Vol. 1 of 3

Sandia National Laboratories/New Mexico

PROPOSALS FOR NO FURTHER ACTION ENVIRONMENTAL RESTORATION PROJECT SWMUs 16, 228A, 65A, 65B, 65C, AND 94E

September 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) 16, 228A, 65A, 65B, 65C, and 94E. Review and analysis of all relevant data for these SWMUs indicate that concentrations of constituents of concern (COC) at these sites do not pose an unacceptable risk to human health or the environment. 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 16 (the Open Dumps in Arroyo del Coyote in Operable Unit [OU] 1309), an inactive site, was used as an uncontrolled trash dump and gravel quarry from the late 1950s to the late 1980s. A radiological voluntary corrective measure (VCM) was conducted at SWMU 16 in 1995 and 1996 (Phase I) and 1997 and 1998 (Phase II). Confirmatory sampling analyses revealed residual metals and radionuclides. The site assessment concludes that SWMU 16 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 16 were very low.

- SWMU 228A (the Centrifuge Dump Site in OU 1309), inactive since the 1950's, was used for the disposal of weapons debris and construction debris on the northern rim of Tijeras Arroyo. A radiological VCM was conducted at the site in 1998 and 1999. Subsequent sampling analyses revealed residual metals, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and radionuclides at SWMU 228A. The site assessment concludes that SWMU 228A 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 228A were low.

- SWMU 65A (the Small Debris Mound in OU 1333), an inactive subunit of SWMU 65, was a small concrete bunker (covered with soil) that could have been used for an explosives propagation test at the Lurance Canyon Explosives Test Site (LCETS). A radiological VCM was conducted to excavate and demolish the bunker in March 1999. Subsequent sampling analyses collected under the bunker floor after its removal revealed residual metals and radionuclides slightly above background concentration limits at SWMU 65A. The site assessment concludes that SWMU 65A 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 65A were very low.

- SWMU 65B (the Primary Detonation Area in OU 1333), an inactive subunit of SWMU 65, was the detonation area for general explosives tests, miscellaneous burn tests, slow-heat tests, and the Torch-Activated Burn System Test Location A at the LCETS. A radiological 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 SWMU 65B. The site assessment concludes that SWMU 65B 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 65B were very low.

- SWMU 65C (the Secondary Detonation Area in OU 1333), an inactive subunit of SWMU 65, was used to conduct general explosives tests and miscellaneous burn pit tests at the LCETS. A radiological 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, VOCs, SVOCs, and radionuclides at SWMU 65C. The site assessment concludes that SWMU 65C 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 65C were very low.

- SWMU 94E (the Small Surface Impoundment in OU 1333), an inactive subunit of SWMU 94, was an impoundment used for several fuel-fire burn tests which may have received wastewater from some portable pan burn tests at the Lurance Canyon Burn Test Site. A radiological VCM was conducted in 1996. Confirmatory sampling analyses performed in 1996 and 1998 revealed residual metals and radionuclides at the site. The site assessment concludes that SWMU 94E 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 94E were very 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.

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ACRONYMS AND ABBREVIATIONS

amsl	above mean sea level
AOC	area of concern
bgs	below ground surface
COA	City of Albuquerque
CEARP	Comprehensive Environmental Assessment and Response Program
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm^2	square centimeter(s)
COC	constituent of concern
CON-CON	Conical Container
cpm	counts per minute
DOE	U.S. Department of Energy
dpm	disintegration(s) per minute
DU	depleted uranium
ECF	Explosive Components Facility
EM	electromagnetic
EPA	U.S. Environmental Protection Agency
EP-TOX	extraction procedure toxicity
ER	environmental restoration
FIP	Field Implementation Plan
g	gram(s)
GEL	General Engineering Laboratory
GM	Geiger-Mueller
HE	high explosive(s)
HI	hazard index
HMX	1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane
HQ	hazard quotient
hr	hour(s)
HRMB	Hazardous and Radioactive Materials Bureau
HRS	hazard ranking system
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
LCBS	Lurance Canyon Burn Site
LCETS	Lurance Canyon Explosives Test Site
MCL	maximum contaminant levels
MDA	minimum detectable activity
MDL	method detection limit
µg	microgram(s)
mg	milligram(s)
mrem	millirem(s)
MS	matrix spike
NFA	no further action
NMED	New Mexico Environment Department
NTS	Nevada Test Site
OB	Oversight Bureau
OU	Operable Unit

ACRONYMS AND ABBREVIATIONS (Concluded)

PCB	polychlorinated biphenyls
PCE	perchloroethylene
pCi	picocurie(s)
PID	photoionization detector
PPE	personal protective equipment
ppm	part(s) per million
PQL	practical quantitation limit(s)
PRG	preliminary remediation goal
QA	quality assurance
QC	quality control
RCRA	Resource Conservation and Recovery Act
RCT	radiological control technician
RDX	1,3,5-trinitrobenzene
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RMMA	Radiological Materials Management Area
RMWMF	Radioactive and Mixed Waste Management Facility
RPD	relative percent difference
RPSD	Radiation Protection Sample Diagnostics
RSI	Request for Supplemental Information
SAP	sampling and analysis plan
SGS	Segmented Gate System
SMERF	Smoke Emissions Reduction Facility
SNL/NM	Sandia National Laboratories/New Mexico
SVOC	semivolatile organic compound
SVS	soil vapor survey
SWISH	Small Wind-Shielded
SWMU	Solid Waste Management Unit
TA	Technical Area
TABS	Torch-Activated Burn System
TAL	target analyte list
TCA	1,1,2-trichloroethane
TCE	trichloroethylene
TCLP	toxicity characteristic leaching procedure
TEDE	total effective dose equivalent
tics	total ion counts
TJAOU	Tijeras Arroyo Operable Unit
TNT	trinitrotoluene
TPH	total petroleum hydrocarbons
UXO	unexploded ordnance
VCA	voluntary corrective action
VCM	voluntary corrective measure
VOC	volatile organic compound
yr	year

1.0 INTRODUCTION

Sandia National Laboratories/New Mexico (SNL/NM) is proposing No Further Action (NFA) proposals for six 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 1309

- SWMU 16, Open Dumps, Arroyo del Coyote (Section 2.0)
- SWMU 228A, Centrifuge Dump Site (Section 3.0)

Operable Unit 1333

- SWMU 65A, Small Debris Mound, Lurance Canyon Explosives Test Site (Section 4.0)
- SWMU 65B, Primary Detonation Area, Lurance Canyon Explosives Test Site (Section 5.0)
- SWMU 65C, Secondary Detonation Area, Lurance Canyon Explosives Test Site (Section 6.0)
- SWMU 94E, Small Surface Impoundment, Lurance Canyon Burn Test Site (Section 7.0)

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.

2.0 SOLID WASTE MANAGEMENT UNIT 16, OPEN DUMPS, ARROYO DEL COYOTE

2.1 Summary

Sandia National Laboratories/New Mexico (SNL/NM) is proposing a risk-based no further action (NFA) decision for Solid Waste Management Unit (SWMU) 16, Open Dumps (Arroyo Del Coyote), Operable Unit 1309. Review and analysis of all relevant data for SWMU 16 indicate that concentrations of constituents of concern (COC) at this site are less than applicable risk assessment action levels. Thus, SWMU 16 is proposed for an NFA decision based upon confirmatory sampling data demonstrating that COCs that may have been released from this SWMU into the environment pose an acceptable level of risk under current and projected future land use, as set forth by NFA Criterion 5. NFA Criterion 5 states that "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).

2.2 Description and Operational History

Section 2.2 describes the site and provides the operational history of SWMU 16.

2.2.1 Site Description

SWMU 16 is located in the central portion of Kirtland Air Force Base (KAFB) between Technical Area (TA) V and the horse stables on Pennsylvania Boulevard. It is reached by traveling southeast on Pennsylvania Boulevard and then southwest approximately 0.15 mile on the TA-III/V access road (Figure 2.2.1-1). SWMU 16 lies northwest of the TA-III/TA-V access road, and is bisected by, and located adjacent to Arroyo del Coyote (Figure 2.2.1-2). SWMU 16 encompasses approximately 28 acres of undeveloped land that slopes gently to the northwest and lies at an average elevation of 5,440 feet above mean sea level (amsl). Access to this inactive site is uncontrolled.

The surficial sediments at SWMU 16 consist of modern to Holocene-age stream channel and fluvial terrace deposits (silt to boulder-sized material) in and immediately adjacent to the Arroyo del Coyote. The Arroyo del Coyote–derived sediment package has been deposited within older (late Pleistocene) alluvial fan deposits (SNL/NM December 1995)

Arroyo del Coyote drains a large part of the eastern part of KAFB and eventually flows into Tijeras Arroyo. However, surface water flow in Arroyo del Coyote occurs only several times per year. The average rainfall at the City of Albuquerque airport is 8.1 inches per year (NOAA 1990). The regional water table elevation was projected to be approximately 4,935 feet amsl beneath SWMU 16 in January 1999, which equates to a groundwater depth beneath the site of approximately 505 feet below ground surface (bgs). Regional groundwater flows in a generally westerly to northwesterly direction in the vicinity of the site (SNL/NM March 1999). The nearest monitoring wells are AVN-1 and AVN-2,which lie approximately 0.5 mile southwest of SWMU 16. The depth

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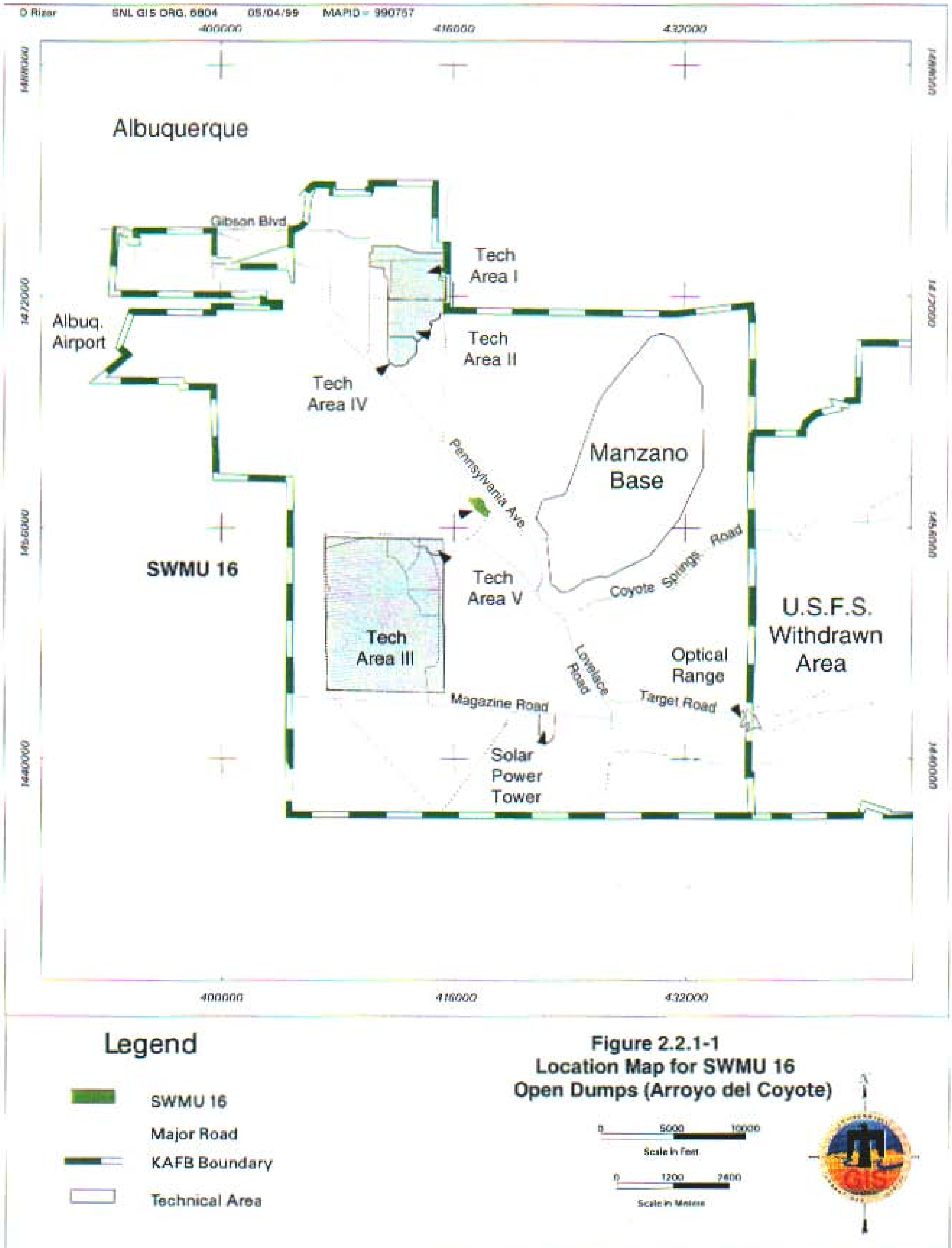

Figure 2.2.1-1
Location Map for SWMU 16
Open Dumps (Arroyo del Coyote)

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Environmental Restoration Geographic Information System

to water in AVN-2, which was completed at the regional aquifer water table, was 507 bgs in July 1998 (SNL/NM March 1999). The nearest production wells are northwest of SWMU 16 and include KAFB-1, 2, 4, 7, and 11, which range from approximately 2.5 miles (KAFB-4) to 3.6 miles (KAFB-2) from the site (SNL/NM August 1996).

2.2.2 Operational History

SWMU 16 was used as an uncontrolled trash dump and gravel quarry from the late 1950s to the late 1980s. A portion of the site was used as a sand and gravel quarry in the early to mid-1970s. Debris from SNL/NM research activities began to appear at the site in the late 1960s; this dumping continued until the late 1980s. Figure 2.2.2-1 shows the primary locations of quarrying, soil disturbance and debris areas. Interviews with SNL/NM personnel familiar with the historical activities at the site and with the research activities that produced the debris and ER Project site inspections indicate that the following types of materials were dumped at SWMU 16:

- Construction demolition debris from facilities such as Building 9939 (the Large Melt Facility) and the TA-III Short and Long Sled Tracks known to have used depleted uranium (DU)
- Concrete slabs (targets, sled track bases/supports)
- Research debris (concrete targets, rocket motors, thermocouple wires)
- Large concrete crucibles used in meltdown experiments (Building 9939)
- Fiberglass wrapped, yellow castable ceramic crucibles
- Two piles of fire bricks coated with asbestos
- A large pile of oil shale and slag dumped between 1983 and 1985
- A large charcoal filter
- Potting compounds (inert materials such as epoxies and plastic foams)
- A parachute
- Spent rocket motors
- Pink mock high explosive (HE) pieces
- Construction debris (foam insulation, empty paint and drums, electrical wire, floor tile, vitrified clay sewer pipe, scrap wood, rebar, cinder block, Transite sheets and piping; fencing)
- Friable asbestos

