of Understanding for Construction of Lurance Canyon Burn Site 'Narrows' Wells, OU 1333, Canyons Test Area, September 24, 1997," Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), September 1997b. "Final Report, Survey and Removal of Radioactive Surface Contamination at Environmental Restoration Sites, Sandia National Laboratories/New Mexico," SAND97-2320/1/2-UC-902, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), December 1997. "Response to Request for Supplemental Information, Background Concentrations of Constituents of Concern to the Sandia National Laboratories/New Mexico Environmental Restoration Project and the Kirtland Air Force Base Installation Restoration Program," Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), February 1998a. "Soil Vapor Surveys at the Lurance Canyon Burn Site," Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), February 1998b. "RESRAD Input Parameter Assumptions and Justification," Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), March 1998. "Field Implementation Plan for OU 1333 Lurance Canyon Burn Site, SWMU 94A Sampling," Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), September 1998. "Proposals for No Further Action Environmental Restoration Project," Sandia National Laboratories, Albuquerque, New Mexico.

SNL/NM, see Sandia National Laboratories/New Mexico

Stevenson, T.R., December 1985. "B61-7 Abnormal Environment Test (U) Fuel Fire (R719168)," SAND85-2786, Sandia National Laboratories, Albuquerque, New Mexico.

Tharp, T.L. (Sandia National Laboratories/New Mexico). "Gross Alpha/Beta Background Data Statistical Analysis for OU 1333," Canyons, Memorandum to Environmental Restoration Project Files, Sandia National Laboratories, Albuquerque, New Mexico. July 1998.

U.S. Department of Energy (DOE), Albuquerque Operations Office, Environmental Safety and Health Division, Environmental Program Branch, September 1987, draft. "Comprehensive Environmental Assessment and Response Program (CEARP) Phase 1: Installation Assessment, Sandia National Laboratories, Albuquerque," Albuquerque Operations Office, U.S. Department of Energy, Albuquerque, New Mexico.

U.S. Department of Energy (DOE), U.S. Air Force, and U.S. Forest Service, October 1995. "Workbook: Future Use Management Area 1," prepared by Future Use Logistics and Support Working Group in cooperation with the Department of Energy Affiliates and the U.S. Air Force, Albuquerque, New Mexico.

U.S. Environmental Protection Agency (EPA), November 1986. "Test Methods for Evaluating Solid Waste," 3rd ed., Update III, SW-846, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), April 1987. "Final RCRA Facility Assessment Report of Solid Waste Management Units at Sandia National Laboratories, Albuquerque, New Mexico," Contract No. 68-01-7038, Region 6, U.S. Environmental Protection Agency, Dallas, Texas.

U.S. Environmental Protection Agency (EPA), 1989. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual," EPA/540-1089/002, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1997. "Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risks," Interim Final, U.S. Environmental Protection Agency, Washington, D.C.

Young, M. (Sandia National Laboratories/New Mexico). Memorandum to Distribution, "Unexploded Ordnance (UXO)/High Explosives (HE) Survey Report, Sandia National Laboratories, Albuquerque, New Mexico. September 1, 1994.

Zamorski, M.J. (U.S. Department of Energy). Letter to R.S. Dinwiddie (New Mexico Environment Department), "Department of Energy/Sandia National Laboratories Response to the NMED Request for Supplemental Information for the *Background Concentrations of Constituents of Concern to the Sandia National Laboratories/New Mexico Environmental Restoration Project and the Kirtland Air Force Base Installation Restoration Program* Report," December 3, 1997.

ANNEX 4-A
Summary of Testing Activities at SWMU 94
Lurance Canyon Burn Site

The Lurance Canyon Burn Site (LCBS) was used for testing fire survivability of transportation containers, weapons components, simulated weapons, and satellite components. Testing programs at the LCBS can be grouped into the following six categories related to burn structures:

- Portable pan burn tests
- Small surface impoundment (Solid Waste Management Unit [SWMU] 94E)
- Large Open Burn Pool (LOBP)
- Small Open Burn Pool (SOBP)
- Light Airtransport Accident Resistant Container (LAARC) Unit (Discharge Pit, SWMU 94F)
- Bomb Burner Unit (Lines at Discharge Pit, SWMUs 94C and 94D)
- Small Wind-Shielded (SWISH) Unit
- Smoke Emissions Reduction Facility (SMERF)
- Bunker 9830 and Support Buildings
- Aboveground tanks (SWMU 94A)
- Debris/soil mounds (SWMU 94B)
- Scrap Yard (SWMU 94G).

Table 4A-1 summarizes the burn testing structures and associated features at SWMU 94. This annex describes the historical operations at each of these structures and locations are shown on Figures 4A-1 and 4A-2.

A.1 PORTABLE PAN BURN TESTS

The test log for SWMU 94 records 65 burn tests involving seven testing programs that took place in portable pans (Table 4A-1) (SNL/NM November 1994), but additional tests may have taken place prior to the first 1979 entry. Portable pan burn tests were conducted from approximately 1975 to 1991 (Palmieri April 1995a). Burn tests requiring a similar testing environment are now conducted in the SOBP. Round portable pans, 6 to 10 feet in diameter and 2 to 3 feet deep (Figure 4A-3), were set up with or without temporary chimneys in at least five locations within SWMU 94 (Gill November 1982, Hickox and Abitz December 1994, Palmieri April 1995a). These sites are just north and just south of the Small Surface Impoundment (SWMU 93E), south of the SWISH Unit in the Bomb Burner Unit trench and at the current-day location of the SOBP (Palmieri April 1995b). Following a test, water remaining in the portable pans was typically left to evaporate (Jercinovic et al. November 1994). However, some wastewater from the portable pans may have been discharged into the Small Surface

Table 4A-1
Summary of Burn Testing and Associated Operations at SWMU 94, Lurance Canyon Burn Site

Test Unit/Structure	Test Type/ Operation	Test Date	Number of Recorded Tests (SNL/NM November 1994)	Test/Operational Release Location	Test Materials/ Operational Release	Reference
Portable Pans	Open Burning	1975 to March 1991 1985 to 1987 (none conducted)	65 (minimum)	Primary Detonation Area (SWMU 65B) and Near Field Dispersion Area (SWMU 65D)	Detonations (HE, gun propellant, radionuclides)	SNL/NM November 1994 Moore September 1981 Larson and Palmieri October 1994 Caregeorges January 1994 Hickox and Abitz December 1994 Palmieri December 1994e Palmieri April 1995a
				None (most evaporated) Small Surface Impoundment	Wastewater (JP-4 fuel and water mixture)	
Small Surface Impoundment	Open Burning	pre-1979 to 1980	4	Subsurface infiltration	Wastewater (JP-4 fuel and water mixture)	SNL/NM November 1994
LOBP (30 x 60 feet)	Open Burning	1977 to present	53 (Includes Railcar Burn Test)	1977 test (evaporated) 1977 to 1983 (inactive) 1983 to 1987 (SWMU 13) 1988 to present (City of Albuquerque POTW via trucking)	Wastewater (JP-4 fuel and water mixture, radionuclides)	Appendix J Palmieri October 1994
SOBP (20 x 20 feet)	Open Burning	1992 to present	23	1992 to present (City of Albuquerque POTW via trucking; connected to the LOBP)	Wastewater (JP-4 fuel and water mixture)	SNL/NM November 1994 Palmieri October 1994
LAARC Unit	Enclosed Burning	June 1980 to August 1987	63	Unlined discharge pit	Wastewater (JP-4 fuel and water mixture)	SNL/NM November 1994
Bomb Burner Unit	Enclosed Burning	September 1982 to January 1988	23	Within Bomb Burner Unit	Detonations (HE radionuclides, metals)	SNL/NM November 1994
				Unlined discharge pit	Wastewater (JP-4 fuel and water mixture)	
			1 TABS Test	Bomb Burner Unit trench	Detonation (HE, radionuclides, metals)	

Refer to footnotes at end of table.

Table 4A-1 (Concluded)
Summary of Burn Testing and Associated Operations at
SWMU 94, Lurance Canyon Burn Site

Test Unit/Structure	Test Type/ Operation	Test Date	Number of Recorded Tests (SNL/NM November 1994)	Test/Operational Release Location	Test Materials/Operational Release	Reference
SWISH Unit	Enclosed Burning	January 1983 to April 1990	61	None (never disposed of wastewater)	None (wastewater recirculated, never disposed)	SNL/NM November 1994 Author [unk] Date [unk]c Palmieri October 1994 Palmieri December 1994d
SMERF	Enclosed Burning	August 1992 to present	27	1992 to present (City of Albuquerque POTW via trucking)	None (wastewater recirculated)	
Bunker 9830	Enclosed Burning	1967 to present (Control Bunker/Storage) 1975 to 1988 (Burn Testing)	Cable testing 10 (fire suppressant)	None (contained within the bunker)	None	Larson and Palmieri August 1994 Palmieri November 1994a
Aboveground Tanks	Supply Water, JP-4 Fuel, and Coolant for Burn Testing	1980 to present	NA	Subsurface infiltration	Accidental spills of JP-4 fuel on soil	Hickox November 1994 Larson and Palmieri October 1994
Debris/Soil Mounds	Grading	pre-1992 to present	NA	Subsurface infiltration or surface runoff	Metals or radionuclides leachate	Palmieri April 1995b
Scrap Yard	Storage of surplus test materials	1980 to present	NA	Subsurface Infiltration	Accidental spills of hydraulic oils on soil	Hickox November 1994 Larson and Palmieri October 1994 Palmieri November 1994a

HE = High explosive.
LAARC = Light Airtransport Accident Resistant Container.
LOBP = Large Open Burn Pool.
NA = Not applicable.
POTW = Publicly Owned Treatment Works.
SMERF = Smoke Emission Reduction Facility.
SNL/NM = Sandia National Laboratories/New Mexico.
SOBP = Small Open Burn Pool.
SWISH = Small Wind-Shielded (Unit).
SWMU = Solid waste management unit.
TABS = Torch Activated Burn System.

This page intentionally left blank.

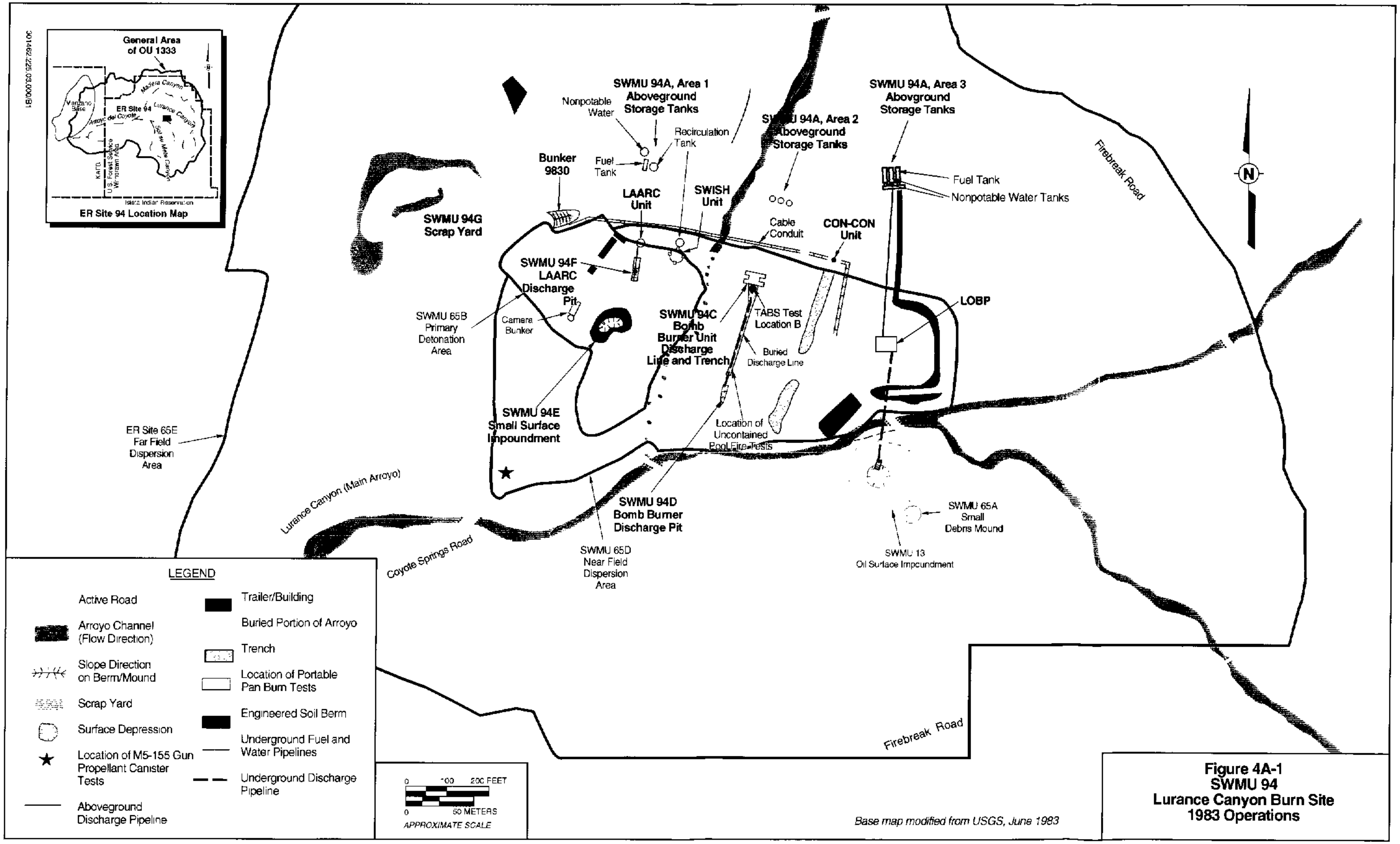


Figure 4A-1
SWMU 94
Lurance Canyon Burn Site
1983 Operations

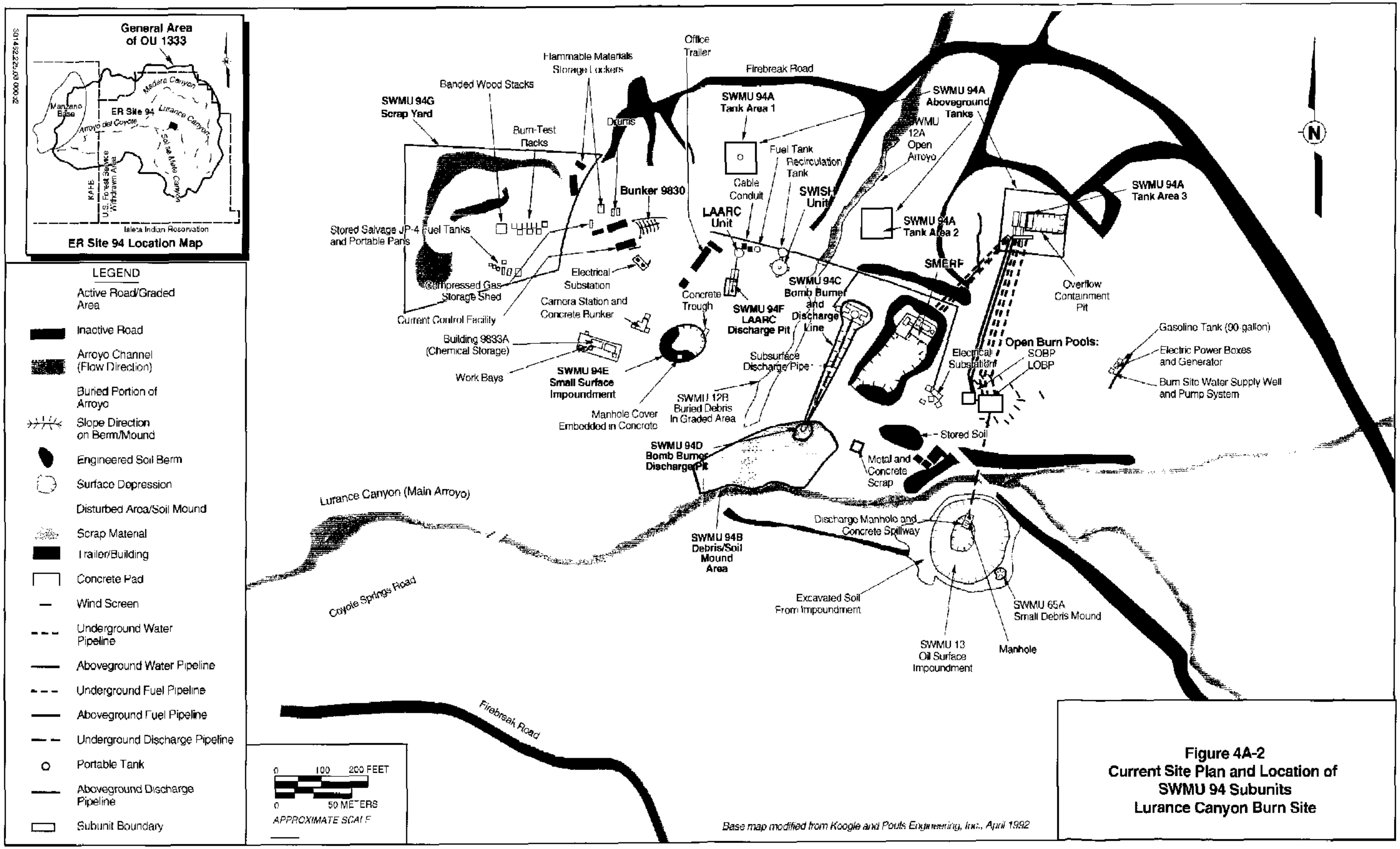


Figure 4A-2
Current Site Plan and Location of SWMU 94 Subunits
Lurance Canyon Burn Site

Photograph of portable pans in the southern portion of the scrap yard in April 1995. The pans held JP-4 fuel and water used in small-scale burn tests at SWMU 94.

Figure 4A-3
Photograph of Portable Pan

301462.225.03.000/cw A26

Impoundment fuel fire at a minimum temperature of 1,850 degrees Fahrenheit (°F) (Caregeorges January 1994). After completing the test, the test unit was swipe tested to determine whether uranium dioxide was released (Larson and Palmieri October 1994). No radioactivity was found on the swipe samples.

Uncontained Pool-Fire Tests

In September 1981, five tests of uncontained pool fires were conducted in the area of the Bomb Burner Unit trench (SWMU 94C) to investigate the size of a fire produced from fuel leaking from an aircraft wing. Jet fuel composition 4 (JP-4) fuel was pumped from a 55-gallon tank onto a steel plate that rested on a pan, which was then covered with a concrete pad. A portable chimney was placed over the pan. The JP-4 fuel was pumped onto the steel plate at varying rates to control the size of the burn pool. No other materials were burned (Moore September 1981, Hickox and Abitz December 1994). These tests occurred prior to the first portable pan entry in the log book.

Gun-Propellant Canister Tests

In October 1982, five burn tests involving exposure of M5-155 gun-propellant canisters to JP-4 fuel fires were performed at SWMU 94 (Gill November 1982, Palmieri December 1994e, SNL/NM November 1994) in a portable pan located near the entrance to the site (Figure 4A-1). Gun and rocket propellants are composed primarily of nitrocellulose, but they differ in that gun propellant does not contain aluminum or potassium perchlorate (Hickox and Abitz December 1994). The purpose of the 11-minute burn tests was to observe and record the behavior of gun-propellant canisters in a fully engulfing fire representative of an accidental fire situation. A portable pan (6 feet in diameter and 2 feet deep) with an air curtain system was used for the tests. The air curtain, produced by a fan rated at 14,000 cubic feet per minute to blow air through an annular area around the lip of the burn pan, protected the fire from wind effects. In three of the tests, the M5-155 gun-propellant canister was breached in approximately 100 seconds, as evidenced by a brilliant flash associated with the ignition of the gun propellant. An accelerated burning of the fire ensued for about 15 to 20 seconds, presumably corresponding to the consumption of the gun propellant. In two of the tests, the accelerated burning stage was followed by an igniter explosion, which is not considered a large explosion (Hickox and Abitz December 1994). The igniter consisted of a mild detonating fuse surrounded by barium nitrate. No detailed information is available for two of the five tests.

Slow-Heat Tests

The vented slow-heat tests conducted in 1983 (Mata December 1983) were designed to investigate whether the combustion products of burning PBX-9502 (TATB-95 percent, Kel-F 800-5 percent) (Dobratz and Crawford January 1995) explosive would vent from the test unit without reaching critical internal pressure that would cause an explosion. A corrugated culvert chimney was placed over a portable burn pan in the Bomb Burner Unit trench, and a hole was cut in the side for a large water-cooled lever arm. The lever arm portion inside the corrugated culvert chimney extended over the portable pan. A mock weapon containing high explosives (HE) was placed on the end of the lever arm that extended over the burn pool, and the other end of the lever arm was attached to a piston-like instrument that determined the change in mass of the HE inside the weapon as a function of burn time (Hickox and Abitz

December 1994). Two burn tests were conducted to demonstrate the successful operation of the water-cooling system. On October 4, 1983, a third test with a vented stainless steel casing containing insensitive (i.e., nonshockwave initiated) HE was conducted in a JP-4 fuel fire at a nominal temperature of 2,000°F for approximately 60 minutes (Mata December 1983, Hickox and Abitz December 1994). The HE inside the weapon was completely burned without an explosion.

Nitromethane Calibration Tests

Thirty-eight nitromethane calibration tests were conducted at SWMU 94 between September and October 1984 (SNL/NM November 1994). The tests involved filling test units with nitromethane and exposing them to a JP-4 fuel fire. The purpose of these tests was to calibrate detonation velocity using liquid nitromethane and Composition-1 (C-1) and Composition-7 explosives (Palmieri December 1994e). The tests were conducted in the Bomb Burner Unit trench. A trial test was conducted in August 1984 using gasoline rather than nitromethane. Neither the trial test using gasoline nor the first two nitromethane tests completely detonated the C-1 explosives. The remaining 36 tests were high-order detonations (see SNL/NM November 1994 for additional information on these tests).

A.2 SMALL SURFACE IMPOUNDMENT

SWMU 94E, Small Surface Impoundment is approximately 60 feet long, 25 feet wide, and less than 2 feet deep (Figure 4A-1) (Palmieri December 1994b, SNL/NM August 1994). The inactive impoundment is surrounded by low soil berms on the south and west sides (Larson and Palmieri October 1994) (Figures 4A-4a and 4A-4b). A crude concrete trough approximately 3 feet long is located at the northeastern edge of the impoundment, and a manhole is on the southern edge of the impoundment (Hickox November 1994, Palmieri December 1994b) (Figure 4A-4a). The exact use of the manhole is not known (Hickox November 1994, Palmieri December 1994b). It is believed that the small surface impoundment was used once to burn JP-4 fuel as a test demonstration (Jercinovic et al. November 1994). The first three log book entries (from October 1979 through February 1980) reference the "old facility" and the "culvert facility," which refer to portable chimney setups in the small surface impoundment (Palmieri April 1995a, SNL/NM November 1994). These tests consisted only of JP-4 fuel fires and investigated the effectiveness of controlling the flames with portable chimneys. The impoundment currently receives storm runoff from the northwestern portion of the site and may have received liquids from the portable pans (Jercinovic et al. November 1994).