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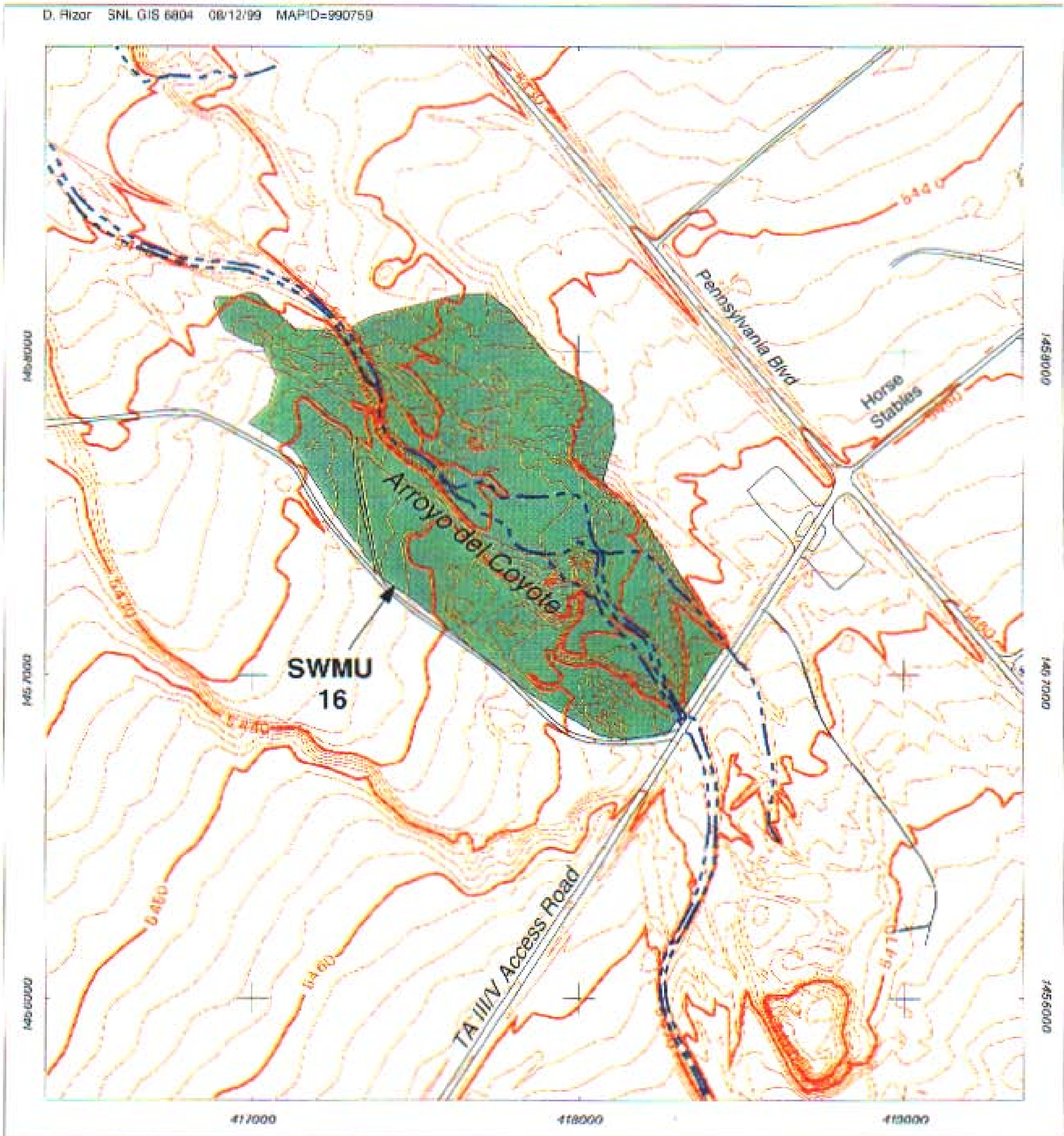

Legend

- SWMU 16
- KAFB Road
- 2 Foot Contour (ft,MSL)
- Arroyo del Coyote

Figure 2.2.1-2
Site Map for SWMU 16
Open Dumps (Arroyo del Coyote)

0 250 500
Scale in Feet

0 60 120
Scale in Meters

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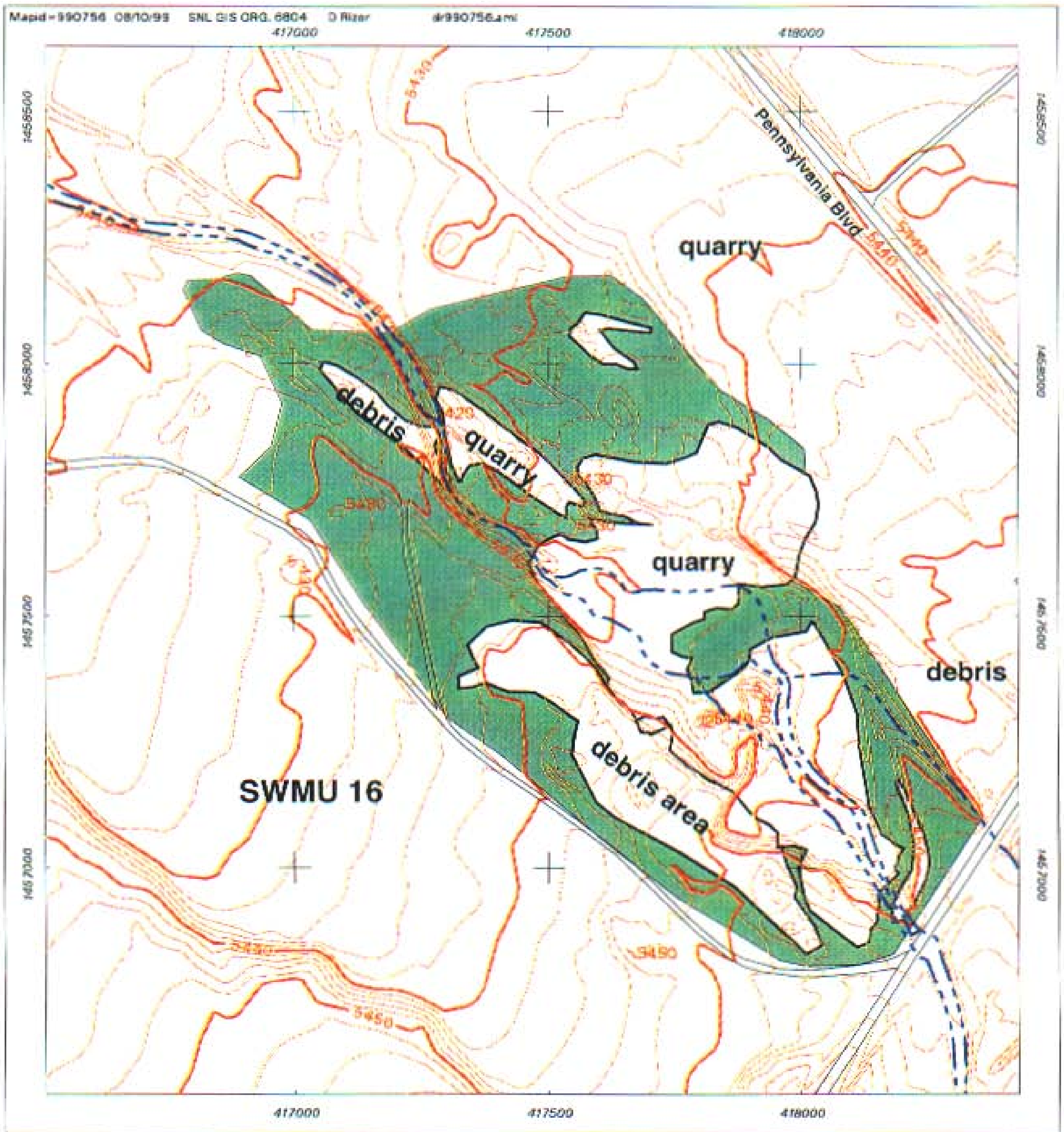

Legend

- Road
- 2 Foot Contour (ft,MSL)
- Arroyo del Coyote
- SWMU 16
- Disturbed Area

Figure 2.2.2-1
SWMU 16, Primary Open Dumping and Quarry Locations

0 160 320
Scale in Feet

0 38.4 76.8
Scale in Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

- Spent smoke canisters
- A concrete septic tank
- Concrete ballast blocks
- Concrete rubble from parking lot demolition
- Asphalt
- Scrap metal (fence posts, pipe, stainless and mild steel tubes, rebar, sheet metal, wire, steel cables)
- Metal slag (iron steel, bronze)
- Clean soil piles originating from excavations at TA-V.

Process knowledge consisted primarily of personnel interviews. The debris at SWMU 16 came from a variety of SNL/NM facilities including the Large Melt Facility (Building 9939), TA-III sled tracks, Thunder Range, and TA-III Drop Tower facility. Figure 2.2.2-2a/b are photographs that show some of the types of debris and the condition of the site prior to remediation. The photos show primarily large blocks of concrete rubble from the TA-III Long Sled Track that were dumped directly into and along the Arroyo del Coyote channel.

SWMU 16 was designated a radioactive material management area (RMMA) in 1990. The site has been approved by the U.S. Department of Energy (DOE) for unrestricted radiological release and was removed from the SNL/NM RMMA tracking program on February 12, 1999 (Vigil February 1999).

2.3 Land Use

Section 2.3 discusses the current and future land-use scenarios for SWMU 16.

2.3.1 Current Land Use

The current land use classification for SWMU 16 is recreational (DOE and USAF January 1996).

2.3.2 Future/Proposed Land Use

The projected land use for SWMU 16 is also recreational (DOE and USAF January 1996).

2.4 Investigatory Activities

SWMU 16 has been characterized and/or remediated in a series of four investigations and voluntary corrective measure (VCM) activities. This section discusses those activities.

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Figure 2.2.2-2a Reinforced Concrete Sled Track Footings Near West Bank of Arroyo del Coyote. 2/2/97. View Looking Southeast.

Figure 2.2.2-2b Sled Track Footings and Construction Debris at Anomalies 16E12/16E13/16E14. 2/2/97. View Looking Southwest.

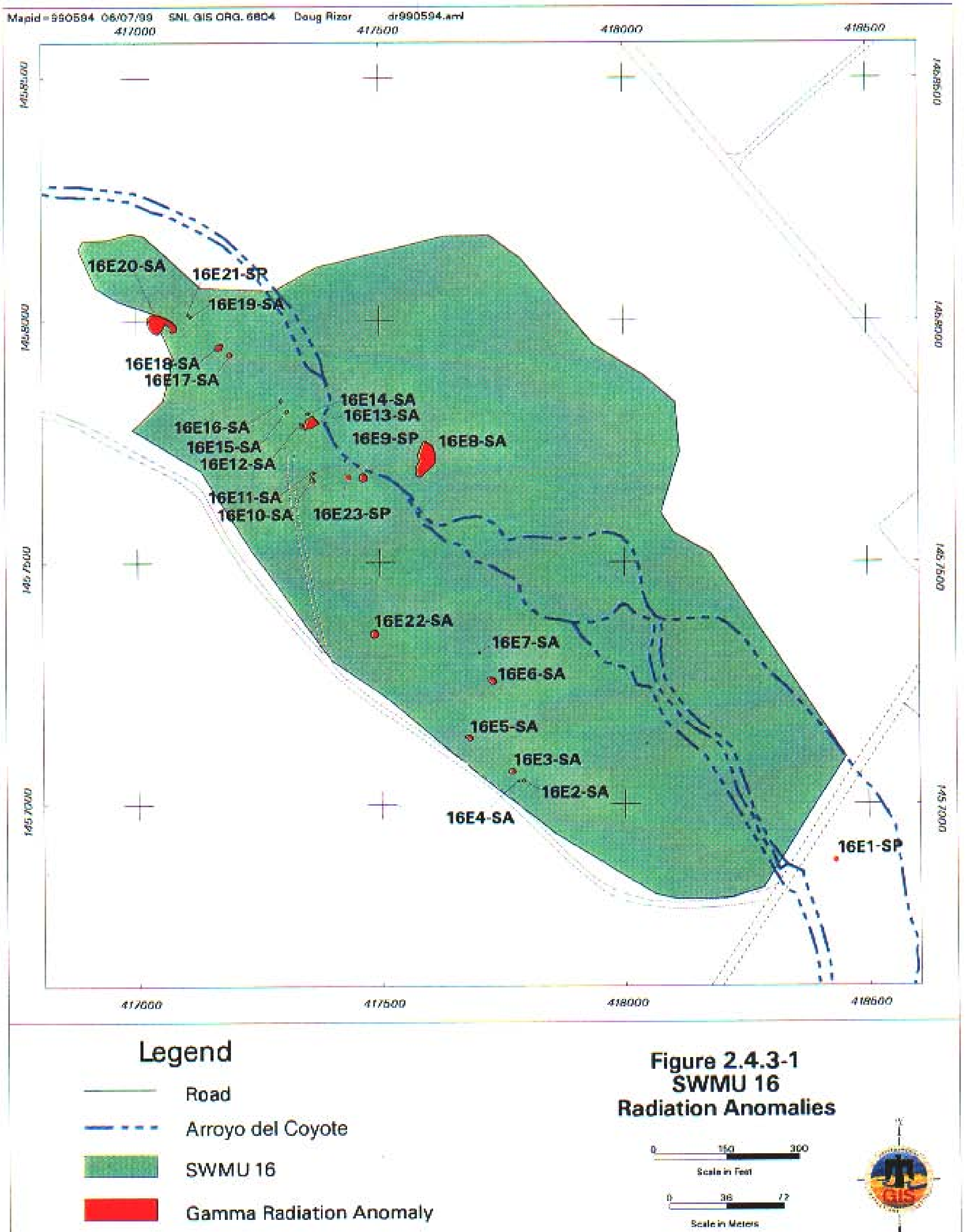

Figure 2.4.3-1
SWMU 16
Radiation Anomalies

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

2.4.1 Summary

SWMU 16 was initially investigated under the DOE's Comprehensive Environmental Assessment and Response Program (CEARP) in the mid-1980s in conformance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The investigation included a visual inspection of the site (Investigation #1).

Preliminary nonsampling investigations for SWMU 16 included personnel interviews, site inspections, site photographs, radiological surveys, surveys for unexploded ordnance (UXO)/HE, cultural resources, and sensitive species. In total, 23 radiological anomalies were identified (Investigation #2).

Between March 1995 and November 1996, a VCM (Phase I) was conducted to remediate the majority of the radiological anomalies identified in the radiological surveys (Investigation #3).

Between November 1997 and October 1998, a second VCM (Phase II) was conducted to remediate the remaining radiological anomalies that had not been completed during the Phase I VCM. All the debris that remained following the VCM was taken from SWMU 16 for recycling or solid waste disposal. Finally, confirmatory sampling was conducted to demonstrate that significant levels of COCs were no longer present at the site, and the site was reseeded (Investigation #4).

2.4.2 Investigation #1—CEARP

2.4.2.1 Nonsampling Data Collection

Several open dumps in the Arroyo del Coyote were identified during the investigation conducted under the CEARP. The CEARP Phase I report stated that

> Several open dumps for the disposal of waste concrete and various other materials are located in the arroyo east of Area III (Site 16). Materials deposited in the arroyo east of Area III include concrete with reinforcing rod, wood, foam, cans, oil-contaminated soil, partially buried drums, rocket pieces, debris from the sled track, and possibly some small pieces of potting compounds and [HE]. The northeast dump contains mostly large pieces of reinforced concrete with a dark coating. Most of the concrete is reported to be from tests at the drop tower and sled tracks. The dark coating could possibly be contaminated with [DU] from field tests (DOE September 1987).

2.4.2.2 Sampling Data Collection

No sampling activities were conducted at SWMU 16 as part of the CEARP.

2.4.2.3 Data Gaps

No samples were obtained during the CEARP to determine whether hazardous materials or wastes were stored or released to the surrounding environment.

2.4.2.4 Results and Conclusions

The CERCLA finding under the CEARP was uncertain for Federal Facility Site Discovery and Identification Findings, preliminary assessment, and preliminary site investigation. Insufficient information was available to calculate a Hazard Ranking System score for the SWMU. The CEARP Phase I report recommended that additional information and sampling be collected to allow evaluation of conditions at the site (DOE September 1987).

2.4.3 Investigation #2—SNL/NM ER Preliminary Investigations

2.4.3.1 Nonsampling Data Collection

This section describes the preliminary (nonsampling) data collection activities conducted at SWMU 16.

2.4.3.1.1 Background Review

A background review was conducted by the ER Project in order to collect any relevant information regarding SWMU 16. Background information sources included interviews with SNL/NM staff and contractors who were familiar with site operational history and existing historical site records and reports. This background research was documented and has provided traceable references that sustain the integrity of the NFA proposal. Table 2.4.3-1 lists these information sources and references for SWMU 16. The key information sources used to assist in evaluating SWMU 16 are described below.

2.4.3.1.2 UXO/HE Survey

On November 5, 1993, a visual surface inspection was conducted at SWMU 16 to determine whether live ordnance, or UXO/HE that might pose an explosive hazard, were located at the site. Ten expended jet-assisted take-off rocket motors were found at the site; no UXO or HE was identified (Young and Byrd September 1994).

2.4.3.1.3 Cultural-Resources Survey

A cultural-resources survey was conducted at SWMU 16 in 1994; no cultural resources were identified at the site (Hoagland and Dello-Russo February 1995).

2.4.3.1.4 Sensitive-Species Survey

A survey was conducted for sensitive species at SWMU 16 on April 18, 1994. The survey was limited to the outer boundaries of the dump area because the debris piles had been found to be

Table 2.4.3-1
Summary of Background Information Reviewed for SWMU 16

Information Source	Reference
Visual walkover surveys and site inspections, site photographs, aerial photographs, UXO/HE survey, cultural resources survey, biological survey, radiological surveys	Ebert and Associates, Inc. (November 1994) Gaither May 1992 Gaither and Karas May 1993 Young and Byrd September 1994 Hoagland and Dello-Russo February 1995 IT February 1995 RUST Geotech Inc. December 1994 SNL/NM September 1997
Interviews and/or site tours with 12 SNL/NM facility personnel	McVey October 1997

HE = High explosives.
SNL/NM = Sandia National Laboratories/New Mexico.
SWMU = Solid Waste Management Unit.
UXO = Unexploded ordnance.

radiologically contaminated. No sensitive species were found during this survey (IT February 1995).

2.4.3.1.5 Radiological Survey(s)

A radiological gamma surface survey of SWMU 16 was performed by RUST Geotech Inc. in January and February of 1994 (RUST Geotech Inc. December 1994). The survey was performed on 10-foot centers and covered a total of 26.4 acres. An approximately 2,200-foot-long section of the bottom and banks of Arroyo del Coyote was surveyed. Three point sources and eighteen area sources of gamma activity 30 percent or more above the natural background were identified during this survey. These 21 anomalies (18 areas sources and 3 point sources) were designated as Anomalies 16E1 through 16E21. Figure 2.4.3-1 shows the location of the 21 anomalies identified in the initial radiological survey of the site. The area sources are labeled "SA," the point sources, "SP."

In June 1996, RUST Geotech Inc. performed a second, more detailed radiological survey at the site. This survey was completed on 6-foot centers over 100 percent of the site and identified only one additional area source (16E22) and one additional point source (16E23) beyond those identified earlier. These two additional radiological sources are also shown on Figure 2.4.3-1 (SNL/NM September 1997).

2.4.3.1.6 Sampling Data Collection

No sampling activities were conducted as part of the SWMU 16 investigations described above.

2.4.3.1.7 Data Gaps

Information gathered from process knowledge, historical site files, surveys and inspections of the site, and personnel interviews were sufficient to identify the most likely COCs, the most likely locations of potential COC releases, and the types of analyses to be performed on soil

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samples. The initial radiological survey conducted in early 1994 defined the location and extent of 21 radiological anomalies at SWMU 16. A second, more detailed radiological survey conducted in June 1996 identified two additional radiological anomalies at the site.

2.4.3.1.8 Results and Conclusions

No UXO/HE hazards, cultural resources, or sensitive species were identified at SWMU 16. No evidence of organic COCs such as stained soil or leaking containers was present. The two radiological surveys conducted at the site identified 23 radiation anomalies. Large amounts and varieties of metal were present at SWMU 16. Therefore the most likely COCs for SWMU 16 were metals and radionuclides.

2.4.4 Investigation #3—SNL/NM ER Project Phase I VCM Activities

2.4.4.1 Nonsampling Data Collection

The second radiological survey over 100 percent of the site that was conducted in June 1996, as discussed in Section 2.4.3.1.5, occurred during the Phase I VCM activities described below.

2.4.4.2 Phase I VCM Activities

Initial or Phase I VCM activities to remediate the majority of the radiological anomalies at SWMU 16 were conducted intermittently from March 1995 through November 1996. A detailed summary of the Phase I VCM activities conducted at SWMU 16 is presented in the "Final Report, Survey and Removal of Radioactive Surface Contamination at Environmental Restoration Sites, Sandia National Laboratories/New Mexico" (SNL/NM September 1997). To assess the need for remediation at those locations, precleanup soil sampling for gamma spectroscopy analysis was conducted by RUST Geotech Inc.

Area sources were associated with large debris/soil mounds. A backhoe was used when the lateral and vertical extent of elevated radiation exceeded the capabilities of manual cleanup procedures. Cleanup activities included radiation scanning to verify anomaly location and the removal of fragments and/or soil until readings were at less than 1.3 times site-specific background levels as well as postcleanup (verification) soil sampling for gamma spectroscopy analysis.

Two point sources (16E1 and 16E21) were remediated during the initial cleanup in March 1995. One point source (16E9) was a large concrete crucible and was not removed. The results of gamma spectroscopy analysis on precleanup samples collected from five area sources indicated that the elevated radiation is related to anthropogenic (man-made) material. Two of these sources (16E6 and 16E7) were not remediated due to the presence of fire bricks containing asbestos. Three of these sources (16E5, 16E11, and 16E15) and eight other area sources (16E2, 16E3, 16E4, 16E10, 16E16, 16E17, 16E18, and 16E19) were cleaned up. Excavation of three closely spaced area sources (16E12, 16E13, and 16E14) showed them to be linked to one large area source. Because of the large quantity of concrete rubble and debris present that exceeded the capabilities of the backhoe, remediation of these area sources was not completed during Phase I. 16E22 and 16E23 were addressed during the Phase II VCM (see Section 2.4.5).

Gamma spectroscopy results on precleanup samples collected from two area sources (16E8 and 16E20) indicated that the elevated radiation was related to naturally occurring geologic material and no cleanup was required. (SNL/NM September 1997).

The Phase I cleanup activities conducted from March 1995 to November 1996 generated soil and personnel protective equipment (PPE) waste. All waste was containerized in either 30- or 55-gallon drums. A total of 423 waste drums (primarily soil) were generated during cleanup activities. Waste consolidation was performed to minimize the number of drums produced for each waste stream. Ten composite soil samples were collected from the waste drums and were analyzed for gamma emitters using standard laboratory gamma spectroscopy methods and for leachable RCRA metals using toxicity characteristic leaching procedure (TCLP) analytical procedures. Mercury had not been identified as a COC and was not included in the TCLP analysis. All samples passed the TCLP tests, and all waste was characterized as radioactive-low level only. This regulated VCM waste was managed by SNL/NM Waste Operations, which packaged and secured waste drums for transfer to Envirocare Inc. of Utah. Nonregulated waste was disposed of using standard SNL/NM-approved waste disposal methods. (See SNL/NM [September 1997] for a detailed summary of the Phase I VCM waste generation and management activities and for analytical results of waste characterization samples collected at the conclusion of this task.)

2.4.4.3 Phase I VCM Confirmatory Sampling

Twelve postcleanup (verification) samples were collected at the conclusion of the SWMU 16 Phase I VCM activities from areas exhibiting the highest residual gamma radiation readings. Gamma spectroscopy analyses were performed on these samples and indicated that only U-238 (indicative of DU) remained in the soil at above approved maximum background activity levels (Dinwiddie September 1997). A detailed summary of the results of the Phase I VCM verification sampling is also presented in the "Final Report, Survey and Removal of Radioactive Surface Contamination at Environmental Restoration Sites, Sandia National Laboratories/New Mexico" (SNL/NM September 1997).

2.4.4.4 Data Gaps

Eight point and area anomalies remained to be remediated at the conclusion of the Phase I VCM activities. The final, or Phase II VCM cleanup (Investigation #4) is described in Section 2.4.5.

2.4.4.5 Results and Conclusions

A total of 13 point and area sources were remediated during the Phase I VCM activities. Gamma spectroscopy results of precleanup samples collected from two other area sources (16E8 and 16E20) indicated that the slightly elevated radiation levels at these locations were related to naturally occurring geologic material such as granitic gravel, and no cleanup was required (SNL/NM September 1997).

Two point sources and six area sources remained to be remediated after November 1996, pending further radiological and nonradiological characterization. These sources included the following:

- 16E23: a 3- by 3- by 3-foot concrete crucible. The elevated radiation levels resulted from a small amount of slag that remained in the crucible bowl.

- 16E9: a 3-foot-long, 18-inch-diameter concrete crucible. The elevated radiation levels resulted from the presence of thorium sand used in the concrete mix. The crucible was also coated with asbestos.

- 16E6 and 16E7: two piles of fire bricks containing thorium sand, resulting in slightly elevated radiation levels. These fire bricks were not remediated during the Phase I VCM because of an asbestos coating on the bricks.

- 16E12, 16E13, and 16E14: excavation of these three closely spaced area sources showed that the three merged into one large area source. Remediation of this large area source was not completed because of the large quantity of heavy concrete rubble and debris that exceeded the capabilities of the heavy equipment (backhoe).

- 16E22: a large pile of partially retorted oil shale. Radiation levels were slightly elevated because of naturally occurring components of oil shale

2.4.5 Investigation #4—Phase II VCM Activities and Confirmatory Sampling

2.4.5.1 Nonsampling Data Collection

No nonsampling data collection activities were associated with the Phase II VCM and confirmatory sampling at SWMU 16.

2.4.5.2 Sampling Data Collection

The Phase II VCM was performed between November 1997 and October 1998 to remediate all remaining area and point radiological sources and nonradiological debris at SWMU 16. Confirmatory soil sampling was conducted following the Phase II VCM to confirm that no DU or RCRA-listed metals remained at the site at levels that posed a significant level of risk under current and projected future land use.

2.4.5.3 Phase II VCM Activities

The Phase II VCM activities at SWMU 16 consisted of remediating the remaining two point and six area sources. VCM activities started in November 1997 and were concluded in June 1998. Waste removal methods used at the site ranged from the manual collection of smaller debris to use of heavy equipment (loader, backhoe, trackhoe, and crane) for large debris that weighed up to 15 tons. The photographs in Figures 2.4.5-1a/b and 2.4.5-2a/b show some of the types of remediation activities that occurred during the Phase II VCM.

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Figure 2.4.5-1a Removing a Reinforced Concrete Target in the Crucible Area (Anomalies 16E9 and 16E23) with a Crane. 11/5/97. View Looking East.

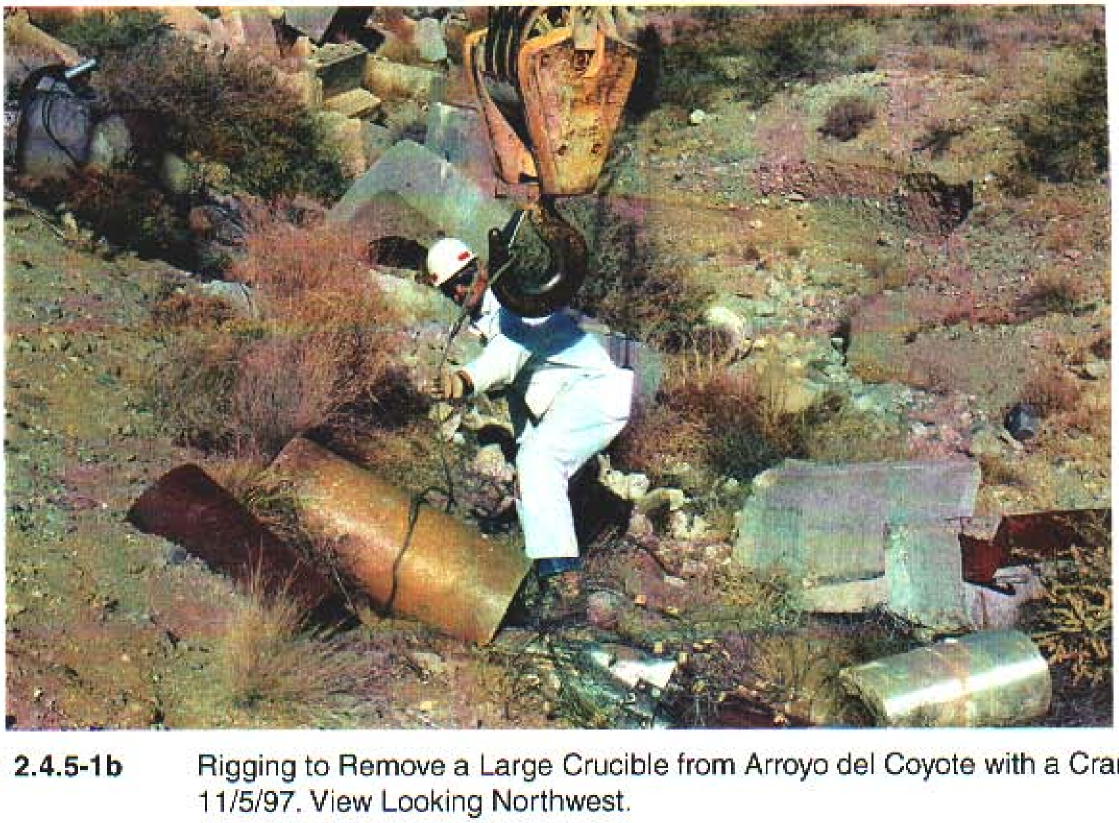

Figure 2.4.5-1b Rigging to Remove a Large Crucible from Arroyo del Coyote with a Crane. 11/5/97. View Looking Northwest.

Figure 2.4.5-2a Removing Small Debris from the Crucible Area (Anomalies 16E9 and 16E23) in Arroyo del Coyote Drainage. 11/10/97. View Looking East.

Figure 2.4.5-2b Asbestos Abatement Contractors Removing Firebrick with Asbestos Coating from Anomaly 16E7. 11/11/97. View Looking Southwest.

2.4.5.3.1 Remediation of Anomalies 16E6 and 16E7

Anomalies 16E6 and 16E7 (two piles of asbestos-coated fire brick) were remediated in November 1997. A subcontractor to the SNL/NM Facilities Asbestos Abatement team was used to remove the fire brick and asbestos debris from the surface and excavate any material that was below the surface. The fire brick, asbestos, and asbestos-contaminated soil removed from the two debris piles were placed in doubled, 6-mil polyethylene waste bags. The bags were then placed into 55-gallon open-top steel drums. A total of 240 polyethylene bags (115 from 16E6, and 125 from 16E7) were filled with excavated asbestos/fire brick/soil debris. Four bags of trash and PPE were also generated.

2.4.5.3.2 Remediation of Anomalies 16E9 and 16E23

Anomalies 16E9 and 16E23 were Large Melt Facility crucibles deposited on the western bank of Arroyo del Coyote with approximately 100 other crucibles (see Figure 2.4.5-1b). As all crucibles were removed from the arroyo bank, a Radiological Control Technician (RCT) checked all previously unexposed surfaces for radiological contamination by frisking and swiping. After all debris had been removed from the crucible area, the RCT performed a walkover surface radiation survey. No additional radiation anomalies were detected in the crucible area.

Anomaly 16E9 was remediated on February 2, 1998. This cylindrical, concrete crucible was 3 feet long with an 18-inch diameter. The elevated radiation levels were caused by the presence of thorium sand, which was used in the concrete mix for its refractory properties. The crucible was also coated with asbestos. Two composite samples of the crucible concrete were collected for gamma spectroscopy analysis. Radioactivity levels in the samples were found to be consistent with naturally occurring radionuclide activities. For remediation of Anomaly 16E9, a sledge hammer was used to break up the crucible and the broken pieces were placed into five 55-gallon open-topped steel drums. After the crucible was broken up, the small pieces of remaining concrete and associated soil in the vicinity of the crucible were shoveled into the drums containing the larger crucible pieces. An RCT used a radiological meter to guide the final soil cleanup at this location.

Anomaly 16E23 was remediated on February 6, 1998. This anomaly consisted of a 3-by 3- by 3-foot concrete crucible. The elevated radiation levels were caused by a small amount of slag that remained in the crucible bowl. For remediation of this anomaly, the residual radioactive slag was chipped from the crucible bowl with a hand-held chipping hammer. The slag fragments were placed in a 55-gallon open-topped steel drum. An RCT used a radiological meter to guide the slag removal operation and to verify that all slag had been removed from the crucible bowl.

2.4.5.3.3 Remediation of Anomaly 16E22

Anomaly 16E22 was remediated in April 1998. This anomaly consisted of a 5-foot-high by 23-foot-diameter pile of oil shale. The slightly elevated levels of radiation (compared to background activity levels) were determined to be naturally occurring by RUST Geotech Inc. However, SNL/NM has no standard approach for naturally occurring radioactive material which was deposited anthropogenically, so the oil shale was excavated with a backhoe, was separated from native soil with a screen, and was placed into a total of 54 55-gallon open-topped steel drums. An RCT performed a surface gamma survey after the oil shale remediation was complete in order to confirm and demonstrate that the radiation levels in the excavated area were similar to naturally occurring background levels.

2.4.5.3.4 *Remediation of Anomalies 16E12/16E13/16E14*

Anomalies 16E12/16E13/16E14 were identified by RUST Geotech Inc. during their initial surface radiological survey in 1994. The three anomalies together were estimated to encompass an area of approximately 1,600 square feet and contained approximately 600 cubic yards of soil. Initial excavation activities found that the three anomalies were linked to one large source area. Because of the very large pieces of debris within the anomaly areas (see Figure 2.2.2-2b) and the limited capabilities of the excavation equipment (a backhoe) on site, RUST Geotech Inc. was not able to complete remediation activities they had started in October and November 1996 as part of the Phase I VCM. A total of 204 drums were filled with DU fragments, DU-contaminated soil, and pieces of concrete during the Phase I VCM work at these anomalies.

Remediation of Anomalies 16E12, 16E13, and 16E14 was completed in March 1998 as part of the Phase II VCM work. A crane was used to remove the remaining large concrete pieces and debris that had prevented RUST Geotech Inc. from completing remediation of these anomalies. An RCT checked the concrete and debris for radiological contamination by frisking and swiping the material after it was removed. One small DU fragment was found imbedded in a sled track target and was subsequently removed. No other concrete or debris that had been removed from the area was found to be contaminated.