A.3 THE LARGE OPEN BURN POOL

The LOBP is an active burn unit located approximately 200 feet southeast of the SMERF (SNL/NM August 1994) (Figure 4A-2). The pool is formed by a rectangular concrete basin 30 by 60 feet and 3 feet deep (Figure 4A-5a) and is concrete/fiber-ceramic-lined (Palmieri October 1994, Larson and Palmieri October 1994). Fire tests at the LOBP were primarily performed on a variety of shipping containers, most of which burned in the LOBP and contained no radioactive materials (Palmieri October 1994). However, one test in 1991 involved an H1501 accident-resistant container unit that did contain uranium-238 and beryllium (SNL/NM November 1994).

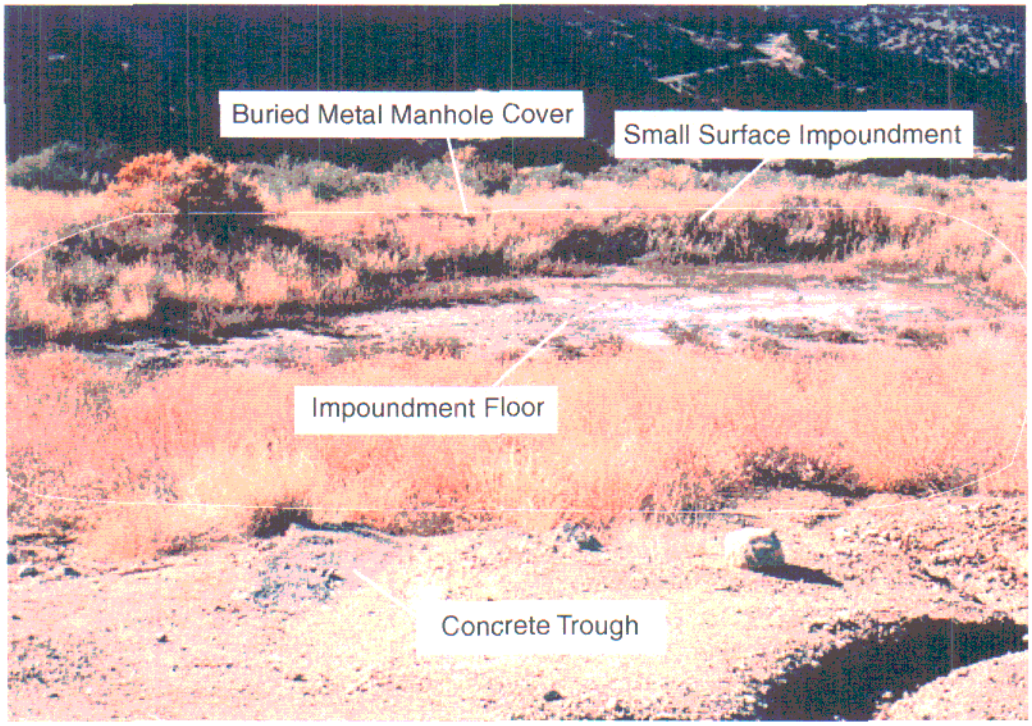


Figure 4A-4a Photograph of the small surface impoundment (SWMU 94E) in December 1994. The impoundment is located east of the camera bunker. View is to the southwest.

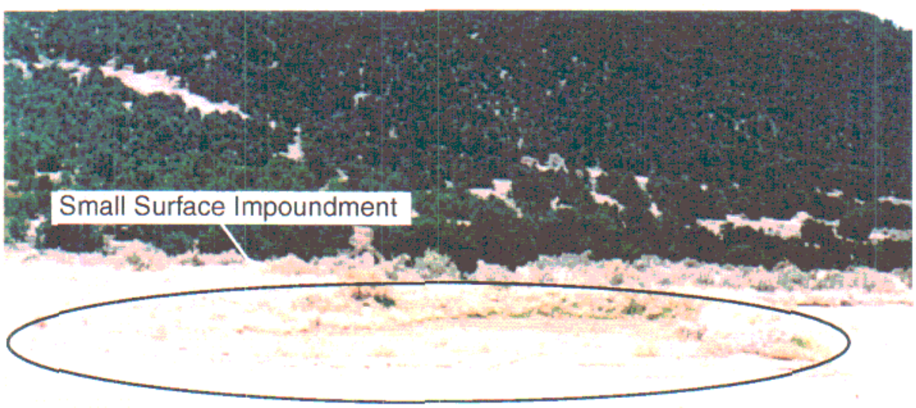


Figure 4A-4b Photograph of the small surface impoundment (SWMU 94E) in April 1995. Photograph was taken from the direction of surface runoff. View is to the southwest.

Figure 4A-4
Photographs of SWMU 94E, Small Surface Impoundment

301462.225.03.000/cw A21

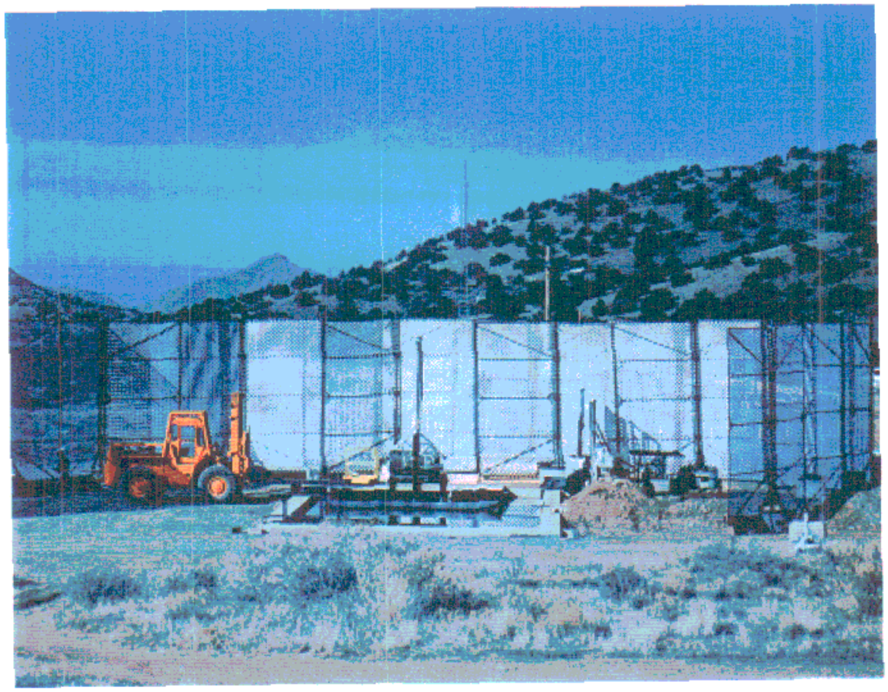


Figure 4A-5a Photograph of the LOBP under construction at SWMU 94 in 1977. View is to the northwest.

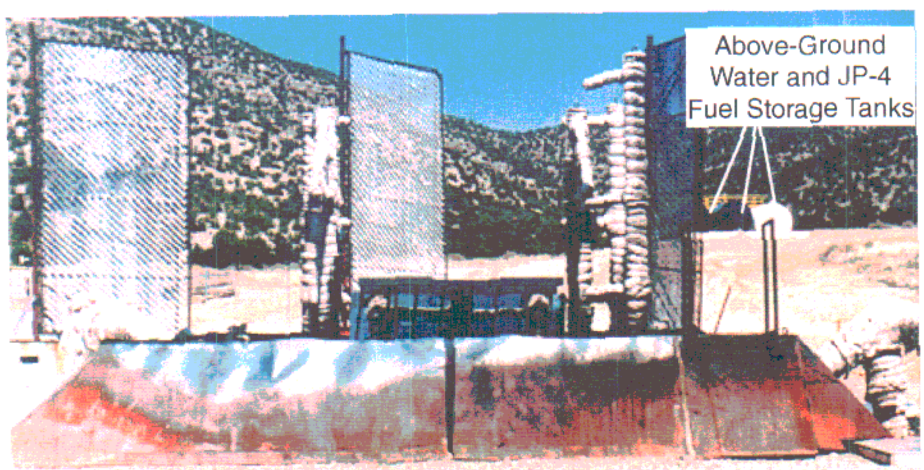


Figure 4A-5b Photograph of the SOBP at SWMU 94 in April 1995. View is to the north.

Figure 4A-5
Photographs of Large Open Burn Pool and Small Open Burn Pool

301462.225.03.000/cw A19

The LOBP was built in 1977 in order to conduct the Railcar Burn Test (synonymous with the Yankee Cask Test) (Palmieri October 1994, Jercinovic et al. November 1994, Palmieri November 1994b). Wastewater from this burn test was left in the LOBP to evaporate. Following the Railcar Burn Test in 1977, the LOBP was inactive until testing resumed in June 1983 (Jercinovic et al. November 1994, Palmieri December 1994e, SNL/NM November 1994).

In 1983 a drain was installed in the LOBP (Jercinovic et al. November 1994) in order to facilitate test unit access following a burn test. The drain was connected to the Oil Surface Impoundment (SWMU 13) with 24-inch-diameter corrugated culvert pipe. The Oil Surface Impoundment is located approximately 200 feet south of the LOBP (Figure 4A-2) (Palmieri October 1994, Jercinovic et al. November 1994).

Fifty-two burn tests have been conducted in the LOBP from June 1983, when burn testing resumed, to the present. From 1984 to 1987, the operational practice was to discharge the water and residual JP-4 fuel from the LOBP to the Oil Surface Impoundment after the JP-4 fuel burned out. Nine tests in the LOBP discharged wastewater to the impoundment through the underground corrugated piping system during this time period (Larson and Palmieri October 1994, Jercinovic et al. November 1994). In 1987 waste-water discharges to the impoundment ceased (Palmieri October 1994, Larson and Palmieri October 1994), and a closed-loop, recirculation system was constructed between the LOBP and the aboveground tanks (SWMU 94A) north of the LOBP. All wastewater associated with the burn testing is currently recycled to these tanks for reuse in subsequent burn tests. Recycled wastewater is periodically tested and pumped into tanker trucks, removed from the site, and released to the City of Albuquerque publicly owned treatment works under the Sandia National Laboratories/New Mexico (SNL/NM) allotment of 1 million gallons per year (Palmieri November 1994b). Nonhazardous solid waste such as damaged ceramic insulation was disposed of at the Kirtland Air Force Base landfill (Author [unk] Date [unk]a, Martz September 1985, Author [unk] Date [unk]d). The personnel conducting the tests are responsible for the disposal of solid residues remaining in the bottom of the LOBP (Larson and Palmieri October 1994).

A.4 THE SMALL OPEN BURN POOL

The SOBP (an active burn unit) is located approximately 8 feet west of the LOBP (Figure 4A-2). The SOBP was built in 1992 in order to reduce the amount of fuel required to perform the same length test in the LOBP and, thereby, reduce the total smoke emissions (Palmieri October 1994). Since its construction, 23 burn tests have been conducted in the SOBP on transportation containers and weapons components (SNL/NM November 1994). The pool is formed by a square concrete basin 20 by 20 feet and 3 feet deep and is lined with sheet steel (Figure 4A-5b). Metal sheets have been welded together and to the metal pan, so that a skirt is formed around the pan at a 45-degree angle. A metal mesh drain is located in the northeastern corner of the SOBP and is connected to the LOBP with a 2-inch-diameter underground pipeline. Wastewater is drained from the SOBP to the LOBP in order to recirculate it back to the aboveground storage tanks to the north (Figure 4A-2) (Palmieri April 1995a). Two aboveground 3.5-inch-diameter galvanized metal pipes supply water and fuel to the SOBP from the aboveground tanks. These pipes connect into a single 3-inch-diameter pipe that enters the SOBP. All testing in the SOBP was completely contained, and there have been no documented historical releases of hazardous constituents to the environment.

A.5 THE LAARC UNIT

The LAARC Unit is an inactive burn unit located approximately 200 feet east of Bunker 9830 (SNL/NM August 1994) (Figures 4A-2 and 4A-6a). This unit was the first permanent structure constructed at the site. The unit was constructed in approximately 1980 and was used for 63 fire tests of small transportation containers and mock weapons (Moore June 1982, Cocke May 1984, Luna and Moore June 1983, Moore and Luna February 1983, Palmieri October 1994, Jercinovic et al. November 1994, Larson and Palmieri August 1994a). The LAARC Unit was last used in August 1987 (SNL/NM November 1994; Author [unk], January 1993; Palmieri December 1994d) under an assurance of discontinuance with the City of Albuquerque Air Pollution Bureau (Palmieri October 1994).

The burn pan located inside the unit is approximately 10 feet in diameter (Moore and Luna February 1983) (Figure 4A-7). The LAARC received water and JP-4 fuel through an underground pipeline from aboveground tanks located approximately 200 feet north of the unit (Figure 4A-1) (Palmieri April 1995a). Wastewater was discharged from the burn pan through a 12-inch-diameter aboveground pipe to the LAARC Discharge Pit (SWMU 94F) located approximately 50 feet south of the unit (Figure 4A-6b).

The wastewater was released into a 55-gallon drum in the bottom of the unlined discharge pit (Figures 4A-6b and 4A-7) (Martz November 1985). The drum functioned as a flame arrestor, sealing off and extinguishing any burning JP-4 fuel discharged with the wastewater (Jercinovic et al. November 1994). As much as 1,500 gallons of wastewater per test may have been discharged into the pit.

A.6 THE BOMB BURNER UNIT

The Bomb Burner Unit (also referred to as the Corrugated Facility) was removed in 1997 under the SNL/NM decontamination and decommissioning program. The Bomb Burner Unit was constructed of corrugated galvanized steel and mantled by a concrete platform (Figure 4A-8a). It is located approximately 200 feet southeast of the SWISH Unit (SNL/NM August 1994) (Figure 4A-2). The Bomb Burner Unit was constructed in 1982 (Palmieri October 1994, Jercinovic et al. November 1994). Between 1982 and its shutdown in 1988, it was used for 23 burn tests involving the exposure of weapons (some containing depleted uranium) and components to abnormal environments (Hooper May 1983, Stevenson December 1985, Mata December 1983, Palmieri October 1994). The Bomb Burner Unit was built inexpensively as an expendable duplicate of the LAARC Unit for conducting burn tests on weapons to avoid risking damage to the LAARC Unit through a possible weapons detonation (Jercinovic et al. November 1994). The Bomb Burner Unit was closed in 1988 under an assurance of discontinuance agreement with the City of Albuquerque Air Pollution Bureau (Palmieri October 1994). The "RCRA [Resource Conservation Facility Investigation (RFI) Work Plan for OU 1333, Canyons Test Area" (SNL/NM September 1995) summarizes the tests conducted at the Bomb Burner Unit.

The Bomb Burner Unit was constructed below ground level to contain potential explosions that might have occurred during burn tests. A shallow, open trench extending southward from the Bomb Burner Unit was constructed to provide vehicle and equipment access to the unit (Figure 4A-8a). Engineering drawings and maps suggest that fuel and water were supplied to the burn unit from three aboveground tanks formerly located approximately 200 feet north of the

Figure 4A-6a February 1993 photograph of the LAARC Unit trench and discharge pit (SWMU 94F) showing the wastewater management system. Dashed lines show approximate location of the discharge pit rim. View is to the north.

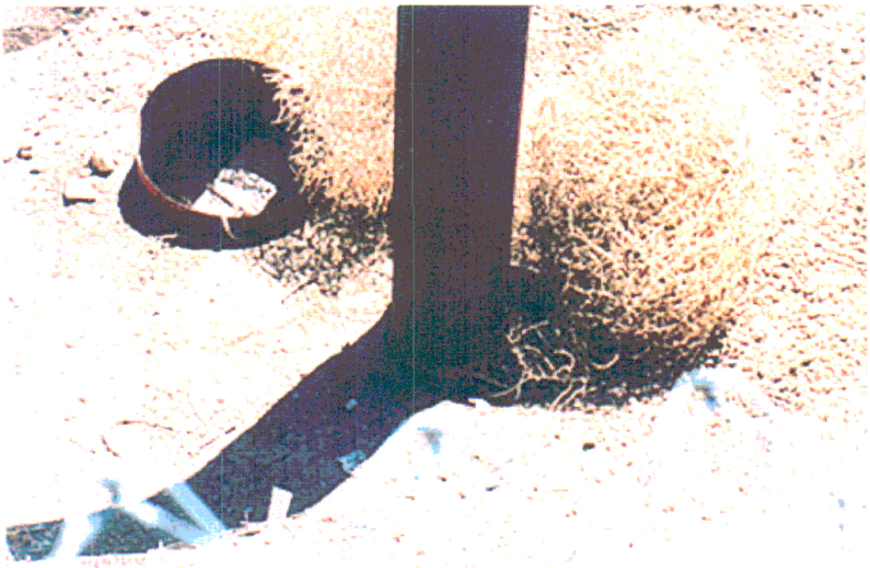


Figure 4A-6b Photograph of LAARC Unit discharge pit (SWMU 94F). The wastewater is discharged through the 12 in.-diameter pipe into a 55-gal drum. The wastewater subsequently overflows into the pit.

Figure 4A-6
Photographs of LAARC Unit and SWMU 94F, LAARC Unit Discharge Pit

301462.225.03.000/cw A18

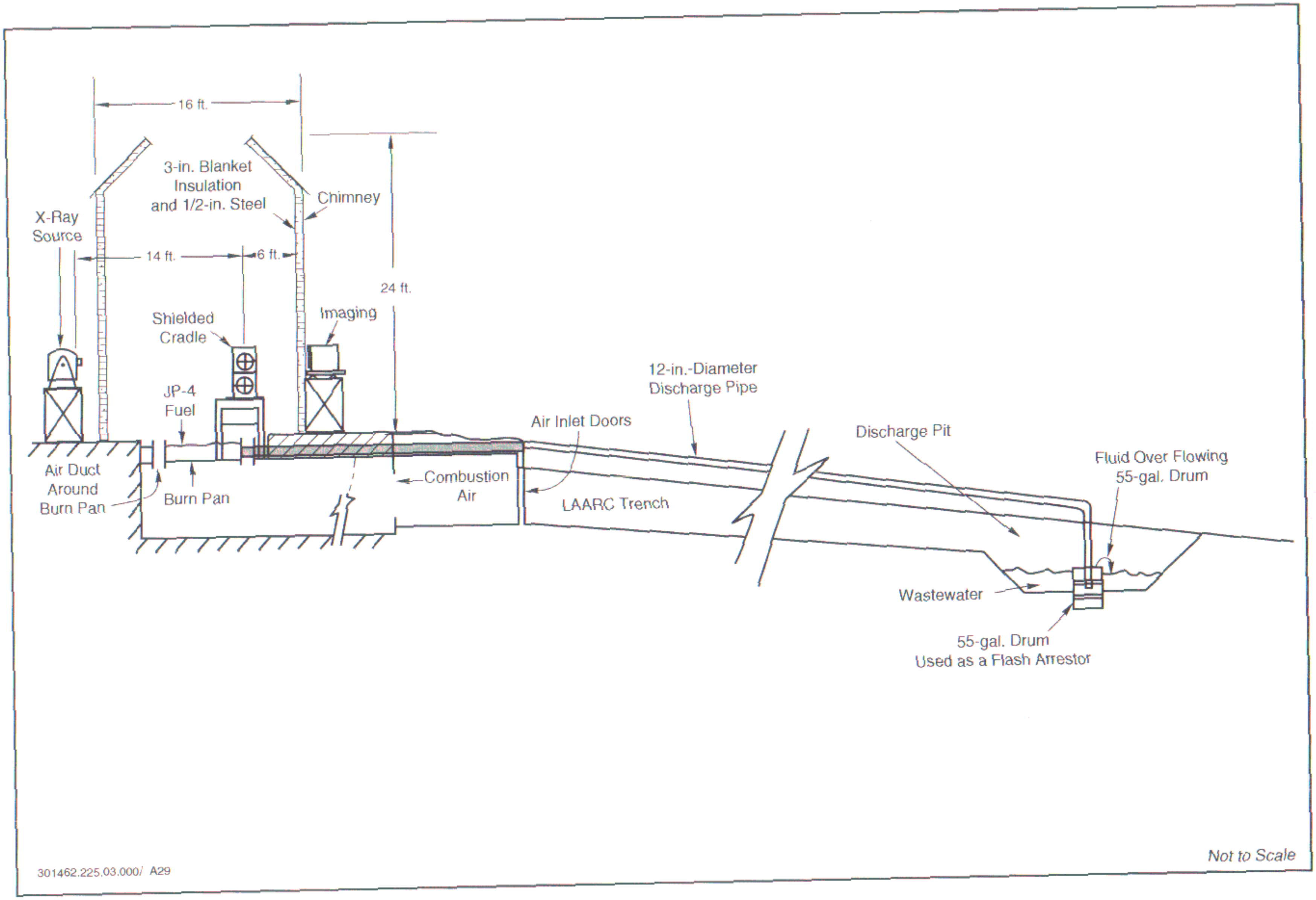


Figure 4A-7
Cross Section of LAARC Unit Showing Aboveground Burn Pan Test and Wastewater System

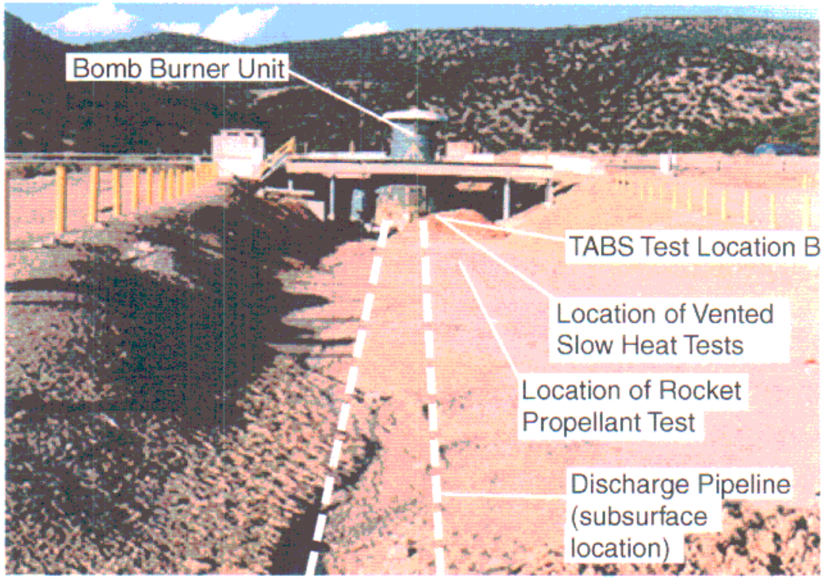


Figure 4A-8a Photograph of the Bomb Burner area and discharge line (SWMU 94C) in February 1993. Approximate locations of the discharge pipeline, TABS Test, Location B rocket propellant test, and vented slow-heat tests are indicated. The approximate location of the uncontained pool-fire tests, which were conducted at the southernmost end of the trench, is not pictured. View is to the north.