After the concrete and debris were removed, a walkover surface radiation survey was performed by the RCT. Visible pieces of DU and some limited areas of elevated radiation were identified during the survey. Because DU was the only COC determined to be located at Anomalies 16E12, 16E13, and 16E14, a contract was signed with the firm of Thermo Nutech, Inc., to use their Segmented Gate System (SGS) to reduce the volume of DU-contaminated soil that would require off-site disposal. The SGS operation is described in Sections 2.4.5.4 and 2.4.5.5.

2.4.5.4 *SGS Operation*

The SGS was operated by the firm of Thermo Nutech, Inc., and was used at SWMU 16 to reduce the volume of soil contaminated with DU that would require off-site disposal. The SGS technology was jointly developed starting in 1995 by the DOE's Innovative Treatment Remediation Demonstration Program and DOE plants in Ohio. The SGS is a mobile automated system that uses gamma radiation detectors and a conveyor belt system to separate radioactively contaminated material from uncontaminated soil. This is accomplished by passing soil beneath the detectors on a conveyor belt. It was first used at SNL/NM in 1997 for cost-effective segregation of clean soil from soil contaminated with plutonium, uranium, thorium, and cesium at SNL/NM's Radioactive Waste Landfill in TA-II. Based on these results, it was concluded that the SGS was a cost-effective technology that could be used to separate clean from radioactively contaminated soil at other SNL/NM ER sites (DOE January 1999).

The SGS equipment was mobilized to SWMU 16 on February 17, 1998, and soil processing started on February 27. Soil was excavated from the 16E12/16E13/16E14 anomalies using a front-end loader. The excavation was guided by an RCT to ensure that all soil with elevated radiation levels was removed and stockpiled for processing with the SGS. The stockpiled soil was then passed through a 10-foot-wide grate to remove oversize (greater than 6 inches) debris and rocks. This operation is shown in the upper photograph of Figure 2.4.5-3a/b. The oversized material (primarily cobbles) slid down and was deposited in front of the grate, while the remaining smaller material passed through the grate. The oversized material was spread

Figure 2.4.5-3a Screening Out Oversized Material at Anomalies 16E12/16E13/16E14 Prior to Treatment with the Segmented Gate System. 2/27/98. View Looking North.

Figure 2.4.5-3b Processing Soil From Anomalies 16E12/16E13/16E14 with the Segmented Gate System. "Clean" Soil Pile on Left, "Hot" Soil Pile on Right. 3/2/98. View Looking Northwest.

out and was hand surveyed with a sodium iodide detector by an RCT to determine whether any of it was contaminated with DU above acceptable criteria. None of the oversize material was found to be contaminated and was, therefore, free-released by the RCT.

Soil that passed through the grate was then fed through a screen and hammer mill to remove all remaining rocks and debris greater than 2 inches in diameter. The rock and debris that did not pass through the screen was hand surveyed with a sodium iodide detector by an RCT as well. The remaining soil was then deposited on the SGS conveyor belt in a 2-inch-thick by 30.75-inch-wide layer, and was conveyed beneath sodium iodide gamma detectors at a rate of approximately 30 feet per minute. The sodium iodide detectors were linked to a computer, which in turn controlled pneumatic diversion gates located at the end of the sorting conveyor to separate clean soil from any soil that failed the acceptance criteria. DU-contaminated soil was diverted to a "hot pile." The lower photograph of Figure 2.4.5-3a/b shows the SGS in operation, with the pile of clean soil (the "cold pile") to be returned to site beneath the left conveyor, and the much smaller "hot pile" beneath the right conveyor.

The SGS equipment was calibrated to use 54 picocuries (pCi)/gram (g) as a criterion for separation of "clean" soil from contaminated soil. Fifty-four pCi/g was one-tenth the preliminary remediation goal of 540 pCi/g, which was calculated to ensure that soil remaining at the site would not pose a significant risk to human health or the environment (Miller October 1998).

The SGS was used to sort approximately 662 cubic yards of soil suspected to contain DU contamination. Of that amount, 15.9 cubic yards were diverted to the "hot pile" after the first processing pass; most of this initial "hot-pile" material consisted of soil that was unnecessarily diverted because of equipment operational pauses. The "hot-pile" material was, therefore, reprocessed, resulting in only 0.32 cubic yard of contaminated soil requiring off-site disposal. Four drums of PPE waste were also generated as a result of the SGS soil processing operation. SGS activities were completed on March 5, 1998, and on March 26, 1998, the equipment was removed from the site (DOE January 1999).

2.4.5.5 Sampling Data Collection

To ensure that soils in the "cold pile" were below the maximum acceptable radiological limits and could be returned to the site without posing a significant threat to human health or the environment, composite soil samples were collected. Soil used for these samples was collected continuously throughout the duration of SGS processing, in order to be as representative as possible. A total of three 5-gallon buckets of sample aliquots were continuously collected from the clean pile conveyor belt while the SGS was operating. At the end of processing, the soil aliquots were thoroughly blended (mixed), and a representative volume was then transferred to the respective sample containers. The "cold pile" samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), RCRA metals, isotopic uranium and thorium, gamma spectroscopy radionuclides, and tritium.

Analytical results for the SGS "cold-pile" samples are presented in Tables 2.4.5-1 through 2.4.5-5 and Annex 2-A. A trace concentration of only one VOC (methylene chloride at 1.1 J µg/kg), and no SVOCs were detected in the four samples analyzed for these constituents (Table 2.4.5-1). Analytical detection limits for VOCs and SVOCs can be found in Tables 2.4.5-2 and 2.4.5-3. Results for the two RCRA metals samples indicated that concentrations of seven of the eight metals were less than their respective New Mexico Environment Department (NMED)/ Hazardous and Radioactive Materials Bureau (HRMB) approved maximum background concentrations (Table 2.4.5-4). Cadmium concentrations in both samples (at 1.22 and 1.1 milligrams [mg]/kilogram [kg]) were slightly above the maximum approved cadmium

Table 2.4.5-1
Summary of VOC and SVOC Analytical Results for Samples from SWMU 16
Segmented Gate System Soil Piles, March 1998
(Off-Site Laboratory)

Sample Attributes			VOCs (EPA Method 8260[a]) (μg/kg)	SVOCs (EPA Method 8270[a]) (μg/kg)
Record Number[b]	ER Sample ID	Sample Depth (ft)[c]		
510356	TJAOU-16-SGCP-003	0–8	ND (0.44-5.0 J)	–
510356	TJAOU-16-SGCP-002	0–8	–	ND (10-75 J)
510356	TJAOU-16-SGMP-003	0–8	**1.1 J (5)**[d]	–
510356	TJAOU-16-SGMP-002	0–8	–	ND (10-75 J)

Note: Values in **bold** represent detected VOC analytes.
[a]EPA November 1986.
[b]Analysis request/chain of custody record.
[c]The sample depth shown above represents the depth below the surface that DU-contaminated soil was excavated from the area of Anomalies 16E12/16E13/16E14 (Figure 2.4.3-1).
[d]Methylene chloride.
– Indicates that no sample was collected, or a sample was collected but was not analyzed for the particular analyte.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
J ( ) = Estimated value less than the laboratory reporting limit, shown in parenthesis.
ID = Identification.
ND (# J) = Nondetect, uncertainty in the method detection limit shown in parenthesis, see data validation report (Annex 2-B).
SWMU = Solid Waste Management Unit .
SVOC = Semivolatile organic compound.
TJAOU = Tijeras Arroyo Operable Unit.
μg/kg = Microgram(s) per kilogram.
VOC = Volatile organic compound.

Table 2.4.5-2
VOC Analytical Detection Limits Pertinent to Samples from
SWMU 16 Soil Piles, March 1998
(Off-Site Laboratory)

Analyte	Soil Sample MDL (µg/kg)
Benzene	0.98
Bromobenzene	0.94
Bromochloromethane	0.67
Bromodichloromethane	0.80
Bromoform	0.48
Bromomethane	1.0
n-butylbenzene	2.1
sec-butylbenzene	2.0
tert-butylbenzene	1.8
Carbon tetrachloride	1.9
Chlorobenzene	1.1
Chloroethane	1.6
Chloroform	1.1
Chloromethane	1.9
2-chlorotoluene	2.1
4-chlorotoluene	1.6
Dibromochloromethane	0.59
1,2-dibromo-3-chloropropane	0.96
1,2-dibromoethane	0.46
Dibromomethane	5.0
1,2-dichlorobenzene	0.85
1,3-dichlorobenzene	1.1
1,4-dichlorobenzene	1.0
Dichlorodifluoromethane	1.8
1,1-dichloroethane	1.2
1,2-dichloroethane	0.46
1,1-dichloroethene	2.1
cis-1,2-dichloroethene	1.2
trans-1,2-dichloroethene	1.6
1,2-dichloropropane	0.81
1,3-dichloropropane	0.44
2,2-dichloropropane	3.4
1,1-dichloropropene	2.0
Ethylbenzene	1.6
Hexachlorobutadiene	1.8
Isopropylbenzene	1.7
p-isopropyltoluene	1.8
Methylene chloride	0.48
Naphthalene	0.61
n-propylbenzene	1.8
Styrene	2.1
1,1,1,2-tetrachloroethane	0.90
1,1,2,2-tetrachloroethane	0.96

Refer to footnotes at end of table.

Table 2.4.5-2 (Concluded)
VOC Analytical Detection Limits Pertinent to Samples from SWMU 16 Soil Piles, March 1998
(Off-Site Laboratory)

Analyte	Soil Sample MDL (µg/kg)
Tetrachloroethene	1.6
Toluene	1.5
1,2,3-trichlorobenzene	1.0
1,2,4-trichlorobenzene	0.90
1,1,1-trichloroethane	1.7
1,1,2-trichloroethane	0.62
Trichloroethene	1.2
Trichlorofluoromethane	5.0
1,2,4-trimethylbenzene	1.5
1,3,5-trimethylbenzene	1.6
1,2,3-trichloropropane	0.46
Vinyl chloride	1.8
Xylenes (total)	3.1

MDL = Method detection limit.
µg/kg = Microgram(s) per kilogram.
SWMU = Solid Waste Management Unit.
VOC = Volatile organic compound.

Table 2.4.5-3
SVOC Analytical Detection Limits Pertinent to Samples from SWMU 16 Soil Piles, March 1998
(Off-Site Laboratory)

Analyte	Soil Sample MDL (µg/kg)
Acenaphthene	20
Acenaphthylene	20
Anthracene	20
Benzidine	10
Benzo(a)anthracene	20
Benzo(b)fluoranthene	30
Benzo(k)fluoranthene	30
Benzo(ghi)perylene	52
Benzo(a)pyrene	20
Benzyl alcohol	20
Butyl benzyl phthalate	20
Bis(2-chloroethoxy)methane	10
Bis(2-chloroethyl)ether	20
Bis(2-chloroisopropyl)ether	20
Bis(2-ethylhexyl)phthalate	20
4-bromophenyl phenyl ether	20
4-chloroaniline	20
2-chloronaphthalene	20
4-chlorophenyl phenyl ether	20
Chrysene	20
Dibenzo(a,h)anthracene	59
Dibenzofuran	20
1,2-dichlorobenzene	20
1,3-dichlorobenzene	20
1,4-dichlorobenzene	20
3,3-dichlorobenzidine	20
Diethyl phthalate	20
Dimethyl phthalate	20
Di-n-butyl phthalate	20
Di-n-octyl phthalate	20
2,4-dinitrotoluene	20
2,6-dinitrotoluene	20
Fluoranthene	20
Fluorene	20
Hexachlorobenzene	20
Hexachlorobutadiene	20
Hexachlorocyclopentadiene	65
Hexachloroethane	30
Indeno(1,2,3-cd)pyrene	55
Isophorone	20
2-methylnaphthalene	20
Naphthalene	20
o-nitroaniline	20
m-nitroaniline	20
p-nitroaniline	20

Refer to footnotes at end of table.

Table 2.4.5-3 (Concluded)
SVOC Analytical Detection Limits Pertinent to Samples from
SWMU 16 Soil Piles, March 1998
(Off-Site Laboratory)

Analyte	Soil Sample MDL (µg/kg)
Nitrobenzene	20
n-nitrosodi-n-propylamine	20
n-nitrosodiphenylamine	20
Phenanthrene	20
Pyrene	20
1,2,4-trichlorobenzene	20
Benzoic acid	20
4-chloro-3-methylphenol	20
2-chlorophenol	10
2,4-dichlorophenol	10
2,4-dimethylphenol	20
2,4-dinitrophenol	36
2-methyl-4,6-dinitrophenol	20
2-methylphenol (o-cresol)	20
4-methylphenol (m,p-cresol)	20
2-nitrophenol	20
4-nitrophenol	20
Pentachlorophenol	75
Phenol	20
2,4,5-trichlorophenol	30
2,4,6-trichlorophenol	20

MDL = Method detection limit.
µg/kg = Microgram(s) per kilogram.
SVOC = Semivolatile organic compound.
SWMU = Solid Waste Management Unit.

Table 2.4.5-4
Summary of Metals Analytical Results for Sample from SWMU 16 Segmented Gate System Soil Piles Sampling,
March 1998
(Off-Site Laboratory)

Sample Attributes			RCRA Metals (EPA Method 6010/7000[a]) (mg/kg)								
Record Number[b]	ER Sample ID	Sample Depth (ft)[c]	Ag	As	Ba	Cd	Cr	Hg	Pb	Se
510356	TJAOU-16-SGCP-001	0–8	ND (0.291 J)	ND (3.31 J)	62.2 J	**1.22 J**	5.5 J	0.0133 J (0.10)	9.34 J	ND (5.49 J)
510356	TJAOU-16-SGMP-001	0–8	ND (0.291 J)	ND (3.31 J)	48.2 J	**1.1 J**	5.89 J	0.0137 J (0.10)	8.71 J	ND (5.49 J)
Background Soil Concentrations, Tijeras Supergroup (mg/kg)[d]			<1	5.6	281	<1	21.8	<0.25	39	<1

Note: Values in **bold** exceed the background soil concentrations.
[a]EPA November 1986.
[b]Analysis request/chain of custody record.
[c]The sample depth shown above represents the depth below the surface that DU-contaminated soil was excavated from the area of radiation anomalies 16E12/16E13/16E14 on the west side of Arroyo del Coyote (Figure 2.4.3–1).
[d]Dinwiddie September 1997.

EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
ID = Identification.
J = Estimated value, see data validation report (Annex 2-B).
# J ( ) = Estimated value less than the laboratory reporting limit, shown in parenthesis.
mg/kg = Milligram(s) per kilogram.
ND (# J) = Nondetect, uncertainty in the method detection limit, shown in parenthesis, see data validation report (Annex 2-B).
RCRA = Resource Conversation and Recovery Act.
SWMU = Solid Waste Management Unit.
TJAOU = Tijeras Arroyo Operable Unit.

Table 2.4.5-5
Summary of Isotopic Uranium, Isotopic Thorium, and Tritium Analytical Results for Samples from SWMU 16 Segmented Gate System Soil Piles, March 1998
(Off-Site Laboratory)

Sample Attributes			Activity (pCi/g)									
			Uranium-234		Uranium-235		Uranium-238		Thorium-232		Tritium (pCi/L)	
Record Number[a]	ER Sample ID	Sample Depth (ft)[b]	Result	Error[c]	Result	Error[c]	Result	Error[c]	Result	Error[c]	Result	Error[c]
510356	TJAOU-16-SGCP-001	0–8	0.71	0.3	0.1	0.0	**2.2**	0.47	0.72 J	0.19	--	--
510356	TJAOU-16-SGCP-004	0–8	--	--	--	--	--	--	--	--	261 J	132
510356	TJAOU-16-SGMP-001	0–8	0.95 J d	0.03	**0.27 J**	0.13	**8.9**	3.1	**1.2 J**	0.31	--	--
510356	TJAOU-16-SGMP-004	0–8	--	--	--	--	--	--	--	--	ND (208 J)	128
Background Activity, Surface Soil, Southwest Supergroup[d]			1.6	NA	0.16	NA	1.4	NA	1.01	NA	420[e]	NA

Note: Values in **bold** exceed the background soil activity.

[a]Analysis request/chain of custody record.

[b]The sample depth shown above represents the depth below the surface that DU-contaminated soil was excavated from the area of Anomalies 16E12/16E13/16E14 (Figure 2.4.3–1).

[c]Error is two standard deviations about the mean detected activity.

[d]Dinwiddie September 1997.

[e]Tharp February 1999.

–	= Indicates that no sample was collected, or a sample was collected but was not analyzed for the particular analyte.
EPA	= U.S. Environmental Protection Agency.
ER	= Environmental Restoration.
ft	= Foot (feet).
ID	= Identification.
J	= Estimated value, see data validation report (Annex 2-B).
NA	= Not applicable.
ND (#J)	= Nondetect, uncertainty in the method detection limit shown in parentheses, see data validation report (Annex 2-B).
pCi/g	= Picocurie(s) per gram.
pCi/L	= Picocurie(s) per liter.
TJAOU	= Tijeras Arroyo Operable Unit.
SWMU	= Solid Waste Management Unit .

Note: Soil pile waste characterization samples were analyzed for isotopic uranium and thorium using methods Mod. HASL 300.0 and CA-GLR-5.0R4, respectively. U-235 and 238 and Th-232 activity levels were also determined using gamma spectroscopy (EPA Method 901.1 [EPA November 1986]). The U-235, U-238, and Th-232 activities presented in this table reflect the most conservative (highest) of the two values for each of these radionuclides, unless an excessive error value invalidates the higher activity, in which case the lower activity with a realistic error value is reported. Tritium activities were determined using EPA Method 906.0 (EPA November 1986).

background concentration of less than 1 mg/kg. Two samples were collected and analyzed for isotopic uranium and thorium. The uranium-235 and thorium-232 activities in one of the two samples (ER Sample ID TJAOU-16-SGMP-001) and the uranium-238 activities in both samples (ER Sample IDs TJAOU-16-SGCP-001 and TJAOU-16-SGMP-001) were slightly above the maximum approved background level (Table 2.4.5-5). Two additional soil samples were also collected and analyzed for tritium. The tritium levels were found to be less than the maximum approved tritium background activity level in both samples (Table 2.4.5-5).

A RESRAD radiological risk assessment analysis (Miller October 1998) was performed using the highest concentrations and activities detected in the soil pile samples. The risk assessment indicated that the soil from the clean pile did not contain COC concentrations or radionuclide activities that would threaten human health or the environment. The soil was, therefore, returned to the site (Vigil February 1999).

2.4.5.6 Phase II VCM, Waste Generation and Disposal

A total of 110 drums of various types of waste were generated as a result of the Phase II VCM activities at SWMU 16. This section summarizes the waste types generated and the current status of the 110 drums of waste.

2.4.5.6.1 Waste Generated from Anomalies 16E6 and 16E7

A total of 42 drums of fire brick and asbestos were removed from these two anomaly areas. Two drums of PPE trash were also generated as part of this activity. All of this material is classified as radioactive/Toxic Substances Control Act waste, is currently stored at the Radioactive and Mixed Waste Management Facility (RMWMF), and will be disposed of at the Nevada Test Site (NTS).

2.4.5.6.2 Waste Generated from Anomaly 16E9

Two drums of crucible concrete, soil, and asbestos were removed from this anomaly. These drums are currently in storage at the RMWMF and will be shipped to the NTS along with the waste from Anomalies 16E6 and 16E7. Three drums of crucible concrete and soil were also removed from this anomaly; this material is nonregulated waste and is slated for disposal in the KAFB landfill.

2.4.5.6.3 Waste Generated from Anomaly 16E23

One drum of radioactive slag and concrete was generated as a result of the remediation activities at this anomaly. This drum of waste is currently in storage at the RMWMF and is slated for disposal at the NTS.

2.4.5.6.4 Waste Generated from Anomaly 16E22

A total of 54 drums of oil shale were removed from this anomaly. The oil shale was determined to contain only normal (naturally occurring) levels of radioactivity and is nonregulated. The material will be recycled and used as road bed material at various KAFB and SNL/NM locations.

2.4.5.6.5 *Waste Generated from Anomalies 16E12/16E13/16E14*

Five drums of DU and soil were generated from the SGS operation. The drums are currently in storage at SNL/NM's RMWMF and are awaiting shipment to the NTS for disposal. Four drums of PPE and trash was also generated during the SGS operation. This material is also currently stored at the RMWMF and is slated for disposal.

2.4.5.7 *Final Site Remediation and Reclamation*

The final site remediation activities began in July 1998 and were completed in October 1998. Final remediation included breaking up and removing all remaining concrete targets and general concrete debris at the site, stockpiling all scrap metal (including rebar removed from concrete), and stockpiling all trash (tires, plastic, vitrified clay pipe, asphalt, construction debris, etc.). NMED Surface Water Bureau personnel conducted a walkover of the site and identified all asphalt to be removed from SWMU 16. As a result, approximately 100 cubic yards of asphalt in or adjacent to the Arroyo del Coyote drainage channel was removed and disposed of at the KAFB landfill.

A total of approximately 2,000 cubic yards of concrete were generated during the final remediation at SWMU 16. All of this concrete was recycled for use as erosion control at various KAFB locations. A total of 400 cubic yards of general trash was removed and disposed of at the KAFB landfill, and approximately 500 cubic yards of scrap metal was sold to a scrap metal recycling company.

When the final remediation activities at SWMU 16 had been completed, reclamation of the site was begun. The site was regraded and restored to original conditions. Figure 2.4.5-4 is an aerial photograph taken on February 15, 1999, after all reclamation and regrading activities had been completed. As a final restoration measure, the site was reseeded with native grasses on April 12 and 13, 1999.

2.4.5.8 *Confirmatory Sampling*

SNL/NM, NMED/HRMB, and the NMED/DOE Oversight Bureau (OB) personnel met on October 30, 1998, to discuss confirmatory sampling requirements sufficient to demonstrate that COCs no longer remained at SWMU 16 following completion of the VCM activities. In accordance with these agreements, confirmatory samples were collected at the site on February 8, 1999, after the site had been regraded but prior to reseeding (McVey November 1998). Confirmatory samples were collected at the locations shown on Figure 2.4.5-5, as follows:

- All samples were collected from 0 to 6 inches bgs.
- All samples were analyzed for isotopic uranium (because of the DU at the site) and RCRA metals because of the large amount and variety of metal at SWMU 16. No VOC or SVOC samples were required because walkover surveys by SNL/NM, NMED/HRMB and NMED/DOE OB personnel failed to detect any evidence such as stained soil or leaking containers. This indicated that no organic COCs were present at the site.

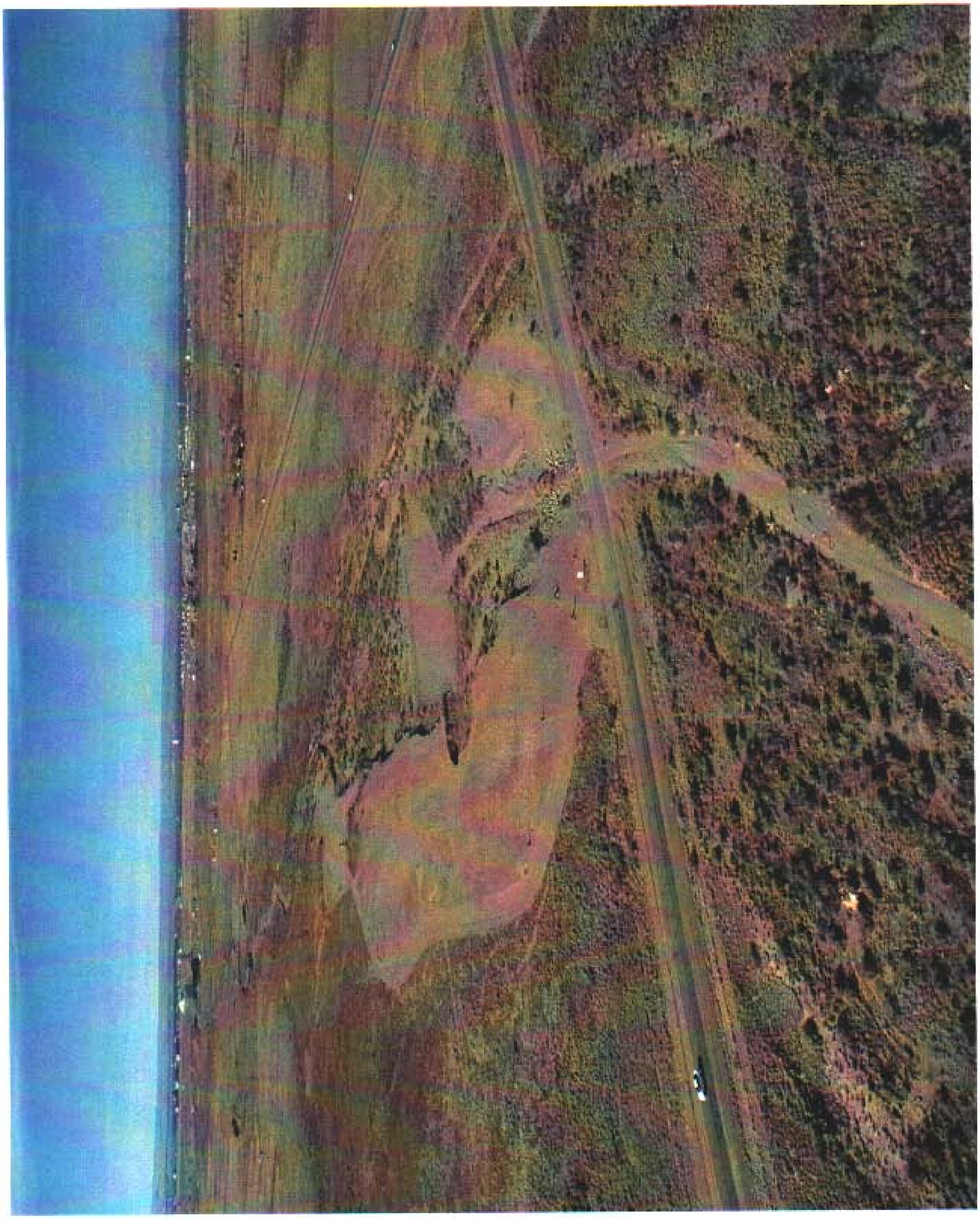

Figure 2.4.5-4 Aerial View of SWMU 16 After Remediation and Regrading Activities Were Completed. TA-III/V Access Road in Foreground. 2/15/99. View Looking Northwest.

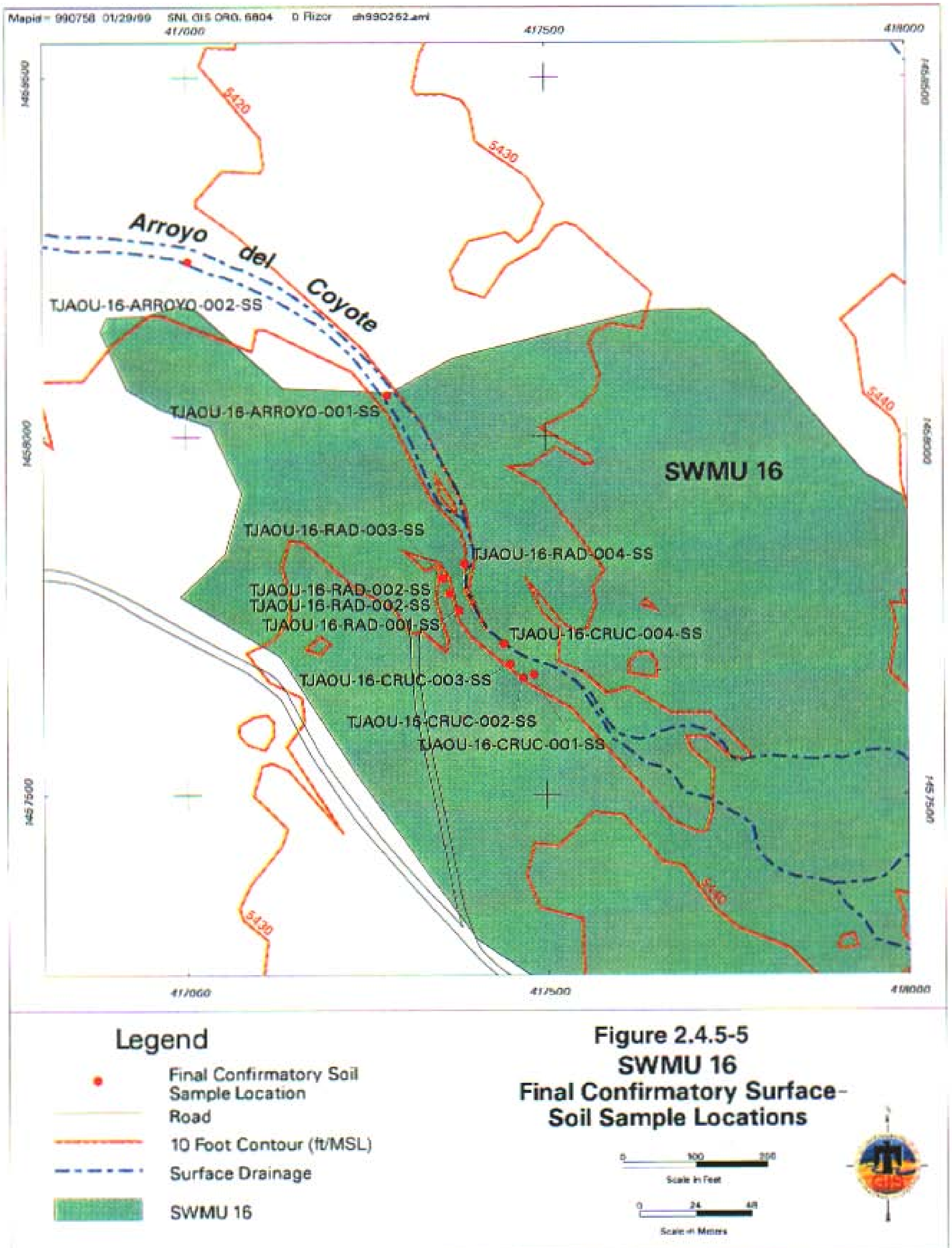

Figure 2.4.5-5
SWMU 16
Final Confirmatory Surface-Soil Sample Locations

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

- Five samples (TJAOU-16-RAD-001-SS through TJAOU-16-RAD-004-SS as well as the duplicate sample TJAOU-16-RAD-002-DU) were collected from the area of Anomalies 16E12, 16E13, and 16E14, where the SGS cleanup occurred. Four of the samples were collected from the excavated area on the west bank of Arroyo del Coyote, and the fifth was collected in the bottom of the drainage channel (Figure 2.4.5-5).

- Four samples (TJAOU-16-CRUC-001-SS through TJAOU-16-CRUC-004-SS) were collected from the crucible area (Anomalies 16E9 and 16E23) (Figure 2.4.5-5). Three of the samples were collected from the remediated area on the west bank of the arroyo, and the fourth was collected from the bottom of the drainage channel.

- Two soil samples (TJAOU-16-ARROYO-001-SS and TJAOU-16-ARROYO-002-SS) were collected from the bottom of the Arroyo del Coyote drainage downstream of Anomalies 16E12/16E13/16E14 to demonstrate that no COCs had been transported off site by occasional runoff in the drainage channel.

All of the confirmatory soil samples were analyzed off site by the General Engineering Laboratory (GEL), Charleston, South Carolina. The metals samples were analyzed using EPA SW-846 Method 7471 (EPA November 1986) for mercury and EPA Method 6010A (EPA November 1986) for the other seven metals. The isotopic uranium samples were analyzed using EPI Method A-011B. Quality assurance (QA)/quality control (QC) field samples collected as part of the confirmatory soil sampling event included two aqueous equipment blanks. One of the blanks was analyzed for RCRA metals using EPA SW-846 Methods 7470 for mercury and 6010A for the other seven metals. The second blank was analyzed for three isotopic uranium radionuclides using EPI Method A-011.

2.4.5.9 Data Gaps

Information gathered from process knowledge, site inspections, and personnel interviews aided in identifying the COCs for SWMU 16. The analytical data from confirmatory soil sampling are sufficient to determine whether significant COC concentrations or activities remained at or have migrated away from the site via Arroyo del Coyote.