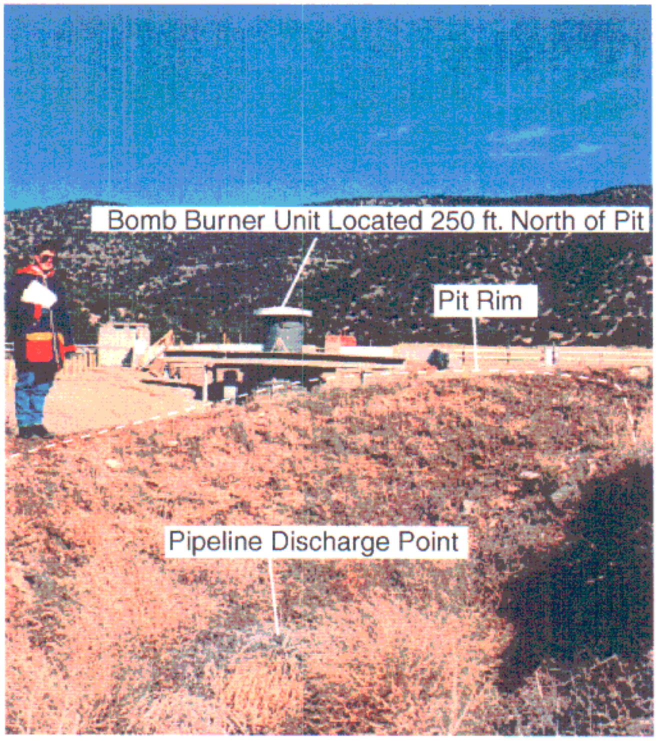


Figure 4A-8b Photograph of Bomb Burner discharge pit (SWMU 94D) in December 1994. The pit is approximately 10 ft wide x 25 ft long x 8 ft deep. View is to the north.

Figure 4A-8

Photographs of SWMU 94C, Bomb Burner Area and Discharge Line, and SWMU 94D, Bomb Burner Discharge Pit

301462.225.03.000/cw A23

unit (Figure 4A-1) (SNL/NM 1983). These aboveground tanks have since been removed from the site. The burn pan used in the Bomb Burner Unit is 10 feet in diameter (Hooper May 1983, Mata December 1983). A 12-inch-diameter corrugated pipe connects the burn pan to the Bomb Burner Discharge Pit (SWMU 94D) located approximately 250 feet south of the Bomb Burner Unit (Figure 4A-1) (Palmieri October 1994, Jercinovic et al. November 1994). The discharge pit is approximately 25 feet long, 10 feet wide and 8 feet deep (Figure 4A-8b) (Palmieri December 1994b). Following tests that involved radionuclides, wastewater from the Bomb Burner Unit was screened for radiological activity before being released into the discharge pit (Palmieri October 1994). As many as 1,500 gallons of wastewater per test may have been discharged into the pit.

Test reports document a number of the tests at the Bomb Burner Unit (Hooper May 1983, Stevenson December 1985, Hill Date [unk], Mata December 1983) and describe the test set up and materials involved. The Bomb Burner Area and Discharge Line are designated as SWMU 94C. The remainder of this section describes two reported tests that are representative of the testing conducted in the Bomb Burner Unit.

In September 1982, a burn test was conducted on a W-69 warhead used in the SRAM missile (Hooper May 1983). Aluminum, steel, HE, and insulation materials were exposed to a JP-4 fuel fire in order to determine the response of the W-69 to an accidental fuel fire. The fuel fire was performed at a temperature of approximately 1,800°F for a total burn time of 95 minutes. The warhead remained in place on the test stand and, as expected, all aluminum and organic components melted (Hooper May 1983). The PBX-9404 HE did not detonate and was consumed in a nonviolent manner, and no warhead materials were expelled from the unit.

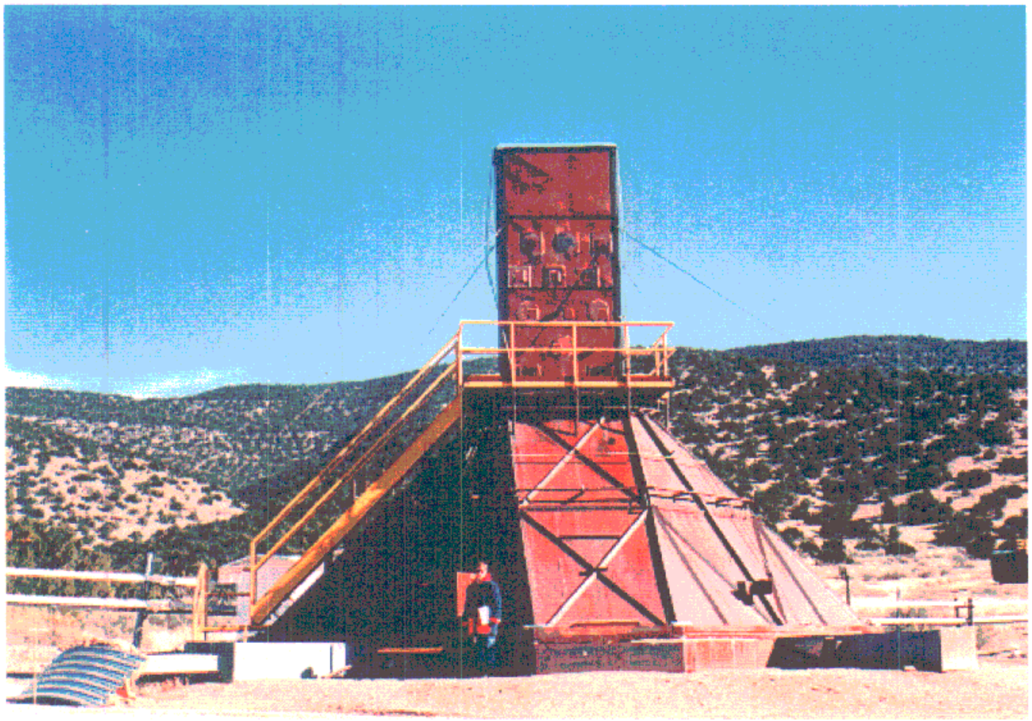
On March 9, 1983, a W-80 warhead was subjected to a high-intensity JP-4 fuel fire at a nominal temperature of 2,000°F for approximately 30 minutes (Hill Date [unk], Luna March 1983, SNL/NM November 1994). The purpose of the test was to determine the behavior of internal HE components and the inherent safety of the weapon when exposed to an accidental fuel fire. The test unit configuration consisted of the warhead external aluminum case, binary parts, live insensitive HE material, and a mass simulated canned subassembly placed 3.5 feet above the surface of the fuel. Test unit thermocouples were wrapped with cera-blanket insulation, shielded in a steel pipe, and then wrapped with additional insulation. The HE burned successfully without any explosive incident. Real-time radiography and video coverage of the warhead burn test was observed at Bunker 9830 (Hill Date [unk]).

Several burn tests have been conducted in the Bomb Burner Unit trench since 1982, including portable pan burn tests such as the vented slow-heat tests and uncontained pool fires. Fuel-fire burn testing conducted in the trench includes the Torch Activated Burn System (TABS) test Location B (Figure 4A-1) and one series of rocket propellant tests. The TABS test Location B resulted in detonation within the trench.

A.7 THE SWISH UNIT

The SWISH Unit (Figure 4A-9) is located approximately 300 feet east of Bunker 9830 (Figure 4A-2) (SNL/NM August 1994). This active unit was constructed in 1983 and is currently used to study the potential for protecting large pool burns from the wind (Author [unk] Date

This page intentionally left blank.



Photograph of the SWISH Unit at SWMU 94 in December 1994.
View is to the north.

Figure 4A-9
Photograph of SWISH Unit

301462.225.03.000/cw A28

[unk]c, Palmieri October 1994, Palmieri December 1994d). The SWISH Unit is the prototype for meeting air-quality requirements while conducting burn tests. To request an exemption from opacity requirements, testimony was given before the City of Albuquerque and Bernalillo County Joint Air Quality Board on September 13, 1995. Approval for the requested exemption is expected in October 1995. This unit has been used in 61 tests where large explosives fragments or blast overpressures were not expected. Typical tests require small volumes (of up to 150 gallons) of JP-4 fuel and involve test units such as hazardous materials shipping containers, small weapon components and weapons mockups containing insensitive HE. Burn pools, typically ranging from 6 feet up to 9 feet in diameter and 3 feet in depth were placed in the center of the SWISH Unit floor, which is about 25 by 25 feet (Author [unk] Date [unk]c, Jercinovic et al. November 1994). The base of the structure tapers to a stack assembly 3 by 6 feet by 13 feet tall (Figure 4A-9). The stack is insulated and contains baffles to mix the flow and to reduce the visible air emissions. JP-4 fuel was delivered to the SWISH Unit using portable tanks (Hickox November 1994). Other records indicate that the small brown tank stationed between the SWISH and LAARC Units (Figure 4A-2) was used to store fuel for burn tests at either the SWISH or the LAARC Units (Palmieri December 1994b). The tank is portable, may have been supported by wheels, and holds approximately 100 gallons of fuel (Palmieri December 1994b). Wastewater from burn tests conducted in the SWISH Unit is not discharged but is allowed to evaporate (Palmieri December 1994a). There have been no documented historical releases of hazardous constituents to the environment. An external sprinkler system cools the walls of the SWISH Unit. Water circulation pipes and spray nozzles are situated at numerous points on the outside structure. Cooling water that does not evaporate is captured in a shallow trough at the base and is routed to an underground tank for storage and reuse. Burn tests at the SWISH Unit are primarily performed on shipping containers, although lithium batteries have also been burned in the facility (SNL/NM November 1994).

A.8 THE SMERF

The SMERF (Figure 4A-10a and 4A-10b) is an active burn unit located approximately 150 feet east of the Bomb Burner Unit (Figure 4A-2). This facility was constructed after the removal of the CON-CON Unit in 1988 as a scale-up of the SWISH Unit (Author [unk] Date [unk]c, Palmieri October 1994, Larson and Palmieri October 1994). The first recorded test at the SMERF was conducted in August 1992. This burn unit was built to test hazardous materials shipping containers, transportation systems, weapons mockups, and associated materials under actual fire accident conditions (Kent July 1994). Soil removed to enlarge the CON-CON Unit site for the SMERF was bermed to direct surface-water flow away from the burn site facilities into the main arroyo of the Lurance Canyon (Engineered Soil Berms, Figure 4A-2) (Larson and Palmieri October 1994). To date, the only burns conducted in the SMERF have been performance tests with JP-4 fuel (SNL/NM November 1994) to demonstrate compliance with the City of Albuquerque Air Pollution Bureau regulations (Kent July 1994). To request an exemption from opacity requirements, testimony was given before the City of Albuquerque and Bernalillo County Joint Air Quality Board on September 13, 1995. Pending approval for the requested exemption is expected in October 1995.

The SMERF is accessed by a shallow, open trench that rises southward to the entry road (SNL/NM August 1994). The unit consists of a cubical test chamber approximately 20 by 20 feet. The chamber contains a 10- by 10-foot-square burn pan (Author [unk] Date [unk]c) that can be reduced to an 8- or 7-foot-square configuration (SNL/NM November 1994).

This page intentionally left blank.

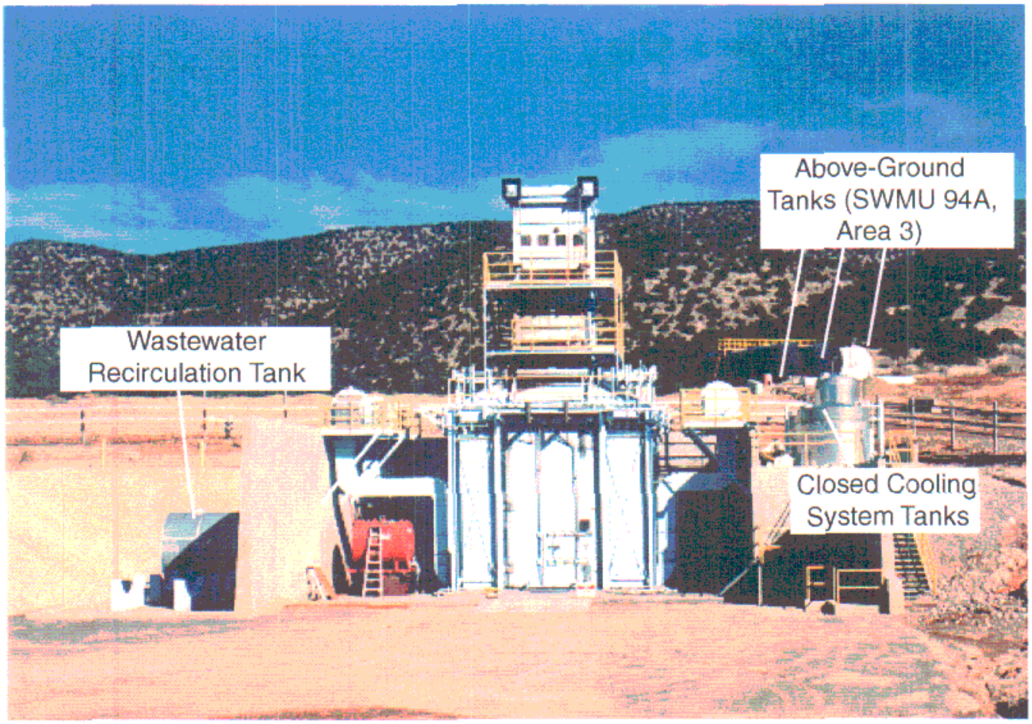


Figure 4A-10a Photograph of the SMERF at SWMU 94 in December 1994. View is to the north.

Figure 4A-10b Photograph of the SMERF conducting performance tests at SWMU 94 in December 1994. View is to the northeast.

Figure 4A-10
Photographs of SMERF

A 20-foot-tall stack houses a passive afterburner to reduce smoke emissions (Author [unk] Date [unk]c, Kent July 1994). Underground pipelines connect the unit to two of the three aboveground tanks located north of the LOBP (SWMU 94A, Area 3). Two of the lines recirculate a glycol/water cooling mixture between the vertical walls, roof panels, and the storage tank. A third line supplies fuel from the JP-4 fuel tank. The underground pipes join the SMERF at a valve box on the northern side of the unit. The valves are marked "fuel," "water," and "water return." Three additional aboveground tanks are located inside a concrete berm enclosure on the eastern side of the SMERF. These tanks are connected to the incoming pipelines by 8- and 3-inch lines. The tanks are part of the water recirculation system. Two of these aboveground tanks are labeled "nonpotable water," and the third is labeled "water/glycol." These tanks are part of a closed recirculation system. Propylene glycol is used for active cooling of the walls and roof panels in the SMERF (Larson and Palmieri October 1994).

A.9 BUNKER 9830 AND SUPPORT BUILDINGS

Bunker 9830, located approximately 200 feet northwest of the LAARC Unit (Figure 4A-1), was constructed in 1967 to house instrumentation for SWMU 65 activities. The eastern half of Bunker 9830 was used from 1975 though 1980 for fire tests on nuclear reactor control cables (Larson and Palmieri August 1994, Palmieri November 1994a). These tests were conducted as part of the reactor safety program in response to the Browns Ferry Reactor fire. In the initial test, a mockup of a nuclear reactor cable assembly was constructed in Bunker 9830 and was ignited to simulate the incident (Brouillard June 1994). The tests used heptane as a fuel source. The number of tests conducted is unknown. Fire suppression tests were conducted in Bunker 9830 from 1975 to 1980. A series of ten fire tests on cable insulation were conducted using propane gas (Palmieri and Larson October 1994). The bunker is not involved in current SWMU 94 burn operations (Palmieri December 1994b) and is used to store equipment. All testing in Bunker 9830 was completely contained, and there have been no documented historical releases of hazardous constituents to the environment.

Several small trailers northwest of Bunker 9830 store equipment, tools, parts, insulation, cable, television monitors, instrumentation, and data systems (Larson and Palmieri October 1994). Several trailers are marked by placards indicating the storage of hazardous chemicals. According to interviewees, these designations are inaccurate for all but one identified trailer, because there actually is no chemical storage in these trailers (Larson and Palmieri October 1994, Palmieri December 1994b). Currently, all chemicals are stored in Building 9833A, which is located about 200 feet southwest of Bunker 9830 (Figure 4A-2) (Larson and Palmieri October 1994).

The control and instrumentation point for the Lurance Canyon Explosives Test Site during explosives testing was Building 9831 at SWMU 81 (New Aerial Cable Site). By 1979, the control facility was moved to what is now the lunch trailer (Palmieri April 1995a) located 30 feet from Bunker 9830. Currently, the control facility is set up in a trailer located off the southwest corner of Bunker 9830 (Figure 4A-1) (Larson and Palmieri August 1994). Cables radiate from each of the previous control facilities to the various burn site units (Larson and Palmieri October 1994).

A.10 ABOVEGROUND TANKS

Aboveground tanks (SWMU 94A) have been used to supply water, JP-4 fuel, and coolant for burn testing at all of the engineered structures. There are three storage tank locations at SWMU 94 that served the LAARC Unit, the Bomb Burner Unit, the SMERF, the SOBP, and the LOBP. The aboveground tank locations include an area north of the LAARC Unit, north of the Bomb Burner Unit, and the current tank location north of the LOBP (Figure 4A-1). These three aboveground tank locations are discussed below.

North of the LAARC Unit (Area 1)

An aboveground tank labeled "nonpotable water" is currently located north of the LAARC Unit and was used to supply water to the unit (Figure 4A-1 and 4A-11a) (Hickox November 1994). Two aboveground tanks were also formerly used for fuel storage at this location (Kervin April 1981). These two tanks have since been removed.

North of the Bomb Burner Unit (Area 2)

The 1983 historical aerial photograph shows that three aboveground tanks were formerly located north of the Bomb Burner Unit (Figures 4A-1 and 4A-11b) (SNL/NM 1983). These aboveground tanks were used to supply JP-4 fuel and water for testing at the Bomb Burner Unit. The tanks are no longer present at the site, and no documentation exists that describes the installation and removal of the tanks. No physical evidence exists at the site to identify their former locations.

North of the LOBP (Area 3)

Three aboveground tanks are now located approximately 400 feet north of the LOBP: One contains JP-4 fuel, another contains nonpotable water, and the third contains glycol/water (Figures 4A-2 and 4A-11c). Prior to 1992, when the nonpotable water and glycol/water tanks were installed, there were two nonpotable water tanks in addition to a JP-4 fuel tank at the same location (Figure 4A-2) (Hickox November 1994). The current nonpotable water and JP-4 fuel tanks provide water and fuel for burn tests conducted at the LOBP, the SOBP, and the SMERF. The glycol/water is used as a coolant for the SMERF. A plastic-lined, earthen, secondary overflow containment pit is installed around the aboveground tank containing JP-4 fuel (Figure 4A-11d) (Larson and Palmieri October 1994).

Two underground pipelines connect the LOBP to the JP-4 fuel tank and to the nonpotable water tank. Two aboveground 3.5-inch-diameter galvanized metal pipelines connect the SOBP to the JP-4 fuel tank and to the nonpotable water tank. Three underground pipelines run from the tanks to the SMERF: One connects to the JP-4 fuel tank, and the other two provide glycol/water coolant for circulation between the vertical walls and roof panels of the SMERF. A recirculation system currently routes wastewater back to the water and water/glycol tanks for storage and reuse (Hickox November 1994, Larson and Palmieri October 1994).

Figure 4A-11a Photograph of the above ground tank (SWMU 94A, Area 1) north of the LAARC Unit in April 1995. Additional above ground tanks storing fuel were located here when the LAARC was active. View is to the northeast.

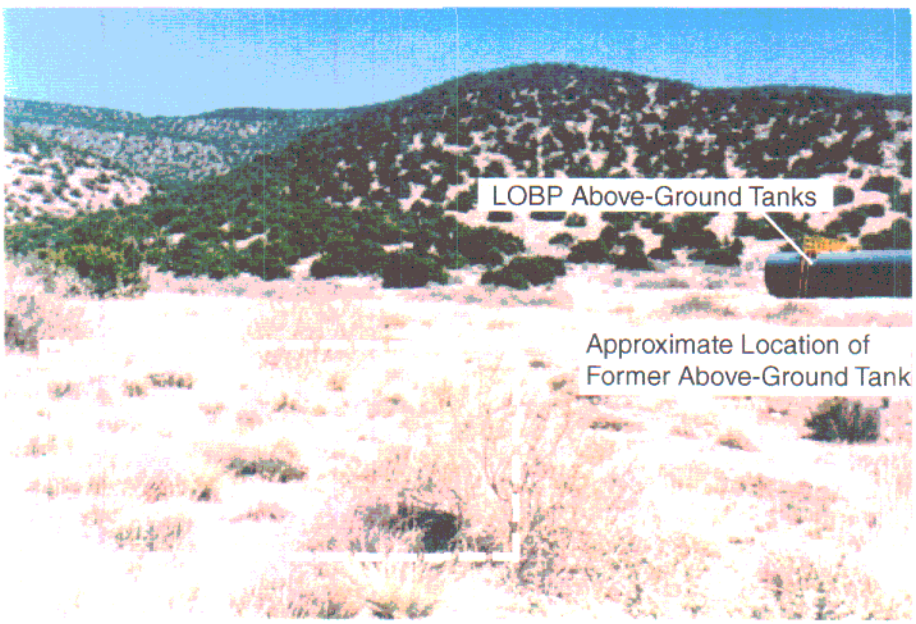


Figure 4A-11b Photograph of the former above ground tank location (SWMU 94A, Area 2) north of the Bomb Burner Unit in April 1995. The above ground tanks north of the LOBP are visable in the background. View is to the northeast.

Figure 4A-11

Photographs of SWMU 94A, Aboveground Tank North of LAARC Unit and Location of Former Aboveground Tank North of Bomb Burner Unit

301462.225.03.000/cw A27

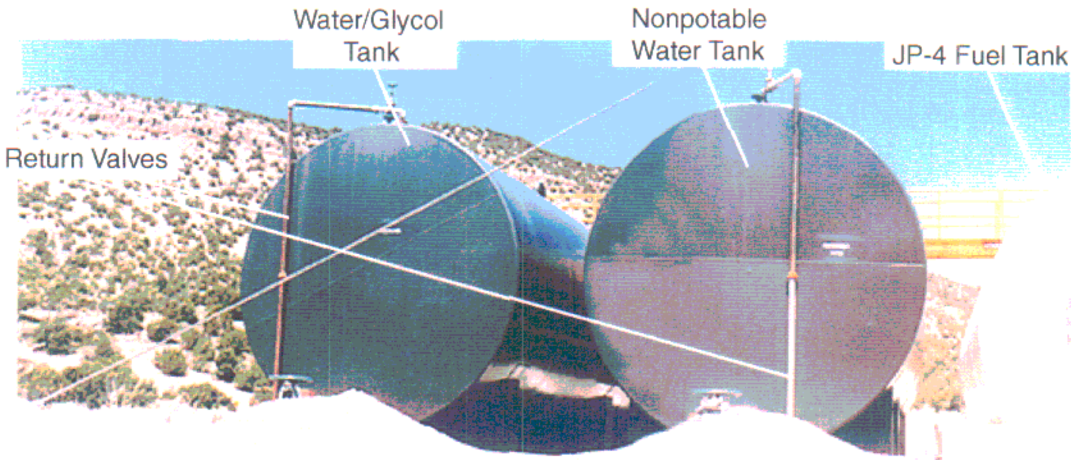


Figure 4A-11c Photograph of the aboveground tanks north of the LOBP (SWMU 94A, Area 3) in April 1995. The aboveground tanks provide the recirculation system for the LOBP, SOBP, and for the SMERF. Nonpotable water is recirculated back to the labeled tank following testing. View is to the north.