2.4.5.10 Results and Conclusions

Tables 2.4.5-6 and 2.4.5-7, respectively, list the analytical results for the RCRA metals and isotopic uranium confirmatory soil and associated QA/QC samples collected at SWMU 16. Concentrations of the eight RCRA metals were less than their respective NMED/HRMB maximum approved background concentrations in all confirmatory samples collected from the site (Table 2.4.5-6). Activity levels for uranium-233/234 and uranium-235 were less than the respective maximum approved background activities in all confirmatory samples collected from SWMU 16 (Table 2.4.5-7). Gamma activity from uranium-238 was slightly above the maximum approved background activity (maximum of 2.33 pCi/g versus 1.4 pCi/g maximum approved background activity) in three of the eleven confirmatory samples collected at the site. These three samples included the TJAOU-16-RAD-002-SS/TJAOU-16-RAD-002-DU field and duplicate pair and TJAOU-16-RAD-003-SS, all from the remediated area of Anomalies 16E12/16E13/16E14 (Figure 2.4.5-5). The slightly elevated uranium-238 activities probably

Table 2.4.5-6
Summary of RCRA Metals Analytical Results for Confirmatory Sample from SWMU 16, February 1999
(Off-Site Laboratory)

Sample Attributes			RCRA Metals (EPA Method 6010/7471[a]) (mg/kg)							
Record Number[b]	ER Sample ID (Figure 2.4.5-5)	Sample Depth (ft)	Ag	As	Ba	Cd	Cr	Hg	Pb	Se
601587	TJAOU-16-CRUC-001-SS	0–0.5	ND (0.031)	2.13	57.7	ND (0.019)	8.47	ND (0.00225)	4.72	ND (0.135)
601587	TJAOU-16-CRUC-002-SS	0–0.5	ND (0.031)	1.21	31.2	ND (0.019)	6.08	ND (0.00225)	4.23	ND (0.135)
601587	TJAOU-16-CRUC-003-SS	0–0.5	ND (0.031)	1.51	48.8	ND (0.019)	17.6	ND (0.00225)	5.34	ND (0.135)
601587	TJAOU-16-CRUC-004-SS	0–0.5	ND (0.031)	3.25	50.3	ND (0.019)	6.32	ND (0.00225)	5.29	ND (0.135)
601587	TJAOU-16-RAD-001-SS	0–0.5	ND (0.031)	2.17	99.8	0.0733 J (0.485)	7.44	0.0124 J (0.0332)	7.03	ND (0.135)
601587	TJAOU-16-RAD-002-SS	0–0.5	ND (0.031)	3.56	82.9	ND (0.019)	9.49	0.00617 J (0.030)	11.6	ND (0.135)
601587	TJAOU-16-RAD-002-DU	0–0.5	ND (0.031)	1.70	49.3	ND (0.019)	6.84	ND (0.00225)	4.52	ND (0.135)
601587	TJAOU-16-RAD-003-SS	0–0.5	ND (0.031)	2.78	72.7	ND (0.019)	10.7	0.00809 J (0.0313)	6.02	ND (0.135)
601587	TJAOU-16-RAD-004-SS	0–0.5	ND (0.031)	2.74	91.4	ND (0.019)	11.6	0.00512 J (0.0324)	8.63	ND (0.135)
601587	TJAOU-16-ARROYO-001-SS	0–0.5	ND (0.031)	1.87	59.5	ND (0.019)	6.89	ND (0.00225)	6.25	ND (0.135)
601587	TJAOU-16-ARROYO-002-SS	0–0.5	ND (0.031)	2.37	81.5	0.193 J (0.481)	7.08	ND (0.00225)	5.91	ND (0.135)
Quality Assurance/Quality Control Sample (mg/L)										
601587	TJAOU-16-EB-001	NA	ND (0.00073)	ND (0.00451)	0.00337 J	ND (0.00044)	0.00104 J	ND (0.000035)	ND (0.00159)	ND (0.00271)
Background Soil Concentrations, Tijeras Supergroup (mg/kg)[c]			<1	5.6	281	<1	21.8	<0.25	39	<1

[a]EPA November 1986.
[b]Analysis request/chain of custody record.
[c]Dinwiddie September 1997.

J () = Estimated value less than the laboratory reporting limit, shown in parentheses.
CRUC = Crucible.
DU = Duplicate.
EB = Equipment blank.
ER = Environmental Restoration.
ft = Foot (feet).
ID = Identification.
mg/kg = Milligram(s) per kilogram.
mg/L = Milligram(s) per liter.
J = Analyte concentration is less than the reporting limit but greater than or equal to method detection limit.
NA = Not applicable.
ND () = Not detected at or above the method detection limit, shown in parentheses.
RAD = Radiological anomaly.
RCRA = Resource Conservation and Recovery Act.
SS = Surface soil.
TJAOU = Tijeras Arroyo Operable Unit.

Table 2.4.5-7
Summary of Isotopic Uranium Analytical Results for Confirmatory Samples from SWMU 16, February 1999
(Off-Site Laboratory)

Sample Attributes			Isotopic Uranium Activity (EPI Method A-001B) (pCi/g)					
			Uranium-233/234		Uranium-235		Uranium-238	
Record Number[a]	ER Sample ID (Figure 2.4.5-5)	Sample Depth (ft)	Result	Error[b]	Result	Error[b]	Result	Error[b]
601587	TJAOU-16-CRUC-001-SS	0–0.5	1.04	0.167	0.0544	0.033	0.985	0.162
601587	TJAOU-16-CRUC-002-SS	0–0.5	0.624	0.116	ND (0.0142)	0.0221	0.648	0.117
601587	TJAOU-16-CRUC-003-SS	0–0.5	0.733	0.126	0.0195	0.0243	0.794	0.133
601587	TJAOU-16-CRUC-004-SS	0–0.5	0.840	0.139	0.0498	0.0311	1.22	0.181
601587	TJAOU-16-RAD-001-SS	0–0.5	0.435	0.0924	0.0335	0.0226	0.771	0.129
601587	TJAOU-16-RAD-002-SS	0–0.5	0.882	0.161	0.0887	0.045	**1.98**	0.276
601587	TJAOU-16-RAD-002-DU	0–0.5	0.916	0.163	0.0863	0.0427	**2.33**	0.31
601587	TJAOU-16-RAD-003-SS	0–0.5	0.792	0.143	0.0903	0.0442	0.941	0.159
601587	TJAOU-16-RAD-004-SS	0–0.5	0.946	0.158	0.0541	0.0316	**2.00**	0.266
601587	TJAOU-16-ARROYO-001-SS	0–0.5	0.488	0.107	0.0354	0.0298	0.469	0.106
601587	TJAOU-16-ARROYO-002-SS	0–0.5	0.722	0.142	0.0263	0.0237	0.702	0.14
Quality Assurance/Quality Control Sample (pCi/L)								
601587	TJAOU-16-EB-001 (aqueous EB)	NA	ND (0.0282)	0.0357	ND (0.0262)	0.0355	0.0868	0.0523
Background Soil Activity, Southwest Supergroup[c]			1.6	NA	0.16	NA	1.4	NA

NOTE: Values in **bold** exceed the background activity.
[a]Analysis request/chain of custody record.
[b]Error is two standard deviations about the mean detected activity.
[c]Dinwiddie September 1997.

CRUC = Crucible.
DU = Duplicate.
EB = Equipment blank.
EPI = Environmental Physics, Inc.
ER = Environmental Restoration.
ft = Foot (feet).
ID = Identification.
NA = Not applicable or not available.
ND ( ) = Not detected at or above the minimum detectable activity, shown in parentheses.
pCi/g = Picocurie(s) per gram.
pCi/L = Picocurie(s) per liter.
RAD = Radiological anomaly.
SS = Surface soil.
TJAOU = Tijeras Arroyo Operable Unit.
SWMU = Solid Waste Management Unit .

reflect residual traces of DU that were previously present at this location; they may also reflect the granitic alluvium in the area.

2.4.5.11 QA/QC Results

Data quality was assessed by reviewing the field QA/QC results and validating the laboratory QA/QC results for all analyses. This section summarizes the data quality assessment.

Tables 2.4.5-6 and 2.4.5-7 show the analytical results for the RCRA metals and isotopic uranium QA/QC samples collected during confirmatory sampling at SWMU 16. QA/QC samples consisted of two equipment blanks analyzed off site by GEL for RCRA metals and isotopic uranium. Trace concentrations of barium (at 0.00337 J mg/liter [L]) and chromium (at 0.00104 J mg/L) were detected; none of the other six RCRA metals were detected in the samples. Uranium-238 was detected in the isotopic uranium blank at 0.0868 pCi/L; uranium-235 and uranium 233/234 were not detected in the sample.

Two duplicate samples were collected as part of the confirmatory sampling effort at SWMU 16 and were analyzed by GEL for RCRA metals and isotopic uranium. The duplicate sample (TJAOU-16-RAD-002-DU) contained lower concentrations of RCRA metals compared to concentrations detected in the primary sample (TJAOU-16-RAD-002-SS). This variability is most likely caused by the inherent heterogeneity of soil at SNL/NM and reflects the difference between the primary and duplicate soil sample aliquots used in the analyses. The activity levels of the three isotopic uranium radionuclides detected in the duplicate sample were comparable to and in good agreement with those detected in the equivalent primary sample (TJAOU-16-RAD-002-SS).

Relative percent differences (RPD) were calculated for the RCRA metals detected in the primary and duplicate samples, both of which were analyzed by GEL. The RCRA metals analyses for the sample pair yielded RPDs that exceeded the acceptable RPD limit of less than 25 percent (Table 2.4.5-8). However, the metals concentrations in all confirmatory samples collected from the site were less than the respective maximum approved background concentrations for those metals. Although the RPDs presented in Table 2.4.5-8 exceed the RPD limit, they are typical of the heterogeneous uncontaminated soil at SNL/NM and are, therefore, acceptable.

Data Validation

All off-site laboratory results were reviewed and verified/validated according to SNL/NM (July 1994). The verification/validation process confirmed that the data are acceptable for use in this NFA proposal for SWMU 16. However, the majority of the organic, metals, and radiological analytical results for the SGS cold pile samples were qualified estimated values during the data validation process. Reasons for the uncertainty included a lack of matrix interference and internal standard recovery data and a lack of RPD and duplicate information. None of the confirmatory soil sample analytical data required qualification. The results of the data validation performed for SGS and confirmatory samples collected from SWMU 16 are presented in Annex 2-B.

Table 2.4.5-8
Summary of SWMU 16 Field-Duplicate Relative Percent Differences

Sample Attributes		Relative Percent Differences							
Record Number[a]	ER Sample ID	Arsenic	Barium	Cadmium	Chromium	Lead	Mercury	Selenium	Silver
601587	TJAOU-16-RAD-002-SS, TJAOU-16-RAD-002-DU	70.7	50.8	NC	32.4	87.8	NC	NC	NC

[a]Analysis request/chain of custody record.

DU = Duplicate.
ER = Environmental Restoration.
ID = Identification.
NC = Not calculated for estimated values or nondetect results.
RAD = Radiological anomaly.
SS = Surface soil.
SWMU = Solid Waste Management Unit.
TJAOU = Tijeras Arroyo Operable Unit.

2.5 Site Conceptual Model

The site conceptual model for SWMU 16 is based upon the residual COCs identified in soil samples following a radiological VCM. Residual COCs identified in samples from soil piles generated during VCM remediation activities also contributed to the site conceptual model for SWMU 16. This section summarizes the nature and extent of contamination and the environmental fate of COCs.

2.5.1 Nature and Extent of Contamination

The COCs at SWMU 16 are metals and radionuclides associated with the open dumping of debris along the Arroyo del Coyote northeast of TA-III and TA-V. No SVOC compounds were detected at SWMU 16. A trace estimated concentration of one VOC was detected in one sample. Because background concentrations for VOCs are not applicable, any detectable VOCs are considered potential contamination. Metal and radionuclide COCs were determined by comparing sample results to background concentrations and activities that had been established for the surface soils in the Tijeras Supergroup and Southwest Supergroup areas (Dinwiddie September 1997). Metals or radionuclides were considered potential COCs for the site. Consequently, potential metal COCs included arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. The potential radiological COCs included thorium-232, uranium-234, uranium-235, uranium-238, and tritium. Table 2.5.1-1 includes summaries of analytical results for the COCs for SWMU 16.

Eleven confirmatory soil samples (including one duplicate sample) were collected both from the areas of radiological anomalies (16E9 and 16E23, and 16E12/16E13/16E14) and in the bottom of the Arroyo del Coyote drainage downstream from radiological anomalies 16E12/16E13/16E14. Additionally, two samples were collected from the SGS soil piles. In most cases, the COCs are only slightly elevated above background concentrations or activity limits specified for SWMU 16 (the Tijeras Supergroup, in the case of metals and Southwest Supergroup, for radionuclides). The COCs that exceed background were mostly from the

Table 2.5.1-1
Summary of Results for COCs at SWMU 16

COC Type	Number of Samples	COCs Greater than Background	Maximum Background Limit/Tijeras Supergroup[a] (mg/kg except where noted)	Maximum Concentration or Activity (mg/kg except where noted)	Average Concentration or Activity[b] (mg/kg except where noted)	Sampling Locations Where Background Concentration or Activity is Exceeded[c]
Metals	13 environmental	Arsenic	5.6	3.56	2.45	None
		Barium	281	99.8	64.3	None
		Cadmium	<1	1.22 J	0.19	TJAOU-16-SGCP-001 TJAOU-16-SGMP-001
		Chromium	21.8	17.6	8.45	None
		Lead	39	11.6	6.74	None
		Mercury	<0.25	0.0137 J	0.0022	None
		Selenium	<1	ND (5.49 J)	0.96	TJAOU-16-SGCP-001 TJAOU-16-SGMP-001
		Silver	<1	ND (0.29 J)	0.07	None
Volatile Organic Compounds	4 environmental	Methylene chloride	NA	1.1 J (5)	1.8	TJAOU-16-SGMP-003
Radionuclides	13 environmental	Uranium-233/234	1.6 pCi/g	1.04 pCi/g	0.78 pCi/g	None
		Uranium-235	0.16 pCi/g	0.27 J pCi/g	0.07 pCi/g	TJAOU-16-SGMP-001
		Uranium-238	1.4 pCi/g	8.9 pCi/g	1.84 pCi/g	TJAOU-16-RAD-002-SS TJAOU-16-RAD-002-DU TJAOU-16-RAD-004-SS TJAOU-16-SGCP-001 TJAOU-16-SGMP-001
		Thorium-232	1.01 pCi/g	1.2 J pCi/g	0.96 pCi/g	TJAOU-16-SGMP-001
		Tritium	420[d] pCi/L	261 J pCi/L	232 J pCi/L	None

Note that Southwest Supergroup is used for radionuclides.
[a]Dinwiddie September 1997.
[b]Average concentration includes all samples and duplicates. For nondetectable results for nonradiological COCs, one-half the method detection limit is used in the average calculation. For radiological COCs, a nondetectable result is not included in the average calculation.
[c]Includes samples with nondetect results where the MDL or MDA exceeds the approved background limit.
[d]Tharp February 1999.
COC = Constituent of concern.

J = The reported value is an estimated concentration between the MDL and the reporting limit, or is an estimated value (see data validation report, Annex 2-B).
MDA = Minimum detectable activity.
MDL = Minimum detection limit.
mg/kg = Milligram(s) per kilogram.
NA = Not applicable.
ND ( ) = Not detected at or above the MDL or MDA, shown in parenthesis.
pCi/g = Picocurie(s) per gram.
pCi/L = Picocurie(s) per liter.
SWMU = Solid Waste Management Unit.
TJAOU = Tijeras Arroyo Operable Unit.

SGS soil piles, although slightly elevated U-238 radionuclide activities were also found in 3 of the 11 confirmatory samples. A trace concentration (1.1 J µg/kg) of only one VOC (methylene chloride) was detected in one of the two SGS soil pile samples, and no SVOCs were identified in the other two samples (Table 2.4.5-1). This analytical information served as additional confirmation that significant concentrations of organic COCs were not present at SWMU 16.

Cadmium concentrations were slightly above the maximum approved background concentrations in both of the SGS soil pile samples (Table 2.4.5-4). Selenium was not detected in the two samples, but the laboratory method detection limit for selenium (5.49 mg/kg) was greater than the maximum approved background concentration (<1) for selenium. The slightly elevated cadmium concentrations may be a result of abundant scrap metal that was deposited at the site. As shown in Table 2.4.5-6, RCRA metals concentrations in all 11 confirmatory soil samples were detected at less than their respective maximum approved background soil concentrations.

Activities for uranium-235, uranium-238, and thorium-232 were slightly above their respective maximum approved background activity levels in one or both of the SGS soil samples (Table 2.4.5-5). Table 2.4.5-7 shows that uranium-233/234 and uranium-235 activities were less than their respective maximum approved background activity levels in all 11 confirmatory soil samples. Uranium-238 activities were slightly above the maximum approved background activity for uranium-238 in 3 of the 11 confirmatory soil samples. All three of these samples, as well as the SGS samples consisted of soil collected from the area of former anomalies 16E12, 16E13, and 16E14 (Figure 2.4.3-1). This was the only area within SWMU 16 where visible fragments of DU (up to approximately 1 inch across) were found. It is believed that the slightly elevated radionuclide activities detected in these samples reflect residual traces of the DU that was dumped in this area.

2.5.2 Environmental Fate

The primary source of COCs for SWMU 16 was the surface disposal of debris along Arroyo del Coyote northeast of TA-III and TA-V. The primary COC release mechanism to the surface (and subsurface) soils is loss of containment from degradation of debris that could have occurred prior to its removal as a result of the VCM activities conducted at the site.

After the removal of metal debris and DU sources, possible secondary release mechanisms include suspension and/or dissolution of trace levels of residual COCs in surface-water runoff and percolation to the vadose zone, direct contact with soil (radionuclides only), dust emissions, and uptake of COCs in the soil by biota (Figure 2.5.2-1). The depth to groundwater at the site (at approximately 505 feet bgs) precludes migration of residual COCs to the aquifer. The pathways to receptors are soil ingestion, inhalation, and direct exposure (radionuclides). Plant uptake was also considered as a pathway for the residential scenario only. Annex 2-C provides additional discussion of the fate and transport of COCs at SWMU 16.

Table 2.5.1-1 summarizes materials originally considered as potential COCs for SWMU 16. Based on the nature and extent of contamination at the site (see Section 2.5.1), metal and VOC COCs occurred only in the soil piles generated during VCM activities, and radionuclide COCs were limited to the SGS soil piles and the remediated area of radiological anomalies 16E12/16E13/16E14. All actual COCs were retained in the conceptual model and were evaluated in the human health and ecological risk assessments.

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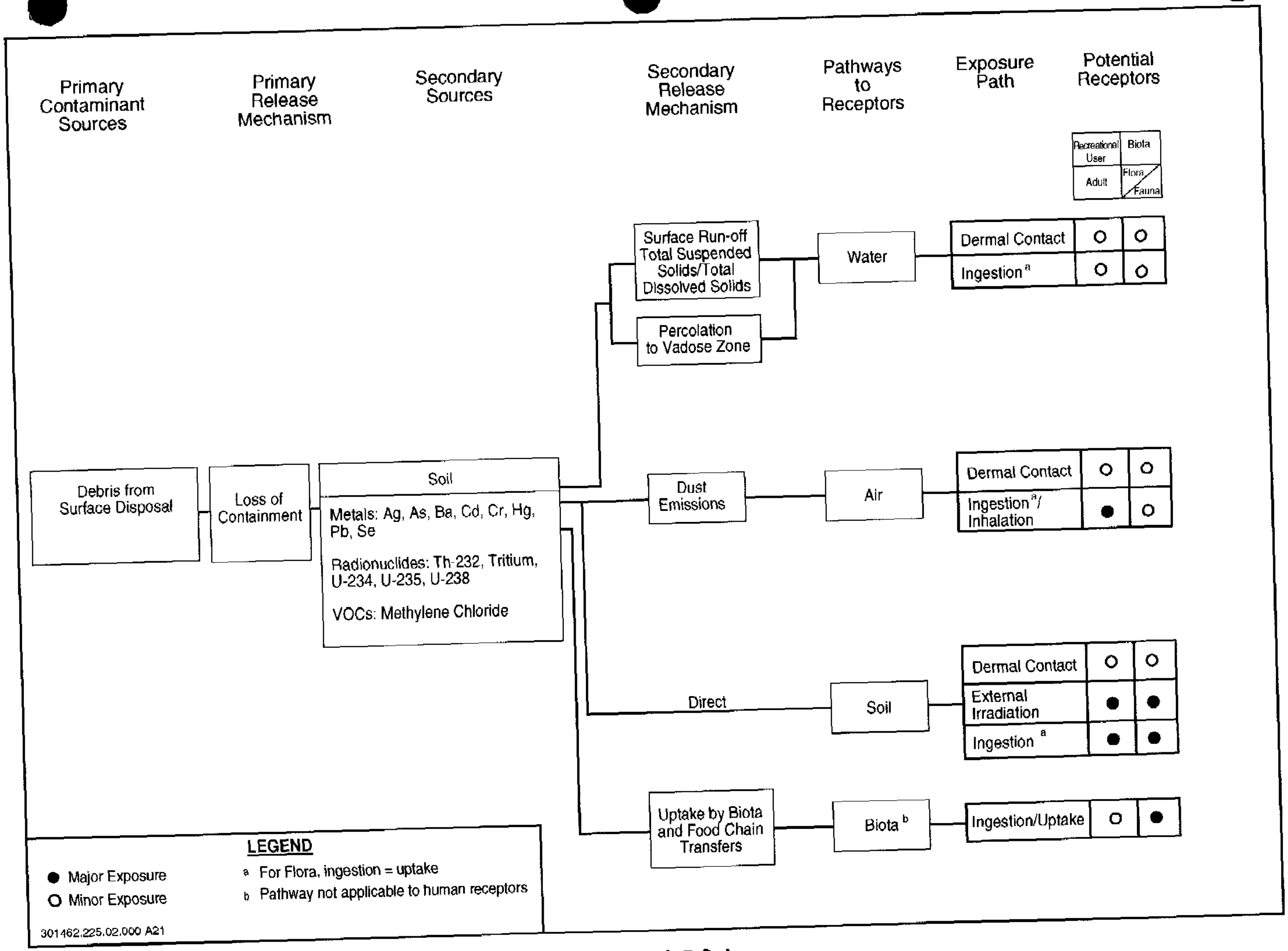

Figure 2.5.2-1
Conceptual Model Flow Diagram for SWMU 16, Open Dumps (Arroyo del Coyote)

The current and future land use for SWMU 16 is recreational (DOE and USAF January 1996). Therefore, 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. Major exposure routes modeled in the human health risk assessment include soil ingestion for nonradiological COCs and direct gamma exposure for the radiological COCs. The inhalation pathway for both nonradiological and radiological COCs is also 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. Only soil ingestion is considered a primary contributor to exposure for the recreational user.

Potential biota receptors include flora and fauna at the site. Direct soil ingestion is considered a major exposure route for biota, in addition to ingesting COCs through food-chain transfers, the direct contact with COCs in soil, and direct gamma exposure from radiological COCs.

Section V, Annex 2-C, provides additional discussion of the exposure routes and receptors at SWMU 16.

2.6 Site Assessments

Site assessment at SWMU 16 includes risk screening assessments followed by risk baseline assessments (as required) for both human health and ecological risk. This section briefly summarizes the site-assessment results. Annex 2-C provides details of the site assessment.

2.6.1 Summary

The site assessment concludes that SWMU 16 has no significant 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 16 were found to be very low. Section 2.6.2 briefly describes, and Annex 2-C provides details of, the site assessments.

2.6.2 Screening Assessments

Risk screening assessments were performed for both human health risk and ecological risk for SWMU 16. This section briefly summarizes the risk screening assessment results.

2.6.2.1 Human Health

SWMU 16 has been recommended for recreational land-use (DOE and USAF January 1996). A complete discussion of the risk assessment process, results, and uncertainties is provided in Annex 2-C. Because of the presence of COCs in concentrations or activities greater than background levels, it was necessary to perform a health risk analysis for the site. Besides COC metals, any VOCs detected above their reporting limits and any radionuclide COCs detected above either background levels and/or minimum detectable activities were included in this assessment. The risk-assessment process provides a quantitative evaluation of the potential adverse human health effects caused by constituents in the site's soil. The Risk Screening Assessment Report calculated the hazard index (HI) and excess cancer risk for both a recreational and a residential 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 16 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 the risk associated with background levels from potential nonradiological COC risk. The incremental HI is also 0.00.

The total excess cancer risk for SWMU 16 nonradiological COCs is 4E-11 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 total excess cancer risk from nonradiological COCs for this site is well below the suggested acceptable risk value (1E-6). The nonradiological incremental excess cancer risk for SWMU 16 is 3.5E-11.

The incremental total effective dose equivalent (TEDE) for radionuclides for a recreational land use setting for SWMU 16 is 0.09 millirem (mrem) per year (yr), which is well below EPA's numerical guideline 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 1998). The incremental excess cancer risk for radionuclides is 1.5E-6 for a recreational land use scenario, which is much less than risk values calculated from naturally occurring radiation and from intakes considered background activity levels.

The residential land use scenarios for this site are provided only for comparison in the Risk Screening Assessment Report (Annex 2-C).

2.6.2.2 Ecological

An ecological screening assessment that corresponds with the screening procedures in the EPA's Ecological Risk Assessment Guidance for Superfund (EPA 1997) was performed as set forth by NMED Risk-Based Decision Tree (NMED March 1998). An early step in the evaluation is comparing COC concentrations and identifying potentially bioaccumulative constituents (see Sections V, VII.2, and VII.3, Annex 2-C). This methodology also requires that a site conceptual model and a food web model be developed and that ecological receptors be selected. 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.

Annex 2-C presents the results of the ecological risk assessment screen. Site-specific information was incorporated into the screening assessment when such data were available. Hazard quotients less than one were predicted for all COCs except selenium. A closer examination of the exposure assumptions revealed an overestimation of risk primarily attributable to the exposure concentration used for selenium, which was not detected in the soil samples from SWMU 16; risk was evaluated using one-half the highest detection limit, which probably overestimates the actual mean concentration of selenium in the soils at this site. Other uncertainties that contribute to the overestimation of risk include exposure setting (area use factors of one were assumed). Based upon an evaluation of these uncertainties, ecological risks associated with this site are expected to be very low.

2.6.3 Baseline Risk Assessments

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

2.6.3.1 Human Health

Human health results of the screening assessment summarized in Section 2.6.2.1 indicate that SWMU 16 does not have the potential to affect human health under a recreational land use setting. Therefore, a baseline human-health risk assessment is not required for SWMU 16.

2.6.3.2 Ecological

Ecological results of the screening assessment summarized in Section 2.6.2.2 indicate that SWMU 16 has very low ecological risk. Therefore, a baseline ecological risk assessment is not required for SWMU 16.

2.6.4 Other Applicable Assessments

No other applicable assessments have been conducted at SWMU 16.

2.6.4.1 Groundwater

No water pathways to the groundwater were considered in the SWMU 16 Risk Screening Assessment. Depth to groundwater beneath the site is approximately 505 feet bgs.

2.7 No Further Action Proposal

SWMU 16 is proposed for an NFA decision based upon all the supporting information contained in this chapter. This section provides the rationale and criterion for the NFA proposal.

2.7.1 Rationale

Based upon field investigation data and the human health-risk assessment analysis, an NFA is recommended for SWMU 16 for the following reason: No COCs (metals, radionuclides, or VOCs) are present or remain at the site in concentrations or activity levels considered hazardous to human health for a recreational land-use scenario.

2.7.2 Criterion

Based upon the evidence provided above, SWMU 16 is proposed for an NFA decision in conformance with Criterion 5 (NMED March 1998), which states that "the SWMU/AOC 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."

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ANNEX 2-C
Risk Screening Assessment

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SWMU 16: RISK SCREENING ASSESSMENT REPORT

I. Site Description and History

Solid Waste Management Unit (SWMU) 16 is located in the central portion of Kirtland Air Force Base (KAFB) between Technical Area (TA) V and the horse stables on Pennsylvania Avenue. It is reached by traveling southeast on Pennsylvania Boulevard and then southwest approximately 0.15 mile on the TA-III/V access road. SWMU 16 lies northwest of the TA-III/TA-V access road and is bisected by and located adjacent to Arroyo del Coyote. Encompassing approximately 28 acres of undeveloped land that slopes gently downward to the northwest, the site lies at an average elevation of 5,440 feet above mean sea level (amsl). Access to this inactive site is uncontrolled.

The surficial sediments at SWMU 16 consist of modern to Holocene-age stream channel and fluvial terrace deposits (silt to boulder-sized material) in and directly adjacent to the Arroyo del Coyote. Arroyo del Coyote sediments are deposited within older (late Pleistocene) alluvial fan deposits (SNL/NM December 1995)

Arroyo del Coyote drains a large part of the eastern part of KAFB and eventually flows into Tijeras Arroyo. However, surface-water flow in Arroyo del Coyote occurs only several times per year. The average rainfall at the City of Albuquerque airport is 8.1 inches per year (NOAA 1990). The regional water table elevation was projected to be approximately 4,935 feet amsl beneath SWMU 16 in January 1999. This equates to a groundwater depth beneath the site of approximately 505 feet below ground surface (bgs). Regional groundwater flows in a generally westerly to northwesterly direction in the vicinity of the site (SNL/NM March 1999). The nearest monitoring wells are AVN-1 and AVN-2, which lie approximately 0.5 mile southwest of SWMU 16. The depth to water in AVN-2, which was completed at the regional aquifer water table, was 507 feet bgs in July 1998 (SNL/NM March 1999). The nearest production wells are northwest of SWMU 16 and include KAFB-1, 2, 4, 7, and 11, which range from approximately 2.5 miles (KAFB-4) to 3.6 miles (KAFB-2) away from the site (SNL/NM August 1996).

SWMU 16 was used as an uncontrolled trash dump and gravel quarry from the late 1950s to the late 1980s. A portion of the site was used as a sand and gravel quarry in the early to mid-1970s. Debris from Sandia National Laboratories/New Mexico (SNL/NM) research activities began to appear at the site in the late 1960s, and this type of dumping continued until the late 1980s. Figure 2.2.2-1 shows the primary quarrying, soil disturbance, and debris area locations.

Interviews with SNL/NM personnel familiar with the historical activities at the site and with the research activities that produced the debris as well as ER Project site inspections indicate that the following types of materials were dumped at SWMU 16:

- Construction demolition debris from facilities such as Building 9939 (the Large Melt Facility) and the TA-III Short and Long Sled Tracks at which depleted uranium (DU) was known to have been used
- Concrete slabs (targets, and sled track bases and supports)

- Research debris (concrete targets, rocket motors, thermocouple wires)
- Large concrete crucibles used in meltdown experiments (Building 9939)
- Fiberglass-wrapped, yellow castable ceramic crucibles
- Two piles of fire bricks coated with asbestos
- A large pile of oil shale and slag (dumped between 1983 and 1985)
- A large charcoal filter
- Potting compounds (inert materials such as epoxies and plastic foams)
- A parachute
- Spent rocket motors
- Pink mock high explosive pieces
- Construction debris (foam insulation, empty paint and drums, electrical wire, floor tile, vitrified clay sewer pipe, scrap wood, rebar, cinder block, Transite sheets and piping, fencing)
- Friable asbestos
- Spent smoke canisters
- A concrete septic tank
- Concrete ballast blocks
- Concrete rubble from parking lot demolition
- Asphalt
- Scrap metal (fence posts, pipe, stainless and mild steel tubes, rebar, sheet metal, wire, steel cables)
- Metal slag (iron steel, bronze)
- Clean soil piles originating from excavations at TA-V.

Process knowledge consisted primarily of interviews with current and former SNL/NM personnel. The debris at SWMU 16 came from a variety of SNL/NM facilities including the Large Melt Facility (Building 9939), TA-III sled tracks, Thunder Range, and TA-III drop tower facility. The Figure 2.2.2-2 photographs show some of the types of debris and the condition of the site prior to remediation. The photos show primarily large blocks of concrete rubble from the TA-III long sled track that were dumped directly in the Arroyo del Coyote channel.

SWMU 16 was designated a radioactive material management area (RMMA) in 1990. The site has been approved by the U.S. Department of Energy (DOE) for unrestricted radiological release and was removed from the SNL/NM RMMA tracking program on February 12, 1999 (SNL/NM February 1999).

II. Data Quality Objectives

The confirmatory sampling conducted at SWMU 16 was designed to achieve the following goals:

- Demonstrate that the voluntary corrective measure (VCM) activities conducted at SWMU 16 were adequate and left no significant contamination that remained at the site
- Demonstrate that constituents of concern (COCs) (DU and Resource Conservation and Recovery Act [RCRA] metals) do not remain and are not migrating from the site by means of Arroyo del Coyote
- Provide analytical data of sufficient quality to support risk screening assessments.

Table 1 summarizes the sample location plan for SWMU 16. The sources of potential hazardous or radiological COCs at SWMU 16 were the various areas containing piles of trash and debris at this former uncontrolled dump site. The number and location of the confirmatory samples collected at SWMU 16 were based upon historical information, the findings of previous site investigations, visual inspections, and VCM activities conducted at the site. Confirmatory sample quantities and locations were also selected in accordance with discussions and agreement between SNL/NM and New Mexico Environment Department (NMED) personnel.

Table 2 summarizes the analytical methods and data quality requirements necessary to (1) adequately determine whether significant amounts of hazardous or radiological COCs remain at the site following completion of VCM activities, and (2) support risk screening assessments.

Confirmatory samples at SWMU 16 were collected from a total of 10 locations (see Figure 2.4.5-5, no further action [NFA] proposal) and were analyzed by an off-site laboratory (General Engineering Laboratories [GEL]). All confirmatory samples were analyzed for the eight RCRA-listed metals and for isotopic uranium.

Off-site laboratory results for the confirmatory samples collected from this site were reviewed and verified/validated according to SNL/NM (July 1994). These reviews confirmed that the data are acceptable for use in the NFA proposal for SWMU 16.