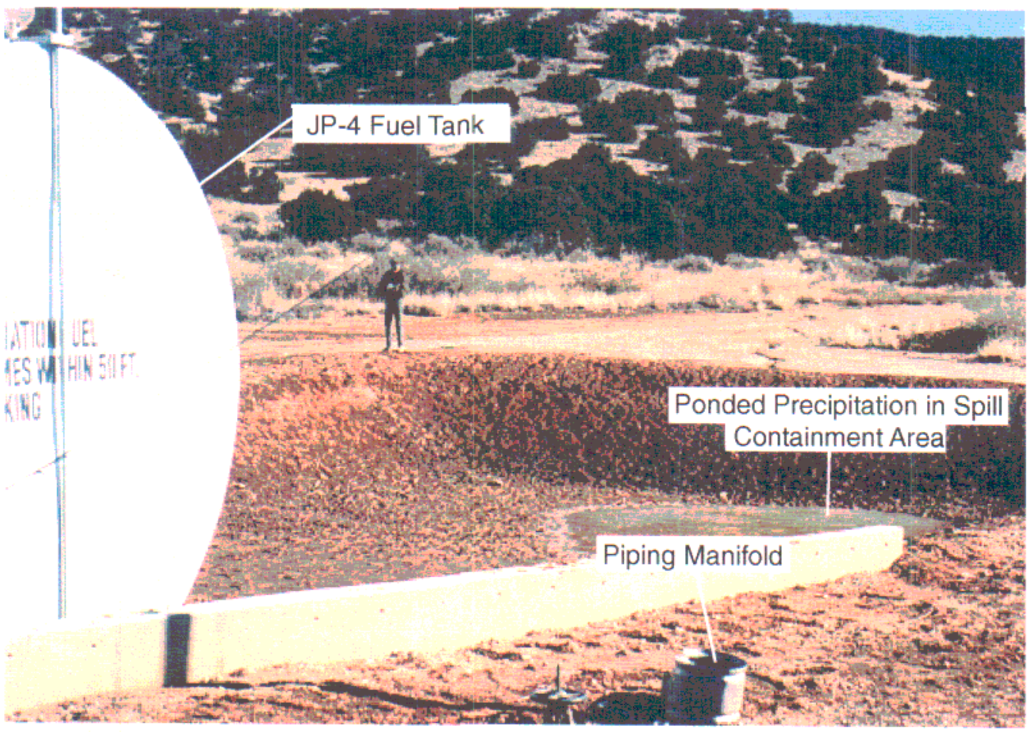


Figure 4A-11d Photograph of the spill containment area surrounding the JP-4 fuel aboveground tank (SWMU 94A, Area 3) north of the LOBP in December 1994. The spill containment area is constructed of soil overlying a plastic liner. View is to the northeast.

Figure 4A-11 (concluded)
Photographs of SWMU 94A, Aboveground Tanks North of LOBP

301462.225.03.000/cw A24

A.11 Debris/Soil Mounds

A Debris/Soil Mound Area (SWMU 94B) is located on the southern portion of SWMU 94, north of the main arroyo in the Lurance Canyon (Figures 4A-2 and 4A-12). There is little documentation for the origination of the debris/soil mound area, but this site appears to be the product of grading and soil redistribution during the evolution of SWMU 94 since 1983. The mounds, which range in height from about 3 to 6 feet, are not clearly defined but merge together. The only apparent debris in the soil mound area is concrete fragments, electrical cables, and wood (Figure 4A-12). Several radiological anomalies have been identified in the debris/soil mound area. The radiological anomalies may be associated with past activities at SWMU 65.

A.12 SCRAP YARD

The Lurance Canyon Burn Site Scrap Yard (SWMU 94G) was started in 1980 in the northwestern portion of the site (Figures 4A-2 and 4A-13a) (Palmieri November 1994). The scrap yard contains unused test equipment, portable generators, fiber/ceramic insulation, pipes, pump motors, cinder blocks, test stands, cables, wood, portable pans, empty tanks labeled JP-4, empty drums, and scrap metal (Figure 4A-13a and 4A-13b) (Hickox November 1994, Larson and Palmieri October 1994). In approximately 1990, hydraulic oil leaked onto the soil in the equipment/scrap yard (Larson and Palmieri October 1994). This is the only documented release of liquid at the scrap yard. The affected soil was placed in 55-gallon drums and removed (Larson and Palmieri October 1994). No other containerized fluids have ever been (nor are expected to be) stored in the scrap yard.

REFERENCES

Author [unk]. Interview notes for SWMU 94, Sandia National Laboratories, Notes (unpublished), Albuquerque, New Mexico. January 23, 1993.

Author [unk], Date [unk]a. Notes collected for SWMU 94 Sandia National Laboratories, Notes (unpublished), Albuquerque, New Mexico.

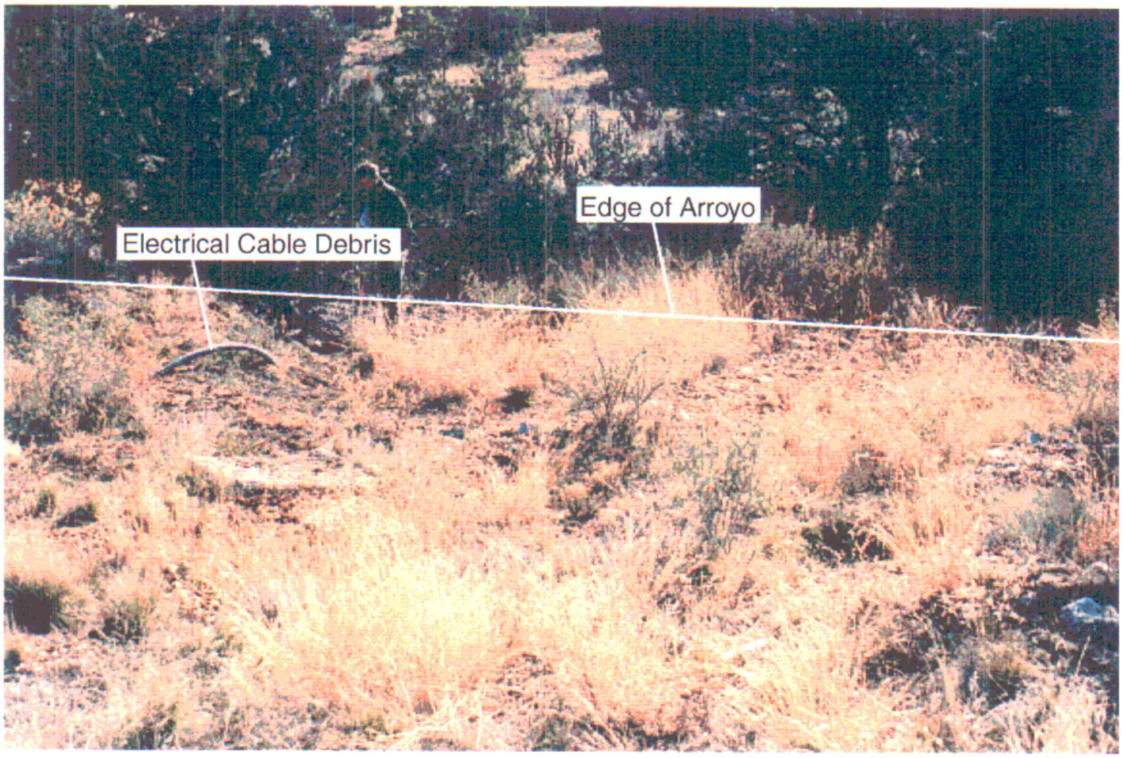
Author [unk], Date [unk]b. Notes collected for SWMU 94, Sandia National Laboratories, Notes (unpublished), Albuquerque, New Mexico.

Author [unk], Date [unk]c. Notes collected for SWMU 94, Sandia National Laboratories, Notes (unpublished), Albuquerque, New Mexico.

Author [unk], Date [unk]d. Notes collected for SWMU 94, Sandia National Laboratories, Notes (unpublished), Albuquerque, New Mexico.

Brouillard, L. Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-021, Sandia National Laboratories, Albuquerque, New Mexico. June 29, 1994.

This page intentionally left blank.



Photograph of part of the debris/soil mound area (SWMU 94B) in December 1994.
Visible debris is identified. View is to the south.

Figure 4A-12
Photograph of SWMU 94B, Debris/Soil Mound Area

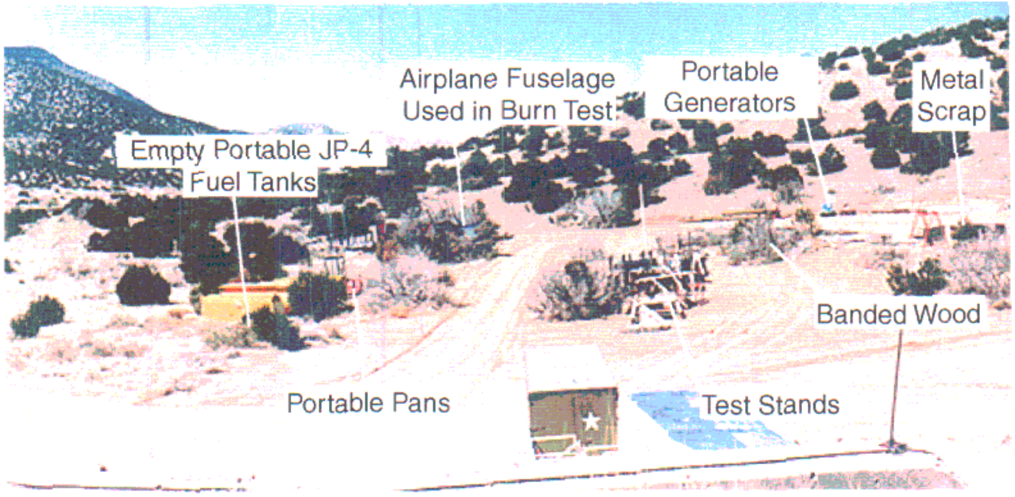


Figure 4A-13a Photograph of the scrap yard (SWMU 94G) in April 1995. Stored inventory is indicated. View is to the west.

Figure 4A-13b Photograph of empty drums in the northern portion of the scrap yard (SWMU 94G) in April 1995. View is to the north.

Figure 4A-13
Photographs of SWMU 94G, Scrap Yard

301462.225.03.000/cw A20

Caregeorges, M. Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-018, Sandia National Laboratories, Albuquerque, New Mexico. January 19, 1994.

Cocke, W.J., May 1984. "Executive Test Report, Results of AB61-Navy Shielded Cradle Fire Test Series (R802995)," SAND84-1027, Sandia National Laboratories, Albuquerque, New Mexico

Dobratz and Crawford, January 1995. "LLNL Explosives Handbook, Properties of Chemical Explosives and Explosive Simulants." Lawrence Livermore National Laboratories, Livermore, California.

Gill, W., November 1982. "Propellant Canister Fire Tests Environmental Test Report," Sandia National Laboratories, Albuquerque, New Mexico.

Hickox, J. (IT Corporation). Memorandum to OU 1333 Project File, Sandia National Laboratories, Albuquerque, New Mexico. November 1994.

Hickox, J, and R. Abitz. Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-019, Sandia National Laboratories, Albuquerque, New Mexico. December 1, 1994.

Hill, T.K., Date [unk.]. "W80 Abnormal Environment Fuel Fire Test (U), Sandia National Laboratories, Albuquerque, New Mexico.

Hooper, P.R., May 1983. "W69 Fuel Fire Test (U)," SAND82-2920, Sandia National Laboratories/New Mexico, Albuquerque, New Mexico.

Jercinovic, D., E. Larson, L. Brouillard, and D. Palmieri. Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-020, Sandia National Laboratories, Albuquerque, New Mexico. November 14, 1994.

Kent, L.A. Memorandum to Harris, J.M., Sandia National Laboratories, Albuquerque, New Mexico. July 8, 1994.

Kervin, J.E., April 1981. "Fire Test of the W84 (U)," Sandia National Laboratories, Albuquerque, New Mexico.

Larson, E., and D. Palmieri. Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-022, Sandia National Laboratories, Albuquerque, New Mexico. August 24, 1994.

Larson, E., and D. Palmieri (Sandia National Laboratories/New Mexico and IT Corporation). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-016, Sandia National Laboratories, Albuquerque, New Mexico. October 26, 1994.

Luna, D.A., and J.W. Moore, June 1983. "Report on B-61 Shielded Cradle Fire Tests Conducted in Lurance Canyon Coyote Test Field," R802995, Sandia National Laboratories, Albuquerque, New Mexico

Luna, D.A., March 1983. "Data Report on the W80 WTE08-01 Fuel Fire Test (Abnormal Environment)," R716200, Sandia National Laboratories, Albuquerque, New Mexico.

Martz M.K. Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-002, Sandia National Laboratories, Albuquerque, New Mexico. November 4, 1985.

Martz M.K. Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-001, Sandia National Laboratories, Albuquerque, New Mexico. September 24, 1985.

Mata, Jr., R., December 1983. "Report on the Vented Slow Heat Fire Test, Environment Test Report, " R803059, Sandia National Laboratories, Albuquerque, New Mexico.

Moore, J.W., and D.A. Luna, February 1983. "Report on Fire Tests for the TRUPACT Shipping Container Program, December 1981—July 1982," Environmental Test Report, Sandia National Laboratories, Albuquerque, New Mexico.

Moore, J.W., June 1982. "CTF Test Conducted at Lurance Canyon Burn Site," Sandia National Laboratories, Albuquerque, New Mexico

Moore, J.W., September 1981. "Uncontained Pool Fire Tests Conducted in Lurance Canyon," R802358, Sandia National Laboratories, Albuquerque New Mexico

Palmieri, D. (IT Corporation). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-015, Sandia National Laboratories, Albuquerque, New Mexico. October 26, 1994.

Palmieri, D. (IT Corporation). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-024, Sandia National Laboratories, Albuquerque, New Mexico. November 28, 1994a.

Palmieri, D. (IT Corporation). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-023, Sandia National Laboratories, Albuquerque, New Mexico. November 23, 1994b.

Palmieri, D. (IT Corporation). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-025, Sandia National Laboratories, Albuquerque, New Mexico. December 9, 1994a.

Palmieri, D. (IT Corporation). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-028, Sandia National Laboratories, Albuquerque, New Mexico. December 16, 1994b.

Palmieri, D. (IT Corporation). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-026, Sandia National Laboratories, Albuquerque, New Mexico. December 15, 1994c.

Palmieri, D. (IT Corporation). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-029, Sandia National Laboratories, Albuquerque, New Mexico. December 14, 1994d.

Palmieri, D. (IT Corporation). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-033, Sandia National Laboratories, Albuquerque, New Mexico. April 19, 1995a.

Palmieri, D. (IT Corporation). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-034, Sandia National Laboratories, Albuquerque, New Mexico. April 19, 1995b.

Palmieri, D., and E. Larson (IT Corporation and Sandia National Laboratories/New Mexico). Interview conducted for the Environmental Restoration Project, Department 7585, Personal Interview (unpublished), ER7585/1333/094/INT/95-015, Sandia National Laboratories, Albuquerque, New Mexico. October 26, 1994.

Sandia National Laboratories/New Mexico (SNL/NM), 1983. "Burn Site," Dwg. No. T95597, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories (SNL/NM), August 1994. "Historical Aerial Photo Interpretation of the Canyons Test Area, OU 1333," Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), November 1994. "Project Log Book, Tests Conducted at SNL/NM Lurance Canyon Burn Site," October 9, 1981, through November 9, 1994, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), September 1995. "RCRA Facility Investigation Work Plan for Operable Unit 1333, Canyons Test Area," Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico.

Stevenson, T.R., December 1985. "B61-7 Abnormal Environment Test (U) Fuel Fire (R719168)," SAND85-2786, Sandia National Laboratories, Albuquerque, New Mexico.

ANNEX 4-D
Risk Screening Assessment

TABLE OF CONTENTS

LIST OF TABLES

SWMU 94D: RISK SCREENING ASSESSMENT REPORT

I. Site Description and History

SWMU 94D is a subunit of SWMU 94, which was identified as the Lurance Canyon Burn Site (LCBS) on the RCRA Hazardous and Solid Waste Amendment permit. SWMU 94D is located on U.S. Air Force land withdrawn from the Bureau of Land Management and permitted to the U.S. Department of Energy (DOE) (SNL/NM July 1994a). The site is located on the canyon floor alluvium in the closed upper reaches of the Lurance Canyon drainage. This drainage is surrounded by moderately steep sloping canyon walls, and the immediate topographic relief around the site is over 500 feet. A 25- to 50-foot-wide road is cut on the hillsides as a firebreak and encircles the site. The canyon floor at the site is isolated by the canyon walls except for the western drainage into the Arroyo del Coyote. Coyote Springs Road follows this drainage and is the main access road into the Lurance Canyon.

The LCBS is currently used for testing fire survivability of transportation containers, weapons components, simulated weapons, and satellite components (Author [unk] Date [unk], Martz November 1985, SNL/NM May 1986). Only a few of the permanent engineered structures present at the site are active today. The location of SWMU 94 coincides with SWMU 65, Lurance Canyon Explosives Test Site, an inactive site used for high explosives (HE) tests and for liquid and solid propellant burn tests.

In order to facilitate site characterization, SWMU 94 has been subdivided into seven subunits where hazardous constituents could have been released: SWMU 94A (Aboveground Tanks), SWMU 94B (Debris/Soil Mound Area), SWMU 94C (Bomb Burner Area and Discharge Line), SWMU 94D (Bomb Burner Discharge Pit), SWMU 94E (Small Surface Impoundment), SWMU 94F (Light Airtransport Accident Resistant Container [LAARC] Discharge Pit), and SWMU 94G (Scrap Yard). All of these subunits are inactive except for SWMU 94G (Scrap Yard), and SWMU 94A, which contains both active and inactive tanks. This NFA addresses historical releases from the discharge pit. The NFA proposal for SWMU 94 was submitted in September 1998 (SNL/NM September 1998). SWMUs 94B, 94C, 94E, 94F, and 94G will be addressed in future NFA submittals.

SWMU 94D, which occupies less than 0.1 acre (SNL/NM April 1995), consists of an open pit with no visible surface debris or soil discoloration. The mean elevation of this subunit is 6,333 feet above sea level (SNL/NM April 1995).

Historical published information regarding the hydrogeology of the Lurance Canyon was summarized in the "RCRA Facility Investigation [RFI] Work Plan for the Operable Unit 1333, Canyons Test Area" (SNL/NM September 1995). Since that time, additional bedrock wells and alluvial piezometers have been installed in the Lurance Canyon, and data collected from the new bedrock wells have supported the hydrologic model of semiconfined to confined groundwater conditions at a depth of approximately 222 feet below ground surface (bgs) beneath the Lurance Canyon SWMUs. The data collected from the alluvial piezometers support the absence of alluvial groundwater. Hydrologic data have been based upon the Burn Site Well, CYN-MW1D, 12AUP01 (piezometer), and CYN-MW2S (piezometer). This section summarizes the hydrologic conditions at each monitoring location.

The Burn Site well (located approximately 720 feet northeast of SWMU 94D) was drilled in February 1986 to a total depth of 350 feet bgs. A total of 74 feet of clay, silt, and shale units were encountered overlying the bedrock identified as metamorphic schists and fractured granite. Water-bearing bedrock was encountered at a depth of 222 to 350 feet bgs (New Mexico State Engineers Office Well Record RG-44986 [April 1986]). Following well completion, the water level rose to 68 feet bgs.

A shallow underflow piezometer was installed in November 1996 in SWMU 12A approximately 480 feet north of SWMU 94D. The piezometer was installed in conformance with a document of understanding between SNL/NM and the New Mexico Environment Department (NMED)/DOE Oversight Bureau (OB) (Dawson August 1996). The subsurface geology at the site is comprised of approximately 55 feet of alluvial sand, silt, and gravel overlying metamorphic phyllite to schist bedrock. The piezometer, identified as 12AUP01, was completed to a depth of approximately 58 feet bgs. Moist soil was encountered in the first 5 feet of alluvium. The remaining 53 feet to bedrock were dry. No groundwater was encountered during drilling. The piezometer was instrumented in February 1997 and has been collecting data since that time. In addition, manual checks have been conducted for the presence of water as a verification procedure. No water has been recorded in the piezometer subsequent to its installation.

The Burn Site Spring is an ephemeral spring or, more accurately described, a seep, located approximately 2,640 feet northeast of SWMU 94D. The seep discharges small quantities of water from fractures and/or bedding plane permeability within the carbonate rocks (Goodrich [Month Unk.] 1993). It is believed that the source of the water is seasonal recharge of fractures from the surrounding mountain terrain.

A groundwater monitoring well nest was installed in November and December 1997 approximately 3,000 feet west of (downgradient from) the LCBS. The groundwater wells were installed in conformance with the documents of understanding between SNL/NM and the NMED OB (SNL/NM July 1997, SNL/NM September 1997). The monitoring well nest is comprised of a shallow underflow piezometer (CYN-MW2S) and a deep groundwater well (CYN-MW1D). The subsurface geology at the nest location is characterized by approximately 25 feet of alluvial sand, silt, and gravel, unconformably overlying the Manzanita Gneiss, which is fractured. No water was encountered while drilling activities were conducted in the alluvium, and no water has been recorded at CYN-M2S since its installation. Groundwater was first encountered in CYN-MWD at a depth of 372 feet bgs and the static level rose to 320 feet bgs. This indicated semiconfined to confined groundwater conditions similar to those encountered in the Burn Site Well.

In summary, the groundwater beneath the LCBS occurs at depths of at least 222 feet bgs under semiconfined to confined conditions in fractured metamorphic rock. There has been no record to date of shallow groundwater occurring in the alluvium overlying the bedrock.

For a detailed discussion regarding the local setting at SWMU 94D, refer to the RFI Work Plan for OU 1333 (SNL/NM September 1995).

II. Data Quality Objectives

The confirmatory sampling conducted at SWMU 94D was designed to collect adequate samples in order to:

- Determine whether hazardous waste or hazardous constituents have been released at the site
- Characterize the nature and extent of any releases
- Provide sufficient quality of analytical data to support risk assessment screening.

Table 1 summarizes the sample location design for SWMU 94D. The sources of potential constituents of concern (COCs) at SWMU 94D are residual concentrations of HE compounds and volatile organic compounds (VOCs) in the surface and subsurface soil at the discharge pit. Although metals and DU were also associated with the testing conducted at the Bomb Burner Unit, none of these constituents are present at the Bomber Burner Discharge Pit. Results of the confirmatory sampling conducted at SWMU 94D indicate that no metals were detected in the surface or subsurface of the discharge pit. In addition, all wastewater was screened for radioactivity prior to release into the discharge pit, and subsequent radiological surveys and confirmatory sampling results verified that no radiological activity is present.

The number and location of the samples collected was dependent upon the completeness of historical information. Surface soil samples were collected from specific locations within the discharge pit where wastewater could concentrate and potentially adsorb COCs. Such areas include the actual discharge point from the outflow pipe and the lowest-most topographical point within the discharge pit. Similarly, the subsurface investigation borehole was positioned to be colinear with the outflow pipe near the lowest-most topographical point within the discharge pit. Subsurface soil samples were collected at 5-foot intervals for assessing potential vertical distribution of COCs beneath the discharge pit.

Table 2 summarizes the analytical methods and data quality requirements necessary for (1) adequate characterization of hazardous waste or hazardous constituents associated with wastewater discharged to the pit and (2) supporting risk assessment screening.

A total of three surface and three subsurface locations were sampled at SWMU 94D. All samples were analyzed off site for RCRA metals plus beryllium, HE compounds, VOCs, and semivolatile organic compounds (SVOCs). Two surface and two subsurface samples were also analyzed off site for gross alpha and gross beta. Sandia National Laboratories/New Mexico (SNL/NM) on-site laboratories analyzed two samples for radionuclides using gamma spectroscopy to free the samples for transport to the off-site laboratory.

All off-site laboratory results were reviewed and verified/validated according to "Data Verification/Validation Level 3—DV-3" in Attachment C of the Technical Operating Procedure 94-03, Rev. 0 (SNL/NM July 1994b). All gamma spectroscopy data were reviewed by SNL/NM Department 7713 (Radiation Protection Sample Diagnostic [RPSD] Laboratory) according to

Table 1
Summary of Sampling Performed to Meet Data Quality Objectives

SWMU 94D Sampling	Potential COC Source	Number of Sampling Locations	Sample Density	Sampling Location Rationale
Surface	Soil contaminated from wastewater discharged to Bomb Burner Discharge Pit	3	Sample collection at specific locations within 525 square foot discharge pit.	Surface sample locations based upon outflow pipe discharge point, lowest point in discharge pit, and point of subsurface investigation borehole.
Subsurface	Soil contaminated from wastewater discharged to Bomb Burner Discharge Pit	3	Sample collection at 5-foot intervals within 15-foot deep subsurface investigation borehole.	Subsurface sample locations based upon potential vertical distribution of contamination within subsurface soil of discharge pit.

COC = Constituent of concern.
SWMU = Solid waste management unit.

Table 2
Summary of Data Quality Requirements

Analytical Requirement	Data Quality Level	Radiation Protection Sample Diagnostics Laboratory Department 7713 SNL/NM	Core Laboratories Inc., Aurora, Colorado
RCRA metals plus beryllium EPA Method 6010/7000[a]	Level 3	NA	6 samples 1 sample (off-site internal duplicate)
HE compounds EPA Method 8330[a]	Level 3	NA	6 samples 1 sample (off-site internal duplicate)
VOCs EPA Method 8330[a]	Level 3	NA	6 samples 1 sample (off-site internal duplicate)
SVOCs EPA Method 8330[a]	Level 3	NA	6 samples 1 sample (off-site internal duplicate)
Gamma Spectroscopy	Level 2	2 samples	NA
Gross Alpha Gross Beta EPA Method 900.0[a]	Level 3	NA	4 samples

[a]EPA November 1986.
EPA = U.S. Environmental Protection Agency.
HE = High explosive(s).
NA = Not applicable.
RCRA = Resource Conservation and Recovery Act.
SVOC = Semivolatile organic compound(s).
VOC = Volatile organic compound(s).

"Laboratory Data Review Guidelines," Procedure No. RPSD-02-11, Issue No. 02 (SNL/NM July 1996). The reviews confirmed that the data are acceptable for use in the NFA proposal for SWMU 94D. The data quality objectives (DQO) for SWMU 94D have been met.

III. Determination of Nature, Rate, and Extent of Contamination

III.1 Introduction

The determination of the nature, rate, and extent of contamination at SWMU 94D was based upon an initial conceptual model validated with confirmatory sampling at the site. The initial conceptual model was developed from historical background information including site inspections, personal interviews, historical photographs, and radiological surveys. The DQOs contained in the Work Plan for OU 1333 (SNL/NM September 1995) and Field Implementation Plan (FIP) addendum to the Work Plan (SNL/NM March 1998) identified the sample locations, sample density, sample depth, and analytical requirements. The data from the analysis of the samples were subsequently used to develop the final conceptual model for SWMU 94D. These data are presented in Section 11.5 of the associated NFA proposal. The quality of the data specifically used to determine the nature, rate, and extent of contamination are described below.

III.2 Nature of Contamination

The nature of contamination at SWMU 94D was determined with analytical testing of soil media and the potential for degradation of relevant COCs (Section V). The analytical requirements included RCRA metals plus beryllium to characterize potential nonradiological inorganic constituents associated with weapons and various HE-containing devices tested at the Bomb Burner Unit that could have been contained in the wastewater discharged to the pit. HE analyses were performed to characterize potentially unreacted explosives materials that could have been contained in the wastewater discharged to the pit. VOC and SVOC analyses were used to characterize potentially unburned JP-4 that could have been contained in the wastewater discharged to the pit. Gamma spectroscopy and gross alpha/gross beta analyses were also performed to verify that no radioactive materials were present at the site. These analytes and methods are appropriate to characterize the COCs and potential degradation products associated with the historical activities at SWMU 94D.

III.3 Rate of Contaminant Migration

SWMU 94D is an inactive site, and therefore, all primary sources of COCs (discharge of wastewater from Bomb Burner Unit) have been eliminated. As a result, only secondary sources of COCs remain at the site in the form of adsorbed or dissolved compounds or VOCs in soil. The rate of COC migration is dependent predominantly upon site meteorological and surface hydrologic processes as described in Section V. Data available from the Site-Wide Hydrogeologic Characterization Project (published annually); numerous SNL/NM air, surface water, and radiological monitoring programs; biological surveys; and other governmental atmospheric monitoring at Kirtland Air Force Base (i.e., National Oceanographic and

Atmospheric Administration) are adequate to characterize the rate of COCs migration at SWMU 94D.

III.4 Extent of Contamination

Surface soil samples were collected at three locations within the Bomb Burner Discharge Pit at SWMU 94D. The samples were collected at locations where discharged wastewater would most likely concentrate potential COCs. As a result, surface soil samples were collected at the location of the outflow pipe (the topographical low point within the pit) and at the location of the subsurface investigation borehole. These sample locations are deemed appropriate to determine the lateral extent of COC migration.

The sample density at SWMU 94D was judgmental, based upon the size of the discharge pit and a reasonable depth of potential contaminant migration. The number of samples was deemed sufficient to establish the presence of detectable COCs from wastewater associated with the tests conducted at the Bomb Burner Unit. The sample density ranged from 3 to 20 samples per acre, which is consistent with comparable EPA remedial investigation/feasibility study studies (Selman et al. 1994).

Because the primary release mechanism of COCs to SWMU 94D was in the form of discharged wastewater, there is potential for vertical migration of contamination. However, the rate of vertical migration of COCs is expected to be limited by the relatively low solubility of most metals and organic compounds and the high evapotranspiration rate for the area. A single vertical borehole was installed in the vicinity of the lowest point within the Bomb Burner Discharge Pit and colinear with the outflow pipe to investigate the vertical extent of contamination. Subsurface soil samples were collected at 5-foot intervals as the borehole was advanced to a total depth of 15 feet. Therefore, the sample collection depths are considered representative of the media potentially affected by site activities and sufficient to determine the vertical extent of COC migration.

In summary, the design of the confirmatory sampling was appropriate and adequate to determine the nature, rate, and extent of contamination.

IV. Comparison of COCs to Background Screening Levels

Site history and characterization activities are used to identify potential COCs. The identification of COCs and the sampling to determine the concentration levels of those COCs across the site are described in the SWMU 94D NFA proposal. Generally, COCs evaluated in this risk assessment included all detected organics and radiologicals and all inorganic COCs for which samples were analyzed. If the detection limit of an organic compound was too high (i.e., could possibly cause an adverse effect to human health or the environment), the compound was retained. Nondetect organics not included in this assessment were determined to have sufficiently low detection limits to ensure protection of human health and the environment. In order to provide conservatism in this risk assessment, the calculation uses only the maximum concentration value of each COC determined for the entire site. The SNL/NM maximum background concentration (Dinwiddie September 1997, Zamorski December 1997) was selected to provide the background screen in Tables 3 through 6. Human health

Table 3
Nonradiological COCs for Human Health Risk Assessment at SWMU 94D with Comparison to the Associated SNL/NM Background Screening Value, BCF, Log K_{ow}, and Subpart S Screening Value

COC Name	Maximum Concentration (mg/kg)	SNL/NM Background Concentration (mg/kg)[a]	Is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background Screening Value?	BCF (maximum aquatic)	Log K_{ow} (for organic COCs)	Bioaccumulator?[b] (BCF>40, log K_{ow}>4)	Subpart S Screening Value[c]	Is Individual COC less than 1/10 of the Action Level?
Arsenic	2.76	9.8	Yes	44[d]	NA	**Yes**	0.5	**No**
Barium	156	246	Yes	170[e]	NA	**Yes**	6000	Yes
Beryllium	0.527	0.75	Yes	19[d]	NA	No	0.2	**No**
Cadmium	0.277 J	0.64	Yes	64[d]	NA	**Yes**	80	Yes
Chromium, total[f]	12.7	18.8	Yes	16[d]	NA	No	400	Yes
Lead	9.0	18.9	Yes	49[d]	NA	**Yes**	--	--
Mercury	0.0172	0.055	Yes	5500[d]	NA	**Yes**	20	Yes
Selenium	0.182 J	2.7	Yes	800[g]	NA	**Yes**	400	Yes
Silver	0.0015[h]	<0.5	**Unknown**	0.5[d]	NA	No	400	Yes
Methylene chloride	0.0012 J	NA	**NA**	5[i]	1.25[i]	No	90	Yes

Note: **Bold** indicates COCs that either failed the background screening procedure, Subpart S screening procedure, and/or are bioaccumulators.
[a]From Zamorski (December 1997) Canyons Area Soils.
[b]NMED (March 1998).
[c]From IT Corporation (July 1994).
[d]BCF and/or Log K_{ow} from Yanicak (March 1998).
[e]BCF from Neumann (1976).
[f]Assumed to be chromium VI for Subpart S screening procedure.
[g]BCF from Callahan et al. (1979).
[h]Parameter nondetect, concentration assumed to be 0.5 of detection limit.
[i]BCF and log K_{ow} from Howard (1990).
BCF = Bioconcentration factor.
COC = Constituent of concern.
J = Estimated concentration.
K_{ow} = Octanol-water partition coefficient.
Log = Logarithm (base 10).
mg/kg = Milligram(s) per kilogram.
NA = Not applicable.
NMED = New Mexico Environment Department.
SNL/NM = Sandia National Laboratories/New Mexico.
SWMU = Solid Waste Management Unit.
-- = Information not available.

Table 4
Nonradiological COCs for Ecological Risk at SWMU 94D with Comparison to the Associated SNL/NM Background Screening Value, BCF, Log K_{ow}, and Subpart S Screening Value

COC Name	Maximum Concentration (mg/kg)	SNL/NM Background Concentration (mg/kg)[a]	Is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background Screening Value?	BCF (maximum aquatic)	Log K_{ow} (for organic COCs)	Bioaccumulator?[b] (BCF>40, log K_{ow}>4)	Subpart S Screening Value[c]	Is Individual COC less than 1/10 of the Action Level?
Arsenic	2.16	9.8	Yes	44[d]	NA	**Yes**	0.5	**No**
Barium	156	246	Yes	170[e]	NA	**Yes**	6000	Yes
Beryllium	0.527	0.75	Yes	19[d]	NA	No	0.2	**No**
Cadmium	0.277 J	0.64	Yes	64[d]	NA	**Yes**	80	Yes
Chromium, total[f]	10.2	18.8	Yes	16[d]	NA	No	400	Yes
Lead	9.0	18.9	Yes	49[d]	NA	**Yes**	--	--
Mercury	0.0172	0.055	Yes	5500[d]	NA	**Yes**	20	Yes
Selenium	0.182 J	2.7	Yes	800[g]	NA	**Yes**	400	Yes
Silver	0.0015[h]	<0.5	**Unknown**	0.5[d]	NA	No	400	Yes
Methylene chloride	0.0012 J	NA	**NA**	5[i]	1.25[i]	No	90	Yes

Note: **Bold** indicates COCs that either failed the background screening procedure and/or Subpart S screening procedure, and/or are bioaccumulators.

[a]From Zamorski (December 1997) Canyons Area Soils.
[b]NMED (March 1998).
[c]From IT Corporation (July 1994).
[d]BCF and/or Log K_{ow} from Yanicak (March 1998).
[e]BCF from Neumann (1976).
[f]Assumed to be chromium VI for Subpart S screening procedure.
[g]BCF from Callahan et al. (1979).
[h]Parameter nondetect, concentration assumed to be 0.5 of detection limit.
[i]BCF and log K_{ow} from Howard (1990).

BCF = Bioconcentration factor.
COC = Constituent of concern.
J = Estimated concentration.
K_{ow} = Octanol-water partition coefficient.
Log = Logarithm (base 10).
mg/kg = Milligram(s) per kilogram.
NA = Not applicable (organic COCs do not have accepted background concentrations).
NMED = New Mexico Environment Department.
SNL/NM = Sandia National Laboratories/New Mexico.
SWMU = Solid Waste Management Unit.
-- = Information not available.

Table 5
Radiological COCs for Human Health Risk Assessment at SWMU 94D with Comparison to the Associated SNL/NM Background Screening Value and BCF

COC Name	Maximum Concentration (pCi/g)	SNL/NM Background Concentration (pCi/g)[a]	Is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background Screening Value?	BCF (maximum aquatic)	Bioaccumulator?[b] (BCF>40)
Cs-137	0.087	0.515	Yes	3000[c]	**Yes**
Th-232	0.57	1.03	Yes	3000[d]	No[f]
U-235	0.213[e]	0.16	**No**	900[d]	**Yes**
U-238	1.23	2.31	Yes	900[d]	**Yes**
U-234	0.15[g]	1.6	Yes	900[d]	**Yes**

Note: **Bold** indicates COCs that exceed background screening values and/or are bioaccumulators.
[a]From Dinwiddie (September 1997), Canyons Area Soil.
[b]NMED (March 1998).
[c]BCF from Whicker and Schultz (1982).
[d]Baker and Soldat (1992).
[e]Concentration for not detected (ND) result, based upon minimum detectable activity (MDA) value.
[f]Yanicak (March 1997).
[g]U-234 values were calculated using the U-238 concentration and assuming that the U-238 to U-234 ratio was equal to that detected during waste characterization of DU-contaminated soils generated during the radiological voluntary corrective measures project, where U-234 = U-238/8 (Miller June 1988).

BCF = Bioconcentration factor.
COC = Constituent of concern.
K_{ow} = Octanol-water partition coefficient.
Log = Logarithm (base 10).
pCi/g = Picocurie(s) per gram.
SNL/NM = Sandia National Laboratories/New Mexico.
SWMU = Solid Waste Management Unit.

Table 6
Radiological COCs for Ecological Risk Assessment at SWMU 94D with Comparison to the Associated SNL/NM Background Screening Value and BCF

COC Name	Maximum Concentration (pCi/g)	SNL/NM Background Concentration (pCi/g)[a]	Is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background Screening Value?	BCF (maximum aquatic)	Bioaccumulator?[b] (BCF>40)
Cs-137	0.087	0.515	Yes	3000[c]	**Yes**
Th-232	0.57	1.03	Yes	3000[d]	No[f]
U-235	0.213[e]	0.16	**No**	900[d]	**Yes**
U-238	1.23	2.31	Yes	900[d]	**Yes**

Note: **Bold** indicates COCs that exceed background screening and/or are bioaccumulators.
[a]From Dinwiddie (September 1997), Canyons Area Soil.
[b]NMED (March 1998).
[c]BCF from Whicker and Schultz (1982).
[d]Baker and Soldat (1992).
[e]Concentration for not detected (ND) result, based upon minimum detectable activity (MDA) value.
[f]Yanicak (March 1997).

BCF = Bioconcentration factor.
COC = Constituent of concern.
K_{ow} = Octanol-water partition coefficient.
Log = Logarithm (base 10).
NMED = New Mexico Environment Department.
pCi/g = Picocurie(s) per gram.
SNL/NM = Sandia National Laboratories/New Mexico.
SWMU = Solid Waste Management Unit.

nonradiological COCs were also compared to SNL/NM proposed Subpart S action levels (Table 3) (IT July 1994).

Nonradiological inorganics that are essential nutrients such as iron, magnesium, calcium, potassium, and sodium are not included in this risk assessment (EPA 1989). Both radiological and nonradiological COCs are evaluated. The nonradiological COCs evaluated included VOCs and inorganics.

Nonradiological COCs for the human health risk assessment at SWMU 94D are listed in Table 3; nonradiological COCs for the ecological risk assessment are listed in Table 4. Radiological COCs for human health and ecological risk assessment are listed in Tables 5 and 6, respectively. All tables show the associated SNL/NM maximum background concentration values (Dinwiddie September 1997, Zamorski December 1997). Section VI.4 discusses Tables 3 and 5 and Sections VII.2 and VII.3 discuss Tables 4 and 6.

V. Fate and Transport

The primary release of COCs at SWMU 94D was to surface soil within an excavated pit. Wind, water, and biota are natural mechanisms of COC transport from the primary release point; however, because the site is situated within the Lurance Canyon in the Manzanita Mountains and is a discharge pit, it is protected from strong winds at the ground surface and from off-site releases of surface water. Therefore, wind and surface water are not considered significant transport mechanisms for COCs in surface soils; although, VOC will be carried from the site by even light breezes.

Water at SWMU 94D is received as precipitation (rain or occasionally snow). Infiltration at the site is enhanced by the coarse texture of the canyon soils (Tesajo-Millett stony sandy loam and rock outcrop [USDA 1977]). Water that infiltrates into the soil will continue to percolate through the soil until field capacity is reached, and COCs desorbed from the soil particles into the soil solution may be leached deeper into the subsurface soil with this percolation. Evapotranspiration from the soil will limit infiltration potential and could reverse the direction of COC migration in the near-surface soil. Based upon observations made during the installation of a piezometer in an arroyo channel approximately 400 feet north of SWMU 94D, the alluvium above the bedrock is 57 feet in thickness. Moist soil was observed in the first 5 feet of alluvium, and the remaining 52 feet (to bedrock) were dry. The Burn Site Well, about 500 feet southeast of the site, did not encounter groundwater until 230 feet below ground surface (bgs). Groundwater at the site is estimated to be 222 feet bgs. Therefore, infiltration does not appear to be sufficient to contact groundwater in the area of the Lurance Canyon Burn Site.

Plant roots can take up COCs that are in the soil solution. These COCs could be transported to the aboveground tissues with the xylem stream and could then be consumed by herbivores or returned to the soil as litter. Aboveground litter could be transported by wind until consumed by decomposer organisms in the soil. Constituents in plant tissues that are consumed by herbivores could pass through the gut and be returned to the soil in feces (at the site or transported from the site in the herbivore) or be absorbed into tissues and held, metabolized, or excreted. The herbivore could be eaten by a primary carnivore or scavenger, and the constituent remaining in the consumed tissues will repeat the sequence of absorption, metabolization, excretion, and consumption by higher predators, scavengers, and decomposers. The potential for transport of the constituents within the food chain is dependent upon the mobility of the species that comprise the food chain and the potential for the constituent to be transferred across the links in the food chain. Although SWMU 94D has been highly disturbed, natural succession has resulted in the reestablishment of vegetation in some of the disturbed areas of the site and small mammals such as ground squirrels have been observed in the area of the site. Therefore, food chain uptake is a potential transport mechanism at SWMU 94D.

Degradation of COCs at SWMU 94D could result from biotic or abiotic processes. Degradation processes for organic COCs could include photolysis, hydrolysis, and biotransformation. Photolysis requires light and, therefore, takes place in the air, at the ground surface, or in surface water. Hydrolysis includes chemical transformations in water and could occur in the soil solution. Biotransformation is the result of metabolic breakdown of the compound by plants, animals, and microorganisms. Inorganic COCs and radionuclides at this site are elemental in form and are, therefore, not considered to be degradable. The latter could, however, undergo decay to stable isotopes or radioactive daughter elements.

Table 7 summarizes the fate and transport processes that could occur at SWMU 94D. COCs that exceed background concentrations at this site include silver, methylene chloride, and U-235. Because the site is a discharge pit within the Lurance Canyon, the COCs are sheltered from significant transport by wind and surface water. Because of the depth to groundwater, the potential for COCs to leach into groundwater is very low. Some vegetation and small animals occur at the site; therefore, uptake into the food chain is possible but unlikely to be a significant transport mechanism. The potential for degradation and/or transformation of silver and U-235 is low. Methylene chloride is biodegradable under aerobic conditions and undergoes photolysis but is less susceptible to hydrolysis (Howard 1990). It could also be lost through volatilization near the soil surface.

Table 7
Summary of Fate and Transport at SWMU 94D

Transport and Fate Mechanism	Existence at Site	Significance
Wind	Yes	Low
Surface runoff	Yes	Low
Migration to groundwater	No	None
Food chain uptake	Yes	Low
Transformation/degradation	Yes	Moderate (organics) Low (inorganics and radionuclides)

VI. Human Health Risk Screening Assessment

VI.1 Introduction

Human health risk screening assessment of this site includes a number of steps that culminate in a quantitative evaluation of the potential adverse human health effects caused by constituents located at the site. The steps to be discussed include the following:

Step 1.	Site data are described that provide information on the potential COCs, as well as the relevant physical characteristics and properties of the site.
Step 2.	Potential pathways are identified by which a representative population might be exposed to the COCs.
Step 3.	The potential intake of these COCs by the representative population is calculated using a tiered approach. The first component of the tiered approach includes two screening procedures. One screening procedure compares the maximum concentration of the COC to an SNL/NM maximum background screening value. COCs that are not eliminated during the first screening procedure are subjected to a second screening procedure that compares the maximum concentration of the COC to the SNL/NM proposed Subpart S action level.
Step 4.	Toxicological parameters are identified and referenced for COCs that were not eliminated during the screening steps.
Step 5.	Potential toxicity effects (specified as a hazard index [HI]) and excess cancer risks are calculated for nonradiological COCs and background. For radiological COCs, the incremental total effective dose equivalent (TEDE) and incremental estimated cancer risk are calculated by subtracting applicable background concentrations directly from maximum on-site contaminant values. This background subtraction only occurs when a radiological COC occurs as contamination and exists as a natural background radionuclide.
Step 6.	These values are compared with guidelines established by the EPA and DOE to determine if further evaluation, and potential site clean-up, is required. Nonradiological COC risk values are also compared to background risk so that an incremental risk can be calculated.
Step 7.	Uncertainties in the previous steps are discussed.

VI.2 Step 1. Site Data

Section I provides the description and history for SWMU 94D. Section II presents a comparison of results to DQOs. Section III describes the determination of the nature, rate, and extent of contamination.

VI.3 Step 2. Pathway Identification

SWMU 94D has been designated a future land-use scenario of recreational (DOE et al. October 1995) (see Appendix 1 for default exposure pathways and parameters). Because of the location and the characteristics of the potential contaminants, the primary pathway for human exposure is considered to be soil ingestion for the nonradiological COCs and direct gamma exposure for the radiological COCs. The inhalation pathway for both nonradiological and radiological COCs is included because of the potential to inhale dust and volatiles (volatile inhalation for nonradiologicals only). Soil ingestion is included for the radiological COCs as well. No water pathways to the groundwater are considered. Depth to groundwater at SWMU 94D is approximately 222 feet bgs. Because of the lack of surface water or other significant mechanisms for dermal contact, the dermal exposure pathway is considered not to be significant. No intake routes through plant, meat, or milk ingestion are considered appropriate for the recreational land-use scenario. However, plant uptake is considered for the residential land-use scenario.

Pathway Identification

Nonradiological Constituents	Radiological Constituents
Soil ingestion	Soil ingestion
Inhalation (dust and volatiles)	Inhalation (dust)
Plant uptake (residential only)	Plant uptake (residential only)
	Direct gamma

VI.4 Step 3. COC Screening Procedures

Step 3 is discussed in this section and includes two screening procedures. The first screening procedure is a comparison of the maximum COC concentration to the background screening level. The second screening procedure compares maximum COC concentrations to SNL/NM proposed Subpart S action levels. This second procedure is applied only to COCs that are not eliminated during the first screening procedure.

VI.4.1 Background Screening Procedure

VI.4.1.1 Methodology

Maximum concentrations of nonradiological COCs are compared to the approved SNL/NM maximum screening level for this area. The SNL/NM maximum background concentration is selected to provide the background screening level shown in Table 3 and is used to calculate risk attributable to background values shown in Table 11. Only the COCs that are above their respective SNL/NM maximum background screening levels or do not have a quantifiable background screening level are considered in further risk assessment analyses.

For radiological COCs that exceed the SNL/NM background screening levels, background values are subtracted from the individual maximum radionuclide concentrations. Those that do not exceed these background levels are carried no further in the risk assessment. This approach is consistent with DOE Order 5400.5, "Radiation Protection of the Public and the Environment" (DOE 1993). Radiological COCs that do not have a background value and are detected above the analytical minimum detectable activity are carried through the risk assessment at their maximum levels. The resultant radiological COCs remaining after this step are referred to as background-adjusted radiological COCs.

VI.4.1.2 Background Screening Procedure Results

Tables 3 and 5 present a comparison of SWMU 94D maximum COC concentrations to the SNL/NM maximum background values (Dinwiddie September 1997, Zamorski December 1997) for the human health risk assessment. For the nonradiological COCs, one nonradiological COC has no quantifiable background concentration, so it is not known whether that COC exceeded background. One COC is an organic compound and does not have a background screening level.

For the radiological COCs, only one constituent (U-235) had a maximum measured activity concentration greater than its respective background. This value was actually based upon the concentration equivalent to the minimum detectable activity (MDA) for the analysis because the result was "not detected above the MDA."

VI.4.2 Subpart S Screening Procedure

VI.4.2.1 Methodology

The maximum concentrations of nonradiological COCs not eliminated during the background screening process were compared with action levels (IT July 1994) calculated using methods and equations promulgated in the proposed RCRA Subpart S (EPA 1990) and Risk Assessment Guidance for Superfund (RAGS) (EPA 1989) documentation. Accordingly, all calculations were based upon the assumption that receptor doses from both toxic and potentially carcinogenic compounds result most significantly from ingestion of contaminated soil. Because the samples were all taken from the surface and near surface, this assumption is considered valid. If there were ten or fewer COCs and each had a maximum concentration less than 1/10 the action level, then the site would be judged to pose no significant health hazard to humans. If there were more than ten COCs, the Subpart S screening procedure is not performed.

VI.4.2.2 Results

Table 3 shows the COCs and the associated proposed Subpart S action level. The table includes a comparison of the maximum concentration values to 1/10 the proposed Subpart S action level. This methodology was guidance given to SNL/NM from the EPA (EPA 1996b). The only COCs that failed the background screening (silver and methylene chloride) were below 1/10 the Subpart S action level. However, for conservatism, it was decided that that silver and methylene chloride would be carried forward in the risk assessment process, and a hazard quotient (HQ) and excess cancer risk value would be calculated.

Radiological COCs have no predetermined action levels analogous to proposed Subpart S levels, and therefore, this step in the screening process is not performed for radiological COCs.

VI.5 Step 4. Identification of Toxicological Parameters

Tables 8 (nonradiological) and 9 (radiological) show the COCs retained in the risk assessment and the values for the available toxicological information. The toxicological values used for nonradiological COCs (Table 8) are from the Integrated Risk Information System (IRIS)

Table 8
Toxicological Parameter Values for SWMU 94D Nonradiological COCs

COC Name	RfD_o (mg/kg-d)	Confidence[a]	RfD_{inh} (mg/kg-d)	Confidence[a]	SF_o (mg/kg-day)$^{-1}$	SF_{inh} (mg/kg-day)$^{-1}$	Cancer Class[b]
Silver	5E-3[c]	L	--	--	--	--	D
Methylene chloride	6E-2[c]	M	8.6E-1[d]	--	7.5E-3[c]	1.7E-3[c]	B2

[a]Confidence associated with IRIS (EPA 1998) database values. Confidence: L = low, M = medium.
[b]EPA weight-of-evidence classification system for carcinogenicity (EPA 1989) taken from IRIS (EPA 1998):
B2 = Probable human carcinogen. Indicates sufficient evidence in animals and inadequate or no evidence in humans.
D = Not classifiable as to human carcinogenicity.
[c]Toxicological parameter values from IRIS electronic database (EPA 1998).
[d]Toxicological parameter values from HEAST database (EPA 1997a).
COC = Constituent of concern.
EPA = U.S. Environmental Protection Agency.
HEAST = Health Effects Assessment Summary Tables.
IRIS = Integrated Risk Information System.
mg/kg-d = Milligram(s) per kilogram day.
(mg/kg-d)$^{-1}$ = Per milligram per kilogram day.
RfD_{inh} = Inhalation chronic reference dose.
RfD_o = Oral chronic reference dose.
SF_{inh} = Inhalation slope factor.
SF_o = Oral slope factor.
SWMU = Solid Waste Management Unit.
-- = Information not available.

Table 9
Radiological Toxicological Parameter Values for SWMU 94D COCs Obtained from RESRAD Risk Coefficients[a]

COC Name	SF_o (1/pCi)	SF_{inh} (1/pCi)	SF_{ev} (g/pCi-yr)	Cancer Class[b]
U-235	4.70E-11	1.30E-08	2.70E-07	A

[a]From Yu et al. (1993a).
[b]EPA weight-of-evidence classification system for carcinogenicity (EPA 1989): A = human carcinogen.
1/pCi = One per picocurie.
COC = Constituent of concern.
EPA = U.S. Environmental Protection Agency.
g/pCi-yr = Gram(s) per picocurie-year.
SF_{ev} = External volume exposure slope factor.
SF_{inh} = Inhalation slope factor.
SF_o = Oral (ingestion) slope factor.
SWMU = Solid Waste Management Unit.

(EPA 1998) and Health Effects Assessment Summary Tables (HEAST) (EPA 1997a) databases. Dose conversion factors (DCF) used in determining the excess TEDE values for radiological COCs for the individual pathways were the default values provided in the RESRAD computer code (Yu et al. 1993a) as developed in the following documents:

- DCFs for ingestion and inhalation are taken from "Federal Guidance Report No. 11, Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion" (EPA 1988).

- DCFs for surface contamination (contamination on the surface of the site) were taken from DOE/EH-0070, "External Dose-Rate Conversion Factors for Calculation of Dose to the Public" (DOE 1988).

- DCFs for volume contamination (exposure to contamination deeper than the immediate surface of the site) were calculated using the methods discussed in "Dose-Rate Conversion Factors for External Exposure to Photon Emitters in Soil" (Kocher 1983) and in ANL/EAIS-8, *Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil* (Yu et al. 1993b).

VI.6 Step 5. Exposure Assessment and Risk Characterization

Section VI.6.1 describes the exposure assessment for this risk assessment. Section VI.6.2 provides the risk characterization, including the HI and the excess cancer risk for both the potential nonradiological COCs and associated background for recreational and residential land uses. The incremental TEDE and incremental estimated cancer risk are provided for the background-adjusted radiological COCs for both recreational and residential land uses.

VI.6.1 Exposure Assessment

Appendix 1 shows the equations and parameter input values used in calculating intake values and subsequent HI and excess cancer risk values for the individual exposure pathways. The appendix shows parameters for both recreational and residential land-use scenarios. The equations for nonradiological COCs are based upon the RAGS (EPA 1989). Parameters are based upon information from the RAGS (EPA 1989) and other EPA guidance documents and reflect the reasonable maximum exposure (RME) approach advocated by the RAGS (EPA 1989). For radiological COCs, the coded equations provided in RESRAD computer code are used to estimate the incremental TEDE and cancer risk for individual exposure pathways. Further discussion of this process is provided in the *Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD*, Version 5.0 (Yu et al. 1993a).

Although the designated land-use scenario is recreational for this site, risk and TEDE values for a residential land-use scenario are also presented. These residential risk and TEDE values are presented only to provide perspective of potential risk to human health under the more restrictive land-use scenario.

VI.6.2 Risk Characterization

Table 10 shows an HI of 0.00 for the SWMU 94D nonradiological COCs, and an excess cancer risk of 5E-12 for the designated recreational land-use scenario. The numbers presented included exposure from soil ingestion and dust and volatile inhalation for nonradiological COCs. Table 11 shows no quantifiable HI or excess cancer risk assuming the maximum background concentrations of the SWMU 94D associated background constituents for the designated recreational land-use scenario.

For the radiological COCs, contribution from the direct gamma exposure pathway is included. For the recreational land-use scenario, a TEDE was calculated for an individual who spends 4 hours per week on the site. This resulted in an incremental TEDE of 8.6E-4 millirem per year (mrem/yr). In accordance with EPA guidance found in Office of Solid Waste and Emergency Response Directive No. 9200.4-18 (EPA 1997b), an incremental TEDE of 15 mrem/yr is used for the probable land-use scenario (recreational in this case); the calculated dose value for SWMU 94D for the recreational land use is well below this guideline. The estimated excess cancer risk is 9.2E-9.

For the residential land-use scenario nonradioactive COCs, the HI is 0.00, and the excess cancer risk is 9E-9 (Table 10). The numbers in the table included exposure from soil ingestion, dust and volatile inhalation, and plant uptake. Although the EPA (EPA 1991) generally recommends that inhalation not be included in a residential land-use scenario, this pathway is included because of the potential for soil in Albuquerque, New Mexico, to be eroded and, subsequently, for dust to be present in predominantly residential areas. Because of the nature of the local soil, other exposure pathways are not considered (see Appendix 1). Table 11 shows that for the SWMU 94D associated background constituents, there is no quantifiable HI or excess cancer risk.

For the radiological COCs, the incremental TEDE for the residential land-use scenario is 1.7E-2 mrem/yr. The guideline being used is an excess TEDE of 75 mrem/yr (SNL/NM February 1998) for a complete loss of institutional controls (residential land use in this case); the calculated dose value for SWMU 94D for the residential land-use scenario is well below this guideline. Consequently, SWMU 94D is eligible for unrestricted radiological release because the residential land-use scenario resulted in an incremental TEDE of less than 75 mrem/yr to the on-site receptor. The estimated excess cancer risk is 1.8E-7. The excess cancer risk from the nonradiological COCs and the radiological COCs is not additive, as noted in the RAGS (EPA 1989).

VI.7 Step 6. Comparison of Risk Values to Numerical Guidelines.

The human health risk assessment analysis evaluated the potential for adverse health effects for both a recreational land-use scenario (the designated land-use scenario for this site) and a residential land-use scenario.

For the recreational land-use scenario nonradiological COCs, the HI calculated is 0.00 (less than the numerical guideline of 1 suggested in the RAGS [EPA 1989]). Excess cancer risk is estimated at 5E-12. Guidance from the New Mexico Environment Department (NMED) indicates that excess lifetime risk of developing cancer by an individual must be less than 1E-6

Table 10
Risk Assessment Values for SWMU 94D Nonradiological COCs

COC Name	Maximum Concentration (mg/kg)	Recreational Land-Use Scenario[a]		Residential Land-Use Scenario[a]	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Silver	0.0015[b]	0.00	--	0.00	--
Methylene chloride	0.0012 J	0.00	5E-12	0.00	9E-9
Total		**0.00**	**5E-12**	**0.00**	**9E-9**

[a]From EPA (1989).
[b]Parameter nondetect, concentration assumed to be 0.5 of detection limit.
COC = Constituent of concern.
EPA = U.S. Environmental Protection Agency.
J = Estimated concentration.
mg/kg = Milligram(s) per kilogram.
SWMU = Solid Waste Management Unit.
-- = Information not available.

Table 11
Risk Assessment Values for SWMU 94D Nonradiological Background Constituents

COC Name	Background Concentration[a] (mg/kg)	Recreational Land-Use Scenario[b]		Residential Land-Use Scenario[b]	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Silver	<0.5	--	--	--	--
Total		--	--	--	--

[a]From Zamorski (December 1997), Canyons Area Soils.
[b]From EPA (1989).
COC = Constituent of concern.
EPA = U.S. Environmental Protection Agency.
SWMU = Solid Waste Management Unit.
-- = Information not available.

for Class A and B carcinogens and less than 1E-5 for Class C carcinogens (NMED March 1998). The excess cancer risk is driven by methylene chloride, which is a Class B2 carcinogen. Thus, the excess cancer risk for this site is below the suggested acceptable risk value (1E-6). This assessment also determined risks considering background concentrations of the potential nonradiological COCs for both the recreational and residential land-use scenarios. For nonradiological COCs, assuming the recreational land-use scenario, both the HI and excess cancer risk are nonquantifiable. Incremental risk is determined by subtracting risk associated with background from potential COC risk. These numbers are not rounded before the difference is determined and, therefore, may appear to be inconsistent with numbers presented in tables and within the text. Incremental HI is 0.00, and incremental cancer risk is 5E-12 for the recreational land-use scenario. These incremental risk calculations indicate insignificant risk to human health from nonradiological COCs considering a recreational land-use scenario.

For radiological COCs of the recreational land-use scenario, incremental TEDE is 8.6E-4 mrem/yr, which is significantly less than EPA's numerical guideline of 15 mrem/yr. Incremental estimated excess cancer risk is 9.2E-9.

The calculated HI for the residential land-use scenario nonradiological COCs is 0.00, which is below the numerical guidance. Excess cancer risk is estimated at 9E-9. Excess cancer risk is driven by methylene chloride. Methylene chloride is a Class B2 carcinogen. Therefore, the excess cancer risk for this site is below the suggested acceptable risk value (1E-6). The HI for associated background for the residential land-use scenario is nonquantifiable as is the excess cancer risk. The incremental HI is 0.00, and the incremental cancer risk is 9E-9 for the residential land-use scenario. These incremental risk calculations indicate insignificant contribution to human health risk from the COCs considering a residential land-use scenario.

The incremental TEDE for a residential land-use scenario from the radiological components is 1.7E-2 mrem/yr, which is significantly less than the numerical guideline of 75 mrem/yr suggested in the SNL/NM RESRAD Input Parameter Assumptions and Justification (SNL/NM February 1998). The estimated excess cancer risk is 1.8E-7.

VI.8 Step 7. Uncertainty Discussion

The determination of the nature, rate, and extent of contamination at SWMU 94D was based upon an initial conceptual model validated with confirmatory sampling conducted at the site. The confirmatory sampling was implemented in accordance with the RFI Work Plan for OU 1333 (SNL/NM September 1995) and the Field Implementation Plan (FIP) addendum to the Work Plan (SNL/NM March 1998). The DQOs contained in the RFI Work Plan and FIP Addendum are appropriate for use in screening risk assessments. The data collected, based upon sample location, density, and depth, are representative of the site. The analytical requirements and results satisfy the DQOs. Data quality were validated in accordance with SNL/NM procedures (SNL/NM July 1994b). Therefore, there is no uncertainty associated with the data quality used to perform the screening risk assessment at SWMU 94D.

Because of the location, history of the site, and future land use (DOE et al. October 1995), there is low uncertainty in the land-use scenario and the potentially affected populations that were considered in making the risk assessment analysis. Because the COCs are found in surface and near-surface soils and because of the location and physical characteristics of the site, there is little uncertainty in the exposure pathways relevant to the analysis.

An RME approach was used to calculate the risk assessment values. This means that the parameter values in the calculations are conservative and that calculated intakes are probably overestimates. Maximum measured values of COC concentrations are used to provide conservative results.

Table 8 shows the uncertainties (confidence) in nonradiological toxicological parameter values. There is a mixture of estimated values and values from the IRIS (EPA 1998) and HEAST (EPA 1997a) databases. Where values are not provided, information is not available from the HEAST (EPA 1997a), IRIS (EPA 1998), or the EPA regions (EPA 1996c, 1997c). Because of the conservative nature of the RME approach, uncertainties in toxicological values are not expected to change the conclusion from the risk assessment analysis.

Risk assessment values for nonradiological COCs are within the human health acceptable range for the recreational land-use scenario compared to established numerical guidance.

For radiological COCs, the conclusion of the risk assessment is that potential effects on human health for both recreational and residential land-use scenarios are within guidelines and are a small fraction of the estimated 360 mrem/yr received by the average U.S. population (NCRP 1987).

The overall uncertainty in all of the steps in the risk assessment process is considered not significant with respect to the conclusion reached.

VI.9 Summary

SWMU 94D has identified COCs consisting of some inorganic, organic, and radiological compounds. Because of the location of the site, the designated recreational land-use scenario, and the nature of contamination, potential exposure pathways identified for this site included soil ingestion and dust and volatile inhalation for chemical constituents and soil ingestion, dust inhalation, and direct gamma exposure for radionuclides. Plant uptake was included as an exposure pathway for the residential land-use scenario.

Using conservative assumptions and employing an RME approach to risk assessment, calculations for nonradiological COCs show that for the recreational land-use scenario the HI (0.00) is significantly less than the accepted numerical guidance from the EPA. Excess cancer risk (5E-12) is also below the acceptable risk value provided by the NMED for a recreational land use scenario (NMED March 1998). The incremental HI is 0.00, and the incremental cancer risk is 5E-12 for the recreational land-use scenario. Incremental risk calculations indicate insignificant risk to human health for a recreational land-use scenario.

Incremental TEDE and corresponding estimated cancer risk from radiological COCs are much less than EPA guidance values; the estimated TEDE is 8.6E-4 mrem/yr for the recreational land-use scenario. This value is much less than the numerical guidance of 15 mrem/yr in EPA guidance (EPA 1997b). The corresponding incremental estimated cancer risk value is 9.2E-9 for the recreational land-use scenario. Furthermore, the incremental TEDE for the residential land-use scenario that results from a complete loss of institutional control is only 1.7E-2 mrem/yr with an associated risk of 1.8E-7. The guideline for this scenario is 75 mrem/yr (SNL/NM February 1998). Therefore, SWMU 94D is eligible for unrestricted radiological release.

Uncertainties associated with the calculations are considered small relative to the conservativeness of risk assessment analysis. It is, therefore, concluded that this site does not have potential to affect human health under a recreational land-use scenario.

VII. Ecological Risk Screening Assessment

VII.1 Introduction

This section addresses the ecological risks associated with exposure to constituents of potential ecological concern (COPEC) in soils at SWMU 94D. A component of the NMED Risk-Based Decision Tree is to conduct an ecological screening assessment that corresponds with that presented in EPA's Ecological Risk Assessment Guidance for Superfund (EPA 1997d). The current methodology is tiered and contains an initial scoping assessment followed by a more detailed screening assessment. Initial components of NMED's decision tree (a discussion of DQOs, a data assessment, and evaluations of bioaccumulation and fate-and-transport potential) are addressed in previous sections of this report. Following the completion of the scoping assessment, a determination is made as to whether a more detailed examination of potential ecological risk is necessary. If deemed necessary, the scoping assessment proceeds to a screening assessment whereby a more quantitative estimate of ecological risk is conducted. Although this assessment incorporates conservatisms in the estimation of ecological risks, ecological relevance and professional judgment are also used as recommended by the EPA (1998b) to ensure that predicted exposures of selected ecological receptors reflect those reasonably expected to occur at the site.

VII.2 Scoping Assessment

The scoping assessment focuses primarily on the likelihood of exposure of biota at or adjacent to the site to be exposed to constituents associated with site activities. Included in this section are an evaluation of existing data and a comparison of maximum detected concentrations to background concentrations, examination of bioaccumulation potential, and fate and transport potential. A scoping risk management decision will involve a summary of the scoping results and a determination as to whether further examination of potential ecological impacts is necessary.

VII.2.1 Data Assessment

As indicated in Section IV (Tables 4 and 6), silver is the only inorganic constituent in soil within the 0- to 5-foot depth interval that could exceed its background concentration (a background screening value has not been determined for silver in this area). The MDA of U-235 exceeded background. And, methylene chloride was the only organic analyte detected within the 0- to 5-foot depth interval..

VII.2.2 Bioaccumulation

Among the COPECs listed in Section VII.2.1, only U-235 was considered to have bioaccumulation potential in aquatic environments (Section IV, Tables 3 and 4). It should be noted, however, that as directed by the NMED (NMED March 1998), bioaccumulation for inorganics is assessed exclusively based upon maximum reported bioconcentration factors (BCF) for aquatic species. Because only aquatic BCFs are used to evaluate the bioaccumulation potential for metals, bioaccumulation in terrestrial species is likely to be overpredicted.

VII.2.3 Fate and Transport Potential

The potential for the COPECs to move from the source of contamination to other media or biota is discussed in Section V. As noted in Table 7 (Section V), wind, surface water, and food chain uptake are expected to be of low significance as transport mechanisms for COPECs at this site. Migration to groundwater is not anticipated. Degradation/transformation for inorganic COPEC (silver) and the radionuclide (U-235) is expected to be of low significance. For the organic COPEC (methylene chloride), the potential for biotransformation is moderate, and loss by volatilization is also expected to occur.

VII.2.4 Scoping Risk Management Decision

Based upon information gathered through the scoping assessment, it was concluded that complete ecological pathways could be associated with this SWMU and that COPECs also exist at the site. As a consequence, a screening assessment was deemed necessary to predict the potential level of ecological risk associated with the site.

VII.3 Screening Assessment

As concluded in Section VII.2.4, complete ecological pathways and COPECs are associated with this SWMU. The screening assessment performed for the site involves a quantitative estimate of current ecological risks using exposure models in association with exposure parameters and toxicity information obtained from the literature. The estimation of potential ecological risks is conservative to ensure that ecological risks are not underpredicted.

Components within the screening assessment include the following:

- Problem formulation—sets the stage for the evaluation of potential exposure and risk.
- Exposure estimation—provides a quantitative estimate of potential exposure.

- Ecological effects evaluation—presents benchmarks used to gauge the toxicity of COPECs to specific receptors.
- Risk characterization—characterizes the ecological risk associated with exposure of the receptors to environmental media at the site.
- Uncertainty assessment—discusses uncertainties associated with the estimation of exposure and risk.
- Risk interpretation—evaluates ecological risk in terms of HQs and ecological significance.
- Screening assessment scientific/management decision point—presents the decision to risk managers based upon the results of the screening assessment.

VII.3.1 Problem Formulation

Problem formulation is the initial stage of the screening assessment that provides the introduction to the risk evaluation process. Components that are addressed in this section include a discussion of ecological pathways and the ecological setting, identification of COPECs, and selection of ecological receptors. The conceptual model, ecological food webs, and ecological endpoints (other components commonly addressed in a screening assessment) are presented in the "Predictive Ecological Risk Assessment Methodology for SNL/NM Environmental Restoration (ER) Program" (IT July 1998) and are not duplicated here.

VII.3.1.1 Ecological Pathways and Setting

SWMU 94D is less than 0.1 acre in size. The site is located in the Lurance Canyon, dominated by woodland habitat; however, much of the habitat at this site has been highly disturbed during its active use and during other activities conducted at the Lurance Canyon Burn Site. Wildlife could use the area, but the small size of the site makes significant transfers of COPECs through the food chain pathway unlikely. Biological and sensitive species surveys of the entire Lurance Canyon Burn Site were conducted in 1991 (Biggs May 1991, August 1991). No sensitive species were reported to occur at this facility.

Complete ecological pathways may exist at this site through the exposure of plants and wildlife to COPECs in surface and subsurface soil. Direct uptake of COPECs from soil was assumed to be the major route of exposure for plants, with exposure of plants to wind-blown soil assumed to be minor. Exposure modeling for the wildlife receptors was limited to the food and soil ingestion pathways and external radiation. Because of the lack of surface water at this site, exposure to COPECs through the ingestion of surface water was considered insignificant. Inhalation and dermal contact were also considered insignificant pathways with respect to ingestion (Sample and Suter 1994). Groundwater is not expected to be affected by COPECs at this site.

VII.3.1.2 COPECs

Wastewater discharged to SWMU 94D from burn tests at the Bomb Burner unit may have contained metals, VOCs, SVOCs, HE compounds, and DU. In order to provide conservatism in this ecological risk assessment, the assessment is based upon the maximum soil concentrations of the COPECs measured at this site. Both radiological and nonradiological COPECs are evaluated. The nonradiological COPECs include both inorganic (i.e., metals) and organic analytes. Inorganic analytes and radionuclides were screened against background concentrations, and those that exceeded the approved SNL/NM background screening levels (Dinwiddie September 1997) for the area were considered to be COPECs. All organic analytes detected are considered to be COPECs for the site. Maximum COPEC concentrations are reported in Tables 4 and 6. Nonradiological inorganics that are essential nutrients such as iron, magnesium, calcium, potassium, and sodium were not included in this risk assessment as determined by the EPA (1989).

VII.3.1.3 Ecological Receptors

As described in detail in IT Corporation (July 1998), a nonspecific perennial plant was selected as the receptor to represent plant species at the site. Vascular plants are the principal primary producers at the site and are key to the diversity and productivity of the wildlife community associate with the site. The deer mouse (*Peromyscus maniculatus*) and the burrowing owl (*Speotyto cunicularia*) were used to represent wildlife use. Because of its opportunistic food habits, the deer mouse was used to represent a mammalian herbivore, omnivore, and insectivore. The burrowing owl was selected to represent a top predator at this site. Although the burrowing owl is not expected to occur in the woodland habitat at SWMU 94D, it is used to provide conservative representation of exposure and risk to other small, predatory birds such as the western screech owl (*Otus kennicottii*) that could inhabit this site. The burrowing owl is present at SNL/NM and is designated a species of management concern by the U.S. Fish and Wildlife Service in Region 2, which includes the state of New Mexico (USFWS September 1995).

VII.3.2 Exposure Estimation

Direct uptake of COPECs from the soil was considered the only significant route of exposure for terrestrial plants. Exposure modeling for the wildlife receptors was limited to food and soil ingestion pathways. Inhalation and dermal contact were considered insignificant pathways with respect to ingestion (Sample and Suter 1994). Drinking water was also considered an insignificant pathway because of the lack of surface water at this site. The deer mouse was modeled under three dietary regimes: as an herbivore (100 percent of its diet as plant material), as an omnivore (50 percent of its diet as plants and 50 percent as soil invertebrates), and as an insectivore (100 percent of its diet as soil invertebrates). The burrowing owl was modeled as a strict predator on small mammals (100 percent of its diet as deer mice). Because the exposure in the burrowing owl from a diet consisting of equal parts of herbivorous, omnivorous, and insectivorous mice would be equivalent to the exposure consisting of only omnivorous mice, the diet of the burrowing owl was modeled with intake of omnivorous mice only. Both species were modeled with soil ingestion comprising 2 percent of the total dietary intake. Table 12 presents the species-specific factors used in modeling exposures in the wildlife receptors. Justification for use of the factors presented in this table is described in the ecological risk assessment methodology document (IT July 1998).

Although home range is also included in this table, exposures for this risk assessment were modeled using an area use factor of 1. This implies that all food items and soil ingested are from the site being investigated. The maximum measured COPEC concentrations from surface soil samples were used to conservatively estimate potential exposures and risks to plants and wildlife at this site.

For the radiological dose rate calculations, the deer mouse was modeled as an herbivore (100 percent of its diet as plants) and the burrowing owl was modeled as a strict predator on small mammals (100 percent of its diet as deer mice). Both were modeled with soil ingestion comprising 2 percent of the total dietary intake. Receptors are exposed to radiation both internally and externally from U-235. Internal and external dose rates to the deer mouse and the burrowing owl are approximated using modified dose rate models from the *Hanford Site Risk Assessment Methodology* (DOE 1995) as presented in the ecological risk assessment methodology document for the SNL/NM ER Program (IT July 1998). Radionuclide-dependent data for the dose rate calculations were obtained from Baker and Soldat (1992). The external dose rate model examines the total-body dose rate to a receptor residing in soil exposed to radionuclides. The soil surrounding the receptor is assumed to be an infinite medium uniformly contaminated with gamma-emitting radionuclides. The external dose rate model is the same for both the deer mouse and the burrowing owl. The internal total-body dose rate model assumes that a fraction of the radionuclide concentration ingested by a receptor is absorbed by the body and concentrated at the center of a spherical body shape. This provides for a conservative estimate for absorbed dose. This concentrated radiation source at the center of the body of the receptor is assumed to be a "point" source. Radiation emitted from this point source is absorbed by the body tissues to contribute to the absorbed dose. Alpha and beta emitters are assumed to transfer 100 percent of their energy to the receptor as they pass through tissues. Gamma-emitting radionuclides only transfer a fraction of their energy to the tissues because gamma rays interact less with matter than do beta or alpha emitters. The external and internal dose rate results are summed to calculate a total dose rate from exposure to U-235 in soil.

Table 13 presents the transfer factors used in modeling the concentrations of COPECs through the food chain. Table 14 presents maximum concentrations in soil and derived concentrations in tissues of the various food chain elements that are used to model dietary exposures for each of the wildlife receptors.

VII.3.3 Ecological Effects Evaluation

Benchmark toxicity values for the plant and wildlife receptors are presented in Table 15. For plants, the benchmark soil concentrations are based upon the lowest-observed-adverse-effect level (LOAEL). For wildlife, the toxicity benchmarks are based upon the no-observed-adverse-effect level (NOAEL) for chronic oral exposure in a taxonomically similar test species. Insufficient toxicity information was found to estimate the LOAELs for methylene chloride for terrestrial plant life and to estimate the NOAELs for either silver or methylene chloride for the burrowing owl.

Table 12
Exposure Factors for Ecological Receptors at SWMU 94D

Receptor Species	Class/Order	Trophic Level	Body Weight (kg)[a]	Food Intake Rate (kg/day)[b]	Dietary Composition[c]	Home Range (acres)
Deer mouse (*Peromyscus maniculatus*)	Mammalia/ Rodentia	Herbivore	2.39E-2[d]	3.72E-3	Plants: 100% (+ Soil at 2% of intake)	2.7E-1[e]
Deer mouse (*Peromyscus maniculatus*)	Mammalia/ Rodentia	Omnivore	2.39E-2[d]	3.72E-3	Plants: 50% Invertebrates: 50% (+ Soil at 2% of intake)	2.7E-1[e]
Deer mouse (*Peromyscus maniculatus*)	Mammalia/ Rodentia	Insectivore	2.39E-2[d]	3.72E-3	Invertebrates: 100% (+ Soil at 2% of intake)	2.7E-1[e]
Burrowing owl (*Speotyto cunicularia*)	Aves/ Strigiformes	Carnivore	1.55E-1[f]	1.73E-2	Rodents: 100% (+ Soil at 2% of intake)	3.5E+1[g]

[a]Body weights are in kg wet weight.
[b]Food intake rates are estimated from the allometric equations presented in Nagy (1987). Units are kg dry weight per day.
[c]Dietary compositions are generalized for modeling purposes. Default soil intake value of 2% of food intake.
[d]From Silva and Downing (1995).
[e]EPA (1993), based upon the average home range measured in semiarid shrubland in Idaho.
[f]From Dunning (1993).
[g]From Haug et al. (1993).
EPA = U.S. Environmental Protection Agency.
kg = Kilogram(s).
kg/day = Kilogram(s) per day.
SWMU = Solid Waste Management Unit.

Table 13
Transfer Factors Used in Exposure Models for Constituents of Potential Ecological Concern at SWMU 94D

Constituent of Potential Ecological Concern	Soil-to-Plant Transfer Factor	Soil-to-Invertebrate Transfer Factor	Food-to-Muscle Transfer Factor
Inorganic			
Silver	1.0E+0[a]	2.5E-1[b]	5.0E-3[a]
Organic			
Methylene chloride[c]	7.3E+0	1.5E+1	3.6E-7

[a]From NCRP (January 1989).
[b]From Stafford et al. (1991).
[c]Soil-to-plant and food-to-muscle transfer factors from equations developed in Travis and Arms (1988). Soil-to-invertebrate transfer factors from equations developed in Connell and Markwell (1990). All three equations based upon relationship of the transfer factor to the log K_{ow} value of compound (K_{ow} = the octanol-water partition coefficient).
K_{ow} = Octanol-water partition coefficient.
Log = Logarithm (base 10).
NCRP = National Council for Radiation Protection and Measurements.
SWMU = Solid Waste Management Unit.

Table 14
Media Concentrations[a] for Constituents of Potential Ecological Concern at SWMU 94D

Constituent of Potential Ecological Concern	Soil (maximum)[a]	Plant Foliage[b]	Soil Invertebrate[b]	Deer Mouse Tissues[c]
Inorganic				
Silver	1.5E-3[d]	1.5E-3	3.8E-4	1.5E-5
Organic				
Methylene chloride	1.2E-3	8.8E-3	1.8E-2	1.5E-8

[a]In milligram(s) per kilogram. All are based upon dry weight of the media.
[b]Product of the soil concentration and the corresponding transfer factor.
[c]Based upon the deer mouse with an omnivorous diet. Product of the average concentration in food times the food-to-muscle transfer factor times the wet weight-dry weight conversion factor of 3.125 (EPA 1993).
[d]Analyte not detected. Concentration is one-half of the detection limit.
EPA = U.S. Environmental Protection Agency.
SWMU = Solid Waste Management Unit.

Table 15
Toxicity Benchmarks for Ecological Receptors at SWMU 94D

Constituent of Potential Ecological Concern	Plant Benchmark[a,b]	Mammalian NOAELs			Avian NOAELs		
		Mammalian Test Species[c,d]	Test Species NOAEL[d,e]	Deer Mouse NOAEL[e,f]	Avian Test Species	Test Species NOAEL	Burrowing Owl NOAEL
Inorganic							
Silver	2	Rat	17.8[g]	34.8	---	---	---
Organic							
Methylene chloride	---	Rat	5.85	11.4	---	---	---

[a]In milligram(s) per kilogram soil.
[b]From Efroymson et al. (1997).
[c]Body weight of the laboratory rat (in kilograms) for the no-observed-adverse-effect level (NOAEL) conversion is 0.35.
[d]From Sample et al. (1996), except where noted.
[e]In milligram(s) per kilogram body weight per day.
[f]Based upon NOAEL conversion methodology presented in Sample et al. (1996), using a deer mouse body weight of 0.0239 kilogram and a mammalian scaling factor of 0.25.
[g]Based upon a rat lowest-observed-adverse-effect-level (LOAEL) of 89 mg/kg/d (EPA 1998) and an uncertainty factor of 0.2.
Body weight: 0.303 kilogram.
SWMU = Solid Waste Management Unit.
--- = Designates insufficient toxicity data.

The benchmark used for exposure of terrestrial receptors to radiation was 0.1 rad per day (rad/day). This value has been recommended by the International Atomic Energy Agency (IAEA 1992) for the protection of terrestrial populations. Because plants and insects are less sensitive to radiation than vertebrates (Whicker and Schultz 1982), the dose of 0.1 rad/day should also offer sufficient protection to other components within the terrestrial habitat of SWMU 94D.

VII.3.4 Risk Characterization

Maximum concentrations in soil and estimated dietary exposures were compared to plant and wildlife benchmark values, respectively. Table 16 shows results of these comparisons. HQs are used to quantify the comparison with benchmarks for plants and wildlife exposure. Neither of the nonradiological COPECs resulted in HQs exceeding unity. However, because of the lack of adequate toxicity information, an HQ for plants could not be determined for methylene chloride, and HQs for the burrowing owl could not be determined for either of the nonradiological COPECs at this site. As directed by the NMED, HI were calculated for each of the receptors (the HI is the sum of chemical-specific HQs for all pathways for a given receptor). None of the HIs that could be calculated were greater than unity.

Tables 17 and 18 summarize the internal and external dose rate model results for U-235. The total radiation dose rate to the deer mouse was predicted to be 5.8E-6 rad/day, with external dose rate contributing more than half of the total. Total dose rate to the burrowing owl was predicted to be 4.5E-6 rad/day, with the contribution of the external dose rate being about four times that of the internal dose rate. The dose rates for the deer mouse and the burrowing owl are considerably less than the benchmark of 0.1 rad/day.

VII.3.5 Uncertainty Assessment

Many uncertainties are associated with the characterization of ecological risks at SWMU 94D. These uncertainties result from assumptions used in calculating risk that may overestimate or underestimate true risk presented at a site. For this risk assessment, assumptions are made that are more likely to overestimate exposures and risk rather than to underestimate them. These conservative assumptions are used to be more protective of the ecological resources potentially affected by the site. Conservatisms incorporated into this risk assessment include the use of the maximum measured analyte concentration for methylene chloride and one-half the detection limit for silver to evaluate risk, the use of wildlife toxicity benchmarks based upon NOAEL values, the incorporation of strict herbivorous and strict insectivorous diets for predicting the extreme HQ values for the deer mouse, and the use of 1.0 as the area use factor for wildlife receptors regardless of seasonal use or home range size. Each of these uncertainties, which are consistent among each of the SWMU-specific ecological risk assessments, is discussed in greater detail in the uncertainty section of the ecological risk assessment methodology document for the SNL/NM ER Program (IT July 1998).

Table 16
Hazard Quotients for Ecological Receptors at SWMU 94D

Constituent of Potential Ecological Concern	Plant HQ	Deer Mouse HQ (Herbivorous)	Deer Mouse HQ (Omnivorous)	Deer Mouse HQ (Insectivorous)	Burrowing Owl HQ
Inorganic					
Silver	7.5E-4	6.8E-6	4.3E-6	1.8E-6	---
Organic					
Methylene chloride	---	1.2E-4	1.8E-4	2.5E-4	---
HI[a]	7.5E-4	1.3E-4	1.8E-4	2.5E-4	---

[a]The HI is the sum of individual HQs.
HI = Hazard index.
HQ = Hazard quotient.
SWMU = Solid Waste Management Unit.
--- = Designates insufficient toxicity data available for risk estimation purposes.

Table 17
Internal and External Dose Rates for
Deer Mice Exposed to Radionuclides at SWMU 94D

Radionuclide	Maximum Concentration (pCi/g)	Internal Dose (rad/day)	External Dose (rad/day)	Total Dose (rad/day)
U-235	2.13E-1[a]	2.3E-6	3.5E-6	5.8E-6

[a]Analyte not detected. Concentration is the minimum detectable activity.
pCi/g = Picocurie(s) per gram.
rad/day = Rad per day.
SWMU = Solid Waste Management Unit.

Table 18
Internal and External Dose Rates for
Burrowing Owls Exposed to Radionuclides at SWMU 94D

Radionuclide	Maximum Concentration (pCi/g)	Internal Dose (rad/day)	External Dose (rad/day)	Total Dose (rad/day)
U-235	2.13E-1[a]	1.0E-6	3.5E-6	4.5E-6

[a]Analyte not detected. Concentration is the minimum detectable activity.
pCi/g = Picocurie(s) per gram.
rad/day = Rad per day.
SWMU = Solid Waste Management Unit.

Uncertainties associated with the estimation of risk to ecological receptors following exposure to U-235 are primarily related to those inherent in the radionuclide-specific data. The dose rates are based upon the minimum detectable activity for U-235, which exceeded the background activity screening value. The dose rate models used for these calculations are based upon conservative estimates on receptor shape, radiation absorption by body tissues, and intake parameters. The goal is to provide a realistic, but conservative, estimate of a receptor's exposure to radionuclides in soil, both internally and externally.

Although HQs for the burrowing owl could not be determined, it is highly unlikely that the toxicity of either silver or methylene chloride would be at a level required to produce an HQ greater than unity in the owl. This is supported by the observations that the maximum HQs for silver and methylene chloride in the deer mouse were 6.8E-6 and 2.5E-4, respectively, while the exposure rates (in milligrams per kilogram per day) for these two COPECs were 47 and 1,060 times greater (respectively) in the deer mouse than in the burrowing owl. Therefore, the toxicity to birds would have to be over a million times higher than the toxicity to mammals in order to produce an HQ greater than unity for either of these two COPECs. This is conservatively based upon the assumption of an area use factor of 1.0 for both the deer mouse and the burrowing owl. Because the home range of the burrowing owl is approximately 130 times larger than that of the deer mouse and the area of SWMU 94D is less than the home ranges of both of these receptors, increasing this difference by another two orders of magnitude would be justified.

Based upon this uncertainty analysis, the probability that ecological risks exist at SWMU 94D is expected to be extremely low.

VII.3.6 Risk Interpretation

Ecological risks associated with SWMU 94D were estimated through a screening assessment that incorporated site-specific information when available. No risks (as indicated by HQ and HI values exceeding unity) were predicted for any of the ecological receptors. Risks are not expected in those cases where HQs could not be determined because of insufficient toxicity information. Based upon this final analysis, the probability that ecological risk exists from COPEC exposure at SWMU 94D is extremely low.

VII.3.7 Screening Assessment Scientific/Management Decision Point

Once potential ecological risks associated with the site have been assessed, a decision is made as whether the site should be recommended for NFA or additional data collected to more thoroughly assess actual ecological risk at the site. With respect to this site, ecological risks were predicted to be low. The scientific/management decision is to recommend this site for NFA.

VIII. References

Author [unk], Date [unk]. Notes collected for SWMU 65, Sandia National Laboratories, Notes (unpublished), Albuquerque, New Mexico.

Baes, III, C.F., R.D. Sharp, A.L. Sjoreen, and R.W. Shor, 1984. "A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture," ORNL-5786, Oak Ridge National Laboratory, Oak Ridge, Tennessee, pp. 10–11.

Baker, D.A., and J.K. Soldat, 1992. "Methods for Estimating Doses to Organisms from Radioactive Materials Released into the Aquatic Environment," PNL-8150, Pacific Northwest Laboratory, Richland, Washington, pp. 16–20.

Biggs, J., May 1991, "A Biological Assessment for Sandia National Laboratories Burn Site, Kirtland Air Force Base, New Mexico," Chambers Group, Inc., Albuquerque, New Mexico.

Biggs, J., August 1991, "Sensitive Species Survey for Sandia National Laboratories Burn Site, Kirtland Air Force Base, New Mexico," Chambers Group, Inc., Albuquerque, New Mexico.

Brown, C.D. (Sandia National Laboratories). Memorandum to D. Jercinovic (IT Corporation), "Radiological Data Tables and DU Ratios, Sandia National Laboratories," Memo (unpublished), Albuquerque, New Mexico. January 14, 1998.

Callahan, M.A., M.W. Slimak, N.W. Gabel, I.P. May, C.F. Fowler, J.R. Freed, P. Jennings, R.L. Durfee, F.C. Whitmore, B. Maestri, W.R. Mabey, B.R. Holt, and C. Gould, 1979, "Water-Related Environmental Fate of 129 Priority Pollutants," EPA-440/4-79-029, Office of Water and Waste Management, Office of Water Planning and Standards, U.S. Environmental Protection Agency, Washington, D.C.

Connell, D.W., and R.D. Markwell, 1990, "Bioaccumulation in the Soil to Earthworm System," Chemosphere, Vol. 20, Nos. 1-2, pp. 91-100.

Dawson, L. (Sandia National Laboratories/New Mexico). Memorandum to Distribution, "Record of Verbal Communication for the NMED/DOE OB and SNL/NM ER Project Meetings on Lurance Canyon Burn Site Groundwater Issues Rounds 1 and 2," Sandia National Laboratories/New Mexico. August 15, 1996.

Dinwiddie, R.S. (New Mexico Environment Department). Letter to M.J. Zamorski (U.S. Department of Energy), "Request for Supplemental Information: Background Concentrations Report, SNL/KAFB." September 24, 1997.

DOE, see U.S. Department of Energy.

Dunning, J.B., 1993. *CRC Handbook of Avian Body Masses*, CRC Press, Boca Raton, Florida.

Efroymson, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten, 1997. "Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants: 1997 Revision." ES/ER/TM-85/R3, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

EPA, see U.S. Environmental Protection Agency.

Goodrich, M. (IT Corporation). Personal Communication with M. Crawley (IT Corporation), Albuquerque, New Mexico. [Month Unk] 1993.

Haug, E.A., B.A. Millsap, and M.S. Martell, 1993. "*Speotyto cunicularia* Burrowing Owl," in A. Poole and F. Gill (eds.), *The Birds of North America*, No. 61, The Academy of Natural Sciences of Philadelphia.

Hazardous Substances Data Bank, 1998. Produced by Micromedex, Inc.

Howard, P.H., 1990. Handbook of Environmental Fate and Exposure Data for Organic Chemicals: Volume II Solvents, Lewis Publishers, Inc., Chelsea, Michigan.

IAEA, see International Atomic Energy Agency.

International Atomic Energy Agency (IAEA), 1992. "Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards," *Technical Report Series No. 332*, International Atomic Energy Agency, Vienna, Austria.

IT Corporation, July 1994. "Report of Generic Action Level Assistance for the Sandia National Laboratories/New Mexico Environmental Restoration Program," IT Corporation, Albuquerque, New Mexico.

IT Corporation, February 1995. "Sensitive Species Survey Results, Environmental Restoration Project, Sandia National Laboratories/New Mexico," IT Corporation, Albuquerque, New Mexico.

IT Corporation, June 1998. "Predictive Ecological Risk Assessment Methodology, Environmental Restoration Program, Sandia National Laboratories, New Mexico," IT Corporation, Albuquerque, New Mexico.

IT Corporation (IT), July 1998. "Predictive Ecological Risk Assessment Methodology, Environmental Restoration Program, Sandia National Laboratories, New Mexico," IT Corporation, Albuquerque, New Mexico.

Kocher, D.C. 1983. "Dose-Rate Conversion Factors for External Exposure to Photon Emitters in Soil," *Health Physics*, Vol. 28, pp. 193–205.

Martz, M.K. Memorandum to Sandia National Laboratories CEARP File regarding Personal Interview (unpublished), ER7585/1333/065/INT/95-014, Sandia National Laboratories, Albuquerque, New Mexico. November 1985.

Nagy, K.A., 1987. "Field Metabolic Rate and Food Requirement Scaling in Mammals and Birds," *Ecological Monographs*, Vol. 57, No. 2, pp. 111–128.

National Council on Radiation Protection and Measurements (NCRP), 1987. "Exposure of the Population in the United States and Canada from Natural Background Radiation," NCRP Report No. 94, National Council on Radiation Protection and Measurements, Bethesda, Maryland.

National Council on Radiation Protection and Measurements (NCRP), January 1989. "Screening Techniques for Determining Compliance with Environmental Standards: Releases of Radionuclides to the Atmosphere," NCRP Commentary No. 3, Rev., National Council on Radiation Protection and Measurements, Bethesda, Maryland.

NCRP, see National Council on Radiation Protection and Measurements.

Neumann, G., 1976. "Concentration Factors for Stable Metals and Radionuclides in Fish, Mussels and Crustaceans – a Literature Survey," Report 85-04-24, National Swedish Environmental Protection Board.

New Mexico Environment Department (NMED), March 1998. "Risk-Based Decision Tree Description," in New Mexico Environment Department, "RPMP Document Requirement Guide," New Mexico Environment Department, Hazardous and Radioactive Materials Bureau, RCRA Permits Management Program, Santa Fe, New Mexico.

Sample, B.E., and G.W. Suter II, 1994. "Estimating Exposure of Terrestrial Wildlife to Contaminants," ES/ER/TM-125, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Sample, B.E., D.M. Opresko, and G.W. Suter II, 1996. "Toxicological Benchmarks for Wildlife: 1996 Revision," ES/ER/TM-86/R3, Risk Assessment Program, Health Sciences Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Sandia National Laboratories/New Mexico (SNL/NM), May 1986. "CEARP Phase I, Draft," Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), 1994. Environmental Operations Records Center Reference Number 7585/1332/27/Int/94-001, 94-002, and 94-00, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), July 1994a. "Ownership (Land Use), Canyons Test Area—ADS 1333," Environmental Restoration Department, GIS Group, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), July 1994b. "Verification and Validation of Chemical and Radiological Data," Technical Operating Procedures (TOP) 94-03, Rev. 0, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), January 1995. "Spade and Scoop Method for Collection of Soil Samples," Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), April 1995. "Acreage and Mean Elevations for SNL Environmental Restoration Sites," Environmental Restoration Project, GIS Group, Sandia National Laboratories/New Mexico, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), September 1995. "RCRA Facility Investigation Work Plan for Operable Unit 1333, Canyons Test Area," Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), July 1996. "Laboratory Data Review Guidelines," Procedure No: RPSD-02-11, Issue No: 02, Radiation Protection Technical

Services, 7713, Radiation Protection Diagnostics Project, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), July 1997. "Bullets of Understanding for Nitrate Assessment at the Lurance Canyon Explosive Test Site (ER Site 65) OU 1333, Canyons Test Area, July 1, 1997," Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), August 1997. "Voluntary Corrective Measure Plan for Excavation and Debris Removal at Environmental Restoration Site 27 Operable Unit 1332, Foothills Test Area, July 1997," Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), September 1997. "Bullets of Understanding for Construction of Lurance Canyon Burn Site 'Narrows' Wells, OU 1333, Canyons Test Area, September 24, 1997," Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), February 1998. "RESRAD Input Parameter Assumptions and Justification," Sandia National Laboratories/New Mexico Environmental Restoration Project, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), March 1998. "Field Implementation Plan (FIP) ER Site 94D, Bomb Burner Pit," Sandia National Laboratories/New Mexico, Environmental Restoration Project, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), September 1998. "Proposals for No Further Action Environmental Restoration Project," Sandia National Laboratories, Albuquerque, New Mexico.

Selman, J.R., J.A. Celorie, and W.D. Featherman, 1994. "RI/FS Benchmarking Study: Process Analysis," EM-40 Technical Scope Analytical Team, U.S. Department of Energy, Washington, D.C.

Silva, M., and J.A. Downing, 1995. *CRC Handbook of Mammalian Body Masses*, CRC Press, Boca Raton, Florida.

SNL/NM, See Sandia National Laboratories, New Mexico.

Stafford, E.A., J.W. Simmers, R.G. Rhett, and C.P. Brown, 1991. "Interim Report: Collation and Interpretation of Data for Times Beach Confined Disposal Facility, Buffalo, New York," Miscellaneous Paper D-91-17, U.S. Army Corps of Engineers, Buffalo, New York.

Travis, C.C., and A.D. Arms, 1988. "Bioconcentration of Organics in Beef, Milk, and Vegetables," *Environmental Science Technology*, Vol. 22, No. 3, pp. 271–274.

U.S. Department of Agriculture (USDA), 1977. "Soil Survey of Bernalillo County and Parts of Sandoval and Valencia Counties, New Mexico," Soil Conservation Service, U.S. Department of the Interior Bureau of Indian Affairs and Bureau of Land Management, and New Mexico Agriculture Experiment Station, U.S. Government Printing Office, Washington, D.C.

U.S. Department of Energy (DOE), 1988. "External Dose-Rate Conversion Factors for Calculation of Dose to the Public," DOE/EH-0070, Assistant Secretary for Environment, Safety and Health, U.S. Department of Energy, Washington, D.C.

U.S. Department of Energy (DOE), 1993. "Radiation Protection of the Public and the Environment," DOE Order 5400.5, U.S. Department of Energy, Washington, D.C.

U.S. Department of Energy (DOE), 1995. "Hanford Site Risk Assessment Methodology," DOE/RL-91-45 (Rev. 3), U.S. Department of Energy, Richland, Washington.

U.S. Department of Energy (DOE), December 1997. "Department of Energy/Sandia National Laboratories response

U.S. Department of Energy, U.S. Air Force, and U.S. Forest Service, October 1995. "Workbook: Future Use Management Area 1," prepared by Future Use Logistics and Support Working Group in cooperation with U.S. Department of Energy Affiliates, U.S. Air Force, and U.S. Forest Service.

U.S. Environmental Protection Agency (EPA), November 1986. "Test Methods for Evaluating Solid Waste," 3rd ed., Update 3, SW-846, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1988. "Federal Guidance Report No. 11, Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion," Office of Radiation Programs, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1989. "Risk Assessment Guidance for Superfund, Vol. I: Human Health Evaluation Manual," EPA/540-1089/002, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1990. "Corrective Action for Solid Waste Management Units (SWMU) at Hazardous Waste Management Facilities, Proposed Rule," *Federal Register*, Vol. 55, Title 40, Code of Federal Regulations, Parts 264, 265, 270, and 271, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1991. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part B)," Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1993. "Wildlife Exposure Factors Handbook, Volume I of II," EPA/600/R-93/187a, Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), July 14, 1994. Memorandum from Elliott Laws, Assistant Administrator to Region Administrators I-X, "Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Active Facilities," U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1996a. Draft Region 6 Superfund Guidance, Adult Lead Cleanup Level, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1996b. Personal communication from M. Martinez (Region 6, U.S. Environmental Protection Agency) to E. Klavetter (Sandia National Laboratories/New Mexico), Proposed Subpart S action levels.

U.S. Environmental Protection Agency (EPA), 1996c. "Region 9 Preliminary Remediation Goals (PRGs) 1996," electronic database maintained by Region 9, U.S. Environmental Protection Agency, San Francisco, California.

U.S. Environmental Protection Agency (EPA), 1997a. "Health Effects Assessment Summary Tables (HEAST), FY 1997 Update," EPA-540-R-97-036, Office of Research and Development and Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C..

U.S. Environmental Protection Agency (EPA), 1997b. "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination," OSWER Directive No. 9200-4-18, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1997c. "Risk-Based Concentration Table," electronic database maintained by Region 3, U.S. Environmental Protection Agency, Philadelphia, Pennsylvania.

U.S. Environmental Protection Agency (EPA), 1997d. "Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risks," Interim Final, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1998, Integrated Risk Information System (IRIS) electronic database, maintained by the U.S. Environmental Protection Agency.

U.S. Fish and Wildlife Service (USFWS), September 1995. "Migratory Nongame Birds of Management Concern in the United States: The 1995 List," Office of Migratory Bird Management, U.S. Fish and Wildlife Service, Washington, D.C.

USFWS, see U.S. Forest and Wildlife Service.

Whicker, F.W., and V. Schultz, 1982. *Radioecology: Nuclear Energy and the Environment*, Volume 2, CRC Press, Boca Raton, Florida.

Will, M.E., and G.W. Suter II, 1995. "Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants: 1995 Revision." ES/ER/TM-85/R2, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Wrightson, Walter (Skip), 1994. Interviews Conducted for the Environmental Restoration Program, Depart 7585, Sandia National Laboratories Personal Interview (unpublished), Albuquerque, New Mexico, ER/7585/1332/27/Int/940005.

Yanicak, S. (Oversight Bureau, Department of Energy, New Mexico Environment Department). Letter to M. Johansen (DOE/AIP/POC Los Alamos National Laboratory), "(Tentative) list of constituents of potential ecological concern (COPECs) which are considered to be bioconcentrators and/or biomagnifiers." March 28, 1997.

Yu, C., A.J. Zielen, J.-J. Cheng, Y.C. Yuan, L.G. Jones, D.J. LePoire, Y.Y. Wang, C.O. Loureiro, E. Gnanapragasam, E. Faillace, A. Wallo III, W.A. Williams, and H. Peterson, 1993. "Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD," Version 5.0. Environmental Assessment Division, Argonne National Laboratory, Argonne, Illinois.

Yu, C., C. Loureiro, J.-J. Cheng, L.G. Jones, Y.Y. Wang, Y.P. Chia, and E. Faillace, 1993b. *Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil,* ANL/EAIS-8, Argonne National Laboratory, Argonne, Illinois.

Zamorski, M.J. (U.S. Department of Energy). Letter to R.S. Dinwiddie (New Mexico Environment Department), "Department of Energy/Sandia National Laboratories Response to the NMED Request for Supplemental Information for the *Background Concentrations of Constituents of Concern to the Sandia National Laboratories/New Mexico Environmental Restoration Project and the Kirtland Air Force Base Installation Restoration Program* Report," December 3, 1997.

APPENDIX 1
EXPOSURE PATHWAY DISCUSSION FOR CHEMICAL AND RADIONUCLIDE CONTAMINATION

Introduction

Sandia National Laboratories (SNL/NM) proposes that a default set of exposure routes and associated default parameter values be developed for each future land-use designation being considered for SNL/NM Environmental Restoration (ER) project sites. This default set of exposure scenarios and parameter values would be invoked for risk assessments unless site-specific information suggested other parameter values. Because many SNL/NM solid waste management units (SWMU) have similar types of contamination and physical settings, SNL/NM believes that the risk assessment analyses at these sites can be similar. A default set of exposure scenarios and parameter values will facilitate the risk assessments and subsequent review.

The default exposure routes and parameter values suggested are those that SNL/NM views as resulting in a Reasonable Maximum Exposure (RME) value. Subject to comments and recommendations by the U.S. Environmental Protection Agency (EPA) Region VI and New Mexico Environment Department (NMED), SNL/NM proposes that these default exposure routes and parameter values be used in future risk assessments.

At SNL/NM, all SWMUs exist within the boundaries of the Kirtland Air Force Base (KAFB). Approximately 157 potential waste and release sites have been identified where hazardous, radiological, or mixed materials may have been released to the environment. Evaluation and characterization activities have occurred at all of these sites to varying degrees. Among other documents, the SNL/NM ER draft Environmental Assessment (DOE 1996) presents a summary of the hydrogeology of the sites, the biological resources present and proposed land-use scenarios for the SNL/NM SWMUs. At this time, all SNL/NM SWMUs have been tentatively designated for either industrial or recreational future land use. The NMED has also requested that risk calculations be performed based upon a residential land-use scenario. All three land-use scenarios will be addressed in this document.

The SNL/NM ER project has screened the potential exposure routes and identified default parameter values to be used for calculating potential intake and subsequent Hazard index (HI), excess cancer risk and dose values. The EPA (EPA 1989a) provides a summary of exposure routes that could potentially be of significance at a specific waste site. These potential exposure routes consist of:

- Ingestion of contaminated drinking water
- Ingestion of contaminated soil
- Ingestion of contaminated fish and shell fish
- Ingestion of contaminated fruits and vegetables
- Ingestion of contaminated meat, eggs, and dairy products
- Ingestion of contaminated surface water while swimming
- Dermal contact with chemicals in water
- Dermal contact with chemicals in soil
- Inhalation of airborne compounds (vapor phase or particulate)

- External exposure to penetrating radiation (immersion in contaminated air; immersion in contaminated water and exposure from ground surfaces with photon-emitting radionuclides).

Based upon the location of the SNL/NM SWMUs and the characteristics of the surface and subsurface at the sites, we have evaluated these potential exposure routes for different land-use scenarios to determine which should be considered in risk assessment analyses (the last exposure route is pertinent to radionuclides only). At SNL/NM SWMUs, there does not currently occur any consumption of fish, shell fish, fruits, vegetables, meat, eggs, or dairy products that originate on site. Additionally, no potential for swimming in surface water is present due to the high-desert environmental conditions. As documented in the RESRAD computer code manual (ANL 1993), risks resulting from immersion in contaminated air or water are not significant compared to risks from other radiation exposure routes.

For the industrial and recreational land-use scenarios, SNL/NM ER has, therefore, excluded the following four potential exposure routes from further risk assessment evaluations at any SNL/NM SWMU:

- Ingestion of contaminated fish and shell fish
- Ingestion of contaminated fruits and vegetables
- Ingestion of contaminated meat, eggs, and dairy products
- Ingestion of contaminated surface water while swimming.

That part of the exposure pathway for radionuclides related to immersion in contaminated air or water is also eliminated.

For the residential land-use scenario, we will include ingestion of contaminated fruits and vegetables because of the potential for residential gardening.

Based upon this evaluation, for future risk assessments, the exposure routes that will be considered are shown in Table 1. Dermal contact is included as a potential exposure pathway in all land-use scenarios. However, the potential for dermal exposure to inorganics is not considered significant and will not be included. In general, the dermal exposure pathway is generally considered to not be significant relative to water ingestion and soil ingestion pathways but will be considered for organic components. Because of the lack of toxicological parameter values for this pathway, the inclusion of this exposure pathway into risk assessment calculations may not be possible and may be part of the uncertainty analysis for a site where dermal contact is potentially applicable.

Equations and Default Parameter Values for Identified Exposure Routes

In general, SNL/NM expects that ingestion of compounds in drinking water and soil will be the more significant exposure routes for chemicals; external exposure to radiation may also be significant for radionuclides. All of the above routes will, however, be considered for their appropriate land-use scenarios. The general equations for calculating potential intakes via these routes are shown below. The equations are from the Risk Assessment Guidance for Superfund (RAGS): Volume 1 (EPA 1989a, 1991). These general equations also apply to calculating potential intakes for radionuclides. A more in-depth discussion of the equations

Table 1
Exposure Pathways Considered for Various Land-Use Scenarios

Industrial	Recreational	Residential
Ingestion of contaminated drinking water	Ingestion of contaminated drinking water	Ingestion of contaminated drinking water
Ingestion of contaminated soil	Ingestion of contaminated soil	Ingestion of contaminated soil
Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)
Dermal contact	Dermal contact	Dermal contact
External exposure to penetrating radiation from ground surfaces	External exposure to penetrating radiation from ground surfaces	Ingestion of fruits and vegetables
		External exposure to penetrating radiation from ground surfaces

used in performing radiological pathway analyses with the RESRAD code may be found in the RESRAD Manual (ANL 1993). Also shown are the default values SNL/NM ER suggests for use in RME risk assessment calculations for industrial, recreational, and residential scenarios, based upon EPA and other governmental agency guidance. The pathways and values for chemical contaminants are discussed first, followed by those for radionuclide contaminants. RESRAD input parameters that are left as the default values provided with the code are not discussed. Further information relating to these parameters may be found in the RESRAD Manual (ANL 1993).

Generic Equation for Calculation of Risk Parameter Values

The equation used to calculate the risk parameter values (i.e., hazard quotients/hazard index [HI], excess cancer risk, or radiation total effective dose equivalent [dose]) is similar for all exposure pathways and is given by:

Risk (or Dose) = Intake x Toxicity Effect (either carcinogenic, noncarcinogenic, or radiological)

$$= C \times (CR \times EFD/BW/AT) \times \text{Toxicity Effect} \quad (1)$$

where

C = contaminant concentration (site specific)
CR = contact rate for the exposure pathway
EFD= exposure frequency and duration
BW = body weight of average exposure individual
AT = time over which exposure is averaged.

The total risk/dose (either cancer risk or HI) is the sum of the risks/doses for all of the site-specific exposure pathways and contaminants.

The evaluation of the carcinogenic health hazard produces a quantitative estimate for excess cancer risk resulting from the constituents of concern (COC) present at the site. This estimate is evaluated for determination of further action by comparison of the quantitative estimate with the potentially acceptable risk range of 1E-6 for Class A and B carcinogens and 1E-5 for Class C carcinogens. The evaluation of the noncarcinogenic health hazard produces a quantitative estimate (i.e., the HI) for the toxicity resulting from the COCs present at the site. This estimate is evaluated for determination of further action by comparison of this quantitative estimate with the EPA standard HI of unity (1). The evaluation of the health hazard due to radioactive compounds produces a quantitative estimate of doses resulting from the COCs present at the site.

The specific equations used for the individual exposure pathways can be found in RAGS (EPA 1989a) and the RESRAD Manual (ANL 1993). Table 2 shows the default parameter values suggested for used by SNL/NM at SWMUs, based upon the selected land-use scenario. References are given at the end of the table indicating the source for the chosen parameter values. The intention of SNL/NM is to use default values that are consistent with regulatory guidance and consistent with the RME approach. Therefore, the values chosen will, in general, provide a conservative estimate of the actual risk parameter. These parameter values are suggested for use for the various exposure pathways based upon the assumption that a particular site has no unusual characteristics that contradict the default assumptions. For sites for which the assumptions are not valid, the parameter values will be modified and documented.

Summary

SNL/NM proposes the described default exposure routes and parameter values for use in risk assessments at sites that have an industrial, recreational or residential future land-use scenario. There are no current residential land-use designations at SNL/NM ER sites, but this scenario has been requested to be considered by the NMED. For sites designated as industrial or recreational land use, SNL/NM will provide risk parameter values based upon a residential land-use scenario to indicate the effects of data uncertainty on risk value calculations or in order to potentially mitigate the need for institutional controls or restrictions on SNL/NM ER sites. The parameter values are based upon EPA guidance and supplemented by information from other government sources. The values are generally consistent with those proposed by Los Alamos National Laboratory, with a few minor variations. If these exposure routes and parameters are acceptable, SNL/NM will use them in risk assessments for all sites where the assumptions are consistent with site-specific conditions. All deviations will be documented.

Table 2
Default Parameter Values for Various Land-Use Scenarios

Parameter	Industrial	Recreational	Residential
General Exposure Parameters			
Exposure frequency (day/yr)	***	***	***
Exposure duration (yr)	25[a,b]	30[a,b]	30[a,b]
Body weight (kg)	70[a,b]	70 adult[a,b] 15 child	70 adult[a,b] 15 child
Averaging Time (days) for carcinogenic compounds (= 70 y x 365 day/yr) for noncarcinogenic compounds (= ED x 365 day/yr)	 25550[a] 9125	 25550[a] 10950	 25550[a] 10950
Soil Ingestion Pathway			
Ingestion rate	100 mg/day[c]	200 mg/day child 100 mg/day adult	200 mg/day child 100 mg/day adult
Inhalation Pathway			
Inhalation rate (m^3/yr)	5000[a,b]	260[d]	7000[a,b,d]
Volatilization factor (m^3/kg)	chemical specific	chemical specific	chemical specific
Particulate emission factor (m^3/kg)	1.32E9[a]	1.32E9[a]	1.32E9[a]
Water Ingestion Pathway			
Ingestion rate (L/day)	2[a,b]	2[a,b]	2[a,b]
Food Ingestion Pathway			
Ingestion rate (kg/yr)	NA	NA	138[b,d]
Fraction ingested	NA	NA	0.25[b,d]
Dermal Pathway			
Surface area in water (m^2)	2[b,e]	2[b,e]	2[b,e]
Surface area in soil (m^2)	0.53[b,e]	0.53[b,e]	0.53[b,e]
Permeability coefficient	chemical specific	chemical specific	chemical specific

***The exposure frequencies for the land-use scenarios are often integrated into the overall contact rate for specific exposure pathways. When not included, the exposure frequency for the industrial land-use scenario is 8 hr/day for 250 day/yr; for the recreational land use, a value of 2 hr/wk for 52 wk/yr is used (EPA 1989b); for a residential land use, all contact rates are given per day for 350 day/yr.

[a]RAGS, Vol 1, Part B (EPA 1991).

[b]Exposure Factors Handbook (EPA 1989b)

[c]EPA Region VI guidance.

[d]For radionuclides, RESRAD (ANL 1993) is used for human health risk calculations; default parameters are consistent with RESRAD guidance.

[e]Dermal Exposure Assessment (EPA 1992).

References

ANL, see Argonne National Laboratory.

Argonne National Laboratory (ANL), 1993. *Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD*, Version 5.0, ANL/EAD/LD-2, Argonne National Laboratory, Argonne, IL.

DOE, see U.S. Department of Energy.

EPA, see U.S. Environmental Protection Agency.

U.S. Department of Energy (DOE), 1996. "Environmental Assessment of the Environmental Restoration Project at Sandia National Laboratories/New Mexico," U.S. Department of Energy, Kirtland Area Office.

U.S. Environmental Protection Agency (EPA), 1989a. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual," EPA/540-1089/002, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1989b. *Exposure Factors Handbook*, EPA/600/8-89/043, U.S. Environmental Protection Agency, Office of Health and Environmental Assessment, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1991. "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part B)," EPA/540/R-92/003, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1992. "Dermal Exposure Assessment: Principles and Applications," EPA/600/8-91/011B, Office of Research and Development, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1996. "Soil Screening Guidance: Technical Background Document," EPA/540/1295/128, Office of Solid Waste and Emergency Response, Washington, D.C.

October 13, 2003

ADDITIONAL /SUPPORTING DATA

CAN BE VIEWED AT THE
ENVIRONMENTAL, SAFETY, HEALTH
AND SECURITY (ES&H and Security)
RECORD CENTER

FOR ASSISTANCE CALL
844-4688