Table 1
Summary of Sampling Performed to Meet Data Quality Objectives

SWMU 16 Sampling Components	Potential COC Source	Number of Sampling Locations	Sample Density	Sampling Location Rationale
RMMA area (Anomalies 16E12, 16E13, and 16E14 on Figure 2.4.3-1 of the NFA report)	Anomalies 16E12, 16E13, and 16E14, contained a large amount of concrete rubble and debris, and DU fragments and DU-contaminated soil	4	Approximately 1 sample per 2.8 acres. Surface samples collected at four locations on the west bank of, and in the Arroyo del Coyote drainage channel.	Samples were collected at locations where the greatest amount of debris and/or DU contamination were located prior to remediation
Crucible area (anomaly areas 16E9 and 16E23 on Figure 2.4.3-1)	Anomaly areas 16E9, 16E23, which contained large concrete blocks, and crucibles (some with residual slightly radioactive slag) from melting experiments	4	Approximately 1 sample per 2.8 acres. Same as above	Same as above
Arroyo del Coyote drainage channel downstream of dump and debris areas, and outside of SWMU boundaries	Upstream debris, trash, and DU-contaminated areas within SWMU 16 boundaries	2	Approximately 1 sample per 2.8 acres. Surface samples collected at two locations in the Arroyo del Coyote drainage channel downstream from the SWMU 16 debris areas.	Sampling locations were judged adequate to determine if COCs were, or were not exiting the site.

COC = Constituent of concern.
DU = Depleted uranium.
NFA = no further action.
RCRA = Resource Conversation and Recovery Act.
RMMA = Radiological Materials Management Area.
SWMU = Solid Waste Management Unit.

Table 2
Summary of Data Quality Requirements

Analytical Requirement	Data Quality Level	General Engineering Laboratory, Inc. Charleston, SC
RCRA metals EPA Method 6010/7000[a]	Level 3	11 samples
Isotopic uranium Method EPI A-001B	Level 3	11 samples

[a]EPA November 1986.
EPA = U.S. Environmental Protection Agency.
EPI = Environmental Physics Inc.
RCRA = Resource Conversation and Recovery Act.

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

III.1 Introduction

The determination of the nature, rate, and extent of contamination at SWMU 16 was based upon historical information, personnel interviews, visual site inspections, radiological surveys, findings from other site investigations and VCM activities conducted at the site. The quality of the data specifically used to determine the nature, rate, and extent of contamination is described below.

III.2 Nature of Contamination

The nature of contamination at SWMU 16 was determined primarily through visual inspection of the types of trash and debris deposited at the site and through radiological surveys. Visual inspections indicated that the great majority of the waste dumped at SWMU 16 consisted of nonhazardous trash, concrete, scrap metal, and other construction and testing-related debris. The nature of the contamination at the site was also determined through analytical testing of soil media. The analytical requirements for the Segmented Gate System (SGS) soil pile characterization samples (see Section 2.4.5.5, NFA proposal) included volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), RCRA metals, and radionuclides (isotopic uranium and thorium, other radionuclides determined by gamma spectroscopy, and tritium). These samples were collected to characterize constituents potentially released in the area of anomalies 16E12/16E13/16E14 (Figure 2.4.3-1), where the SGS cleanup operation occurred. VOCs and SVOCs were not detected in the SGS samples, and there was no historical and site investigation evidence indicating that a significant amount of organic COCs had been released at the site. SNL/NM and NMED personnel, therefore, concluded and agreed that for purposes of confirmatory sampling, only analyses of RCRA metals and isotopic uranium (from the large amount of metal and DU present at the site) would be required.

III.3 Rate of Contaminant Migration

All trash, construction debris, and potential COC sources at SWMU 16 have been removed and eliminated as a result of the VCM activities conducted at the site. The primary migration mechanism for transporting COCs away from the site was surface water, which on occasion flows through the site via the drainage channel during heavy precipitation events. Confirmatory soil samples collected in the Arroyo del Coyote drainage channel both within the site boundaries and downstream of the site are sufficient to demonstrate that significant concentrations or activity levels of COCs have not migrated from the site via this surface-water drainage channel.

III.4 Extent of Contamination

The area and extent of potential contamination at SWMU 16 was clearly defined by the locations of the trash and debris piles, disturbed areas, etc. All of these potential COC sources were cleaned up and remediated as a result of the VCM activities conducted at the site. After the remediation of the site had been completed, nine confirmatory surface soil samples were collected from selected remediated debris areas within SWMU 16 that were believed to have had the greatest potential to contribute significant COCs to the environment. To verify that significant levels of COCs had not been transported away from the site, two confirmatory samples were also collected in the drainage channel itself, one at the site boundary and one downstream. The confirmatory sample locations selected for this site were deemed appropriate by both SNL/NM and NMED personnel to determine the potential extent of COC migration. The confirmatory sample locations at SWMU 16 were considered adequate to determine whether residual COC concentrations or activities that could pose a threat to human health or the environment remained at or downstream from the site following completion of remediation and cleanup activities.

Because of the relatively low solubility of most metals and radionuclides, limited precipitation, and the high evapotranspiration rate in this high desert climate, the vertical rate of contaminant migration is expected to be extremely low. Therefore, all confirmatory samples were collected from the postremediation ground surface to a depth of approximately 6 inches bgs. The 6-inch maximum sample depth was sufficient to determine the potentially very limited vertical extent of COC migration. The confirmatory samples were also considered representative of the shallow subsurface soil that was potentially affected and were sufficient to determine the vertical extent of COC migration within the greatest areas of concern at the site.

In summary, the SWMU 16 confirmatory sampling program was designed with input from NMED technical personnel and was considered appropriate and adequate to determine the nature, rate, and extent of contamination at the site.

IV. Comparison of COCs to Background Screening Levels

Site history and characterization activities were used to aid in identifying potential COCs. The SWMU 16 NFA proposal describes the identification of COCs and the sampling that was conducted to determine the concentration levels of those COCs. Generally, COCs evaluated in this risk assessment included all detected organics and radiological contaminants and all inorganic COCs for which samples were analyzed. If the detection limit of an organic compound was too high (could possibly cause an adverse effect to human health or the environment), the compound was retained. Nondetect organics that were not included in this assessment were determined to have low enough 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) was selected to provide the background screen in Tables 3 and 4. Nonradiological COCs were also compared to SNL/NM proposed Subpart S action levels for human health (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).

Table 3 lists nonradiological COCs for the human health and ecological risk assessments at SWMU 16. Table 4 lists radiological COCs for human health and ecological risk assessments. All tables show the associated SNL/NM maximum background concentration values (Dinwiddie September 1997). Sections VI.4, VII.2, and VII.3 discuss Tables 3 and 4.

V. Fate and Transport

The primary releases of COCs at SWMU 16 were to the ground surface in association with the open dumping of debris along Arroyo del Coyote northeast of TA-III and V. COCs at the site could have been transported downgradient with surface water and could have migrated through the soil from the points of infiltration into the ground. Arroyo del Coyote discharges into Tijeras Arroyo approximately two miles northwest of the site. COCs in the exposed arroyo sediments could have been transported by wind. The corrective action at the site could have temporarily rendered surface soils and sediments open to wind erosion, although most of the primary source material has been removed. No above-background particulate radioactive COCs were found (SNL/NM June 1997).

The average annual precipitation received at this site is only about 8 inches (NOAA 1990); however, surface water in the arroyo is supplemented by runoff from a large drainage basin. Flows in the arroyo are probably limited to intense or prolonged rainfall events. The intermittent flows in Arroyo del Coyote could carry soil particles with adsorbed constituents of potential ecological concern (COPEC). The distance of transport would have depended upon the size of the particle and the velocity of the water. Because most of the debris placed in the arroyo was large (e.g., concrete blocks), transport of the primary source material by these flows probably was not significant.

Water that infiltrates into the soil will continue to percolate through the soil until field capacity is reached. COPECs desorbed from the soil particles into the soil solution may be leached farther into the subsurface soil with this percolation. The COPECs at this site generally do not have a high potential for leaching into soil. Because groundwater at SWMU 16 is approximately 505 feet bgs, it is unlikely that the infiltration and percolation at the site would be sufficient to reach groundwater.

Table 3
Nonradiological COCs for Human Health and Ecological Risk Assessment at SWMU 16 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)	Proposed Subpart S Screening Value[c]	Is Individual COC less than 1/10 of the Action Level?
Arsenic	3.56	5.6	Yes	44[d]	NA	**Yes**	0.5	**No**
Barium	99.8	281	Yes	170[e]	NA	**Yes**	6000	Yes
Cadmium	1.22 J	<1	**No**	64[d]	NA	**Yes**	80	Yes
Chromium, total[f]	17.6	21.8	Yes	16[d]	NA	No	400	Yes
Lead	11.6	39	Yes	49[d]	NA	**Yes**	—	—
Mercury	0.0137 J	<0.25	**Unknown**	5500[d]	NA	**Yes**	20	Yes
Selenium	2.75[g]J	<1	**No**	800[h]	NA	**Yes**	400	Yes
Silver	0.15[g]J	<1	**Unknown**	0.5[d]	NA	No	400	Yes
Methylene chloride	0.0011 J	NA	**NA**	5[i]	1.25[i]	No	90	Yes

Note: **Bold** indicates the COCs that failed the background screening and/or the Subpart S screening procedures and/or are bioaccumulators.
[a]From Dinwiddie (September 1997) Tijeras Supergroup.
[b]NMED (March 1998).
[c]From IT Corporation (July 1994).
[d]BCF and/or Log K_{ow} from Yanicak (March 1997).
[e]BCF from Neumann (1976).
[f]Assumed to be chromium VI for Subpart S screening procedure.
[g]Parameter nondetect, concentration assumed to be 0.5 of detection limit.
[h]BCF from Callahan et al. (1979).
[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
Radiological COCs for Human Health and Ecological Risk Assessment at SWMU 16 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)
U-234[c,d]	1.04	1.6	Yes	900[e]	**Yes**
U-235[d]	0.27J	0.16	**No**	900[e]	**Yes**
U-238[d]	8.9	1.4	**No**	900[e]	**Yes**
Th-232[d]	1.2J	1.01	**No**	3000[e]	No[f]
Tritium[d]	261[g]J	420[h]	Yes	NA	No[f]

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

[a]From Dinwiddie (September 1997), Southwest Supergroup. (Approved background concentrations do not exist for Tijeras sites.)

[b]NMED (March 1998).

[c]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 (Brown January 1998).

[d]These samples were taken from the clean soil piles that were generated during operation of the SGS, which removed elevated contaminants from the soil. The contaminants removed by this process were shipped off site as radioactive waste. The clean soil piles were subsequently spread back over a portion of SWMU 16 and are no longer subject to radiological restrictions.

[e]Baker and Soldat (1992).

[f]Yanicak (March 1997).

[g]Concentration is in pCi/L.

[h]From Tharp (1999).

BCF = Bioconcentration factor.
COC = Constituent of concern.
DU = Depleted uranium.
J = Estimated concentration.
NA = Not applicable.
NMED = New Mexico Environment Department.
pCi/g = Picocurie(s) per gram.
pCi/L = Picocurie(s) per liter.
SNL/NM = Sandia National Laboratories/New Mexico.
SGS = Segmented Gate System.
SWMU = Solid Waste Management Unit.

The original vegetation at this site was riparian scrubland. In general, wildlife use of arroyos is higher than their use of surrounding grasslands. The removal of the debris from the site necessitated the removal of much of the scrub vegetation. Therefore, although the site was reseeded, the potential for COC uptake into the food web and subsequent transport are not expected to be significant at this site until the vegetation becomes better established.

All COCs at SWMU 16 except methylene chloride are inorganics and elemental in form. Therefore, they are not considered to be degradable. Transformations of inorganics may include changes in valence (oxidation/reduction reactions) or incorporation into organic forms (e.g., the conversion of selenite or selenate from soil to seleno-amino acids in plants). Radiological decay of the radionuclides is expected to be insignificant at this site because of their long half lives. Methylene chloride could be lost through volatilization and photolysis, hydrolysis, or biotransformation.

Table 5 summarizes the fate and transport processes that could occur at SWMU 16. Because the vegetative cover at this site had been temporarily removed for the corrective action, the potential for transport by wind was considered low to moderate. The potential for transport by surface water was thought to be moderate because of the periodic flows in the arroyo from storm-water runoff. The current absence of natural vegetative cover and habitat for wildlife at this site results in a low potential for food chain uptake; however, this is not expected to be a significant fate and transport mechanism for COCs at the site even with the future recovery of the habitat. COPECs are not expected to leach significantly into the soil and are, therefore, not expected to reach groundwater. Methylene chloride could be lost at a moderate rate through volatilization and/or transformation processes; however, degradation or transformation of the inorganic COPECs at this site is expected to be negligible.

Table 5
Summary of Fate and Transport at SWMU 16

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

SWMU = Solid Waste Management Unit.

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 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 also exists as a natural background radionuclide.
Step 6.	These values are compared with guidelines established by the U.S. Environmental Protection Agency (EPA) and the DOE to determine whether further evaluation, and potential site clean up, is required. Nonradiological COC risk values are also compared to background risk so that an incremental risk may be calculated.
Step 7.	Uncertainties regarding the contents of the previous steps are addressed.

VI.2 Step 1. Site Data

Section I provides the description and history for SWMU 16. Section II presents a summary of DQOs. Section III describes the determination of the nature, rate, and extent of contamination.

VI.3 Step 2. Pathway Identification

SWMU 16 has been designated a future land-use scenario of recreational (DOE and USAF January 1996) (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 was 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 was included because of the potential to inhale dust and volatiles. Soil ingestion was included for the radiological COCs as well. No water pathways to the groundwater were considered. Depth to groundwater at SWMU 16 is approximately 505 feet bgs. Because of the lack of surface water or other significant mechanisms for dermal contact, the dermal exposure pathway was considered not to be significant. No intake routes through plant, meat, or milk ingestion were considered appropriate for the recreational land-use scenario. However, plant uptake was considered for the residential land-use scenario.

Pathway Identification

Nonradiological Constituents	Radiological Constituents
Soil ingestion	Soil ingestion
Inhalation (dust and volatiles)	Inhalation (dust and volatiles)
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 compared the maximum COC concentration to the background screening level. The second screening procedure compared maximum COC concentrations (for nonradiological COCs) to Proposed Subpart S action levels. This second procedure was applied only to COCs that were not eliminated during the first screening procedure.

VI.4.1 Background Screening Procedure

VI.4.1.1 Methodology

Maximum concentrations of nonradiological COCs were compared to the approved SNL/NM background screening level for this area. The SNL/NM background concentration was selected to provide the background screen (Table 3) and also was used to calculate risk attributable to background (refer to Table 9). Only the COCs that were above their respective SNL/NM maximum background screening levels or did not have a quantifiable background screening level were considered in further risk assessment analyses.

For radiological COCs that exceeded the SNL/NM background screening levels, background values were subtracted from the individual maximum radionuclide concentrations. Those that did not exceed these background levels were not carried any further in the risk assessment. This approach is consistent with DOE Order 5400.5 (DOE 1993). Radiological COCs that did not have a background value and were detected above the analytical minimum detectable activity were 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

A comparison of SWMU 16 maximum COC concentrations to the SNL/NM background values (Dinwiddie September 1997) for the human-health risk assessment is presented in Tables 3 and 4. For the nonradiological COCs, two constituents were above their respective background screening values. Two constituents did not have quantified background concentrations, thus it was not known whether these constituents exceeded background. One constituent was a VOC and had no naturally occurring background concentration.

For the radiological COCs, three constituents had maximum activity concentrations greater than their respective backgrounds (U-238, U-235 and Th-232).

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 resulted most significantly from ingestion of contaminated soil. Because the samples were all taken from the surface, this assumption was considered valid. If there were 10 or fewer COCs and each had a maximum concentration less than one-tenth the action level, then the site was judged to pose no significant health hazard to humans. If there were more than 10 COCs, the Subpart S screening procedure was not performed.

VI.4.2.2 Results

Table 3 shows the COCs and the associated proposed Subpart S action level. The table compares the maximum concentration values to one-tenth the proposed Subpart S action level. For this methodology, guidance from the EPA (EPA 1996) was used. No COCs that failed the background screen were above one-tenth the Subpart S action level. However, for conservatism, all constituents that failed the initial background screen were carried forward in the risk assessment process and a hazard quotient (HQ) and excess cancer risk value were calculated.

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

VI.5 Step 4. Identification of Toxicological Parameters

Tables 6 (nonradiological) and 7 (radiological) show the COCs retained in the risk assessment and the values for the available toxicological information. The toxicological values used for nonradiological COCs in Table 6 are from the Integrated Risk Information System (IRIS) (EPA 1998a), the Health Effects Assessment Summary Tables (HEAST) (EPA 1997a), and the Region 9 (EPA 1996) electronic database. 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. 1993) as developed in the following documents:

Table 6
Toxicological Parameter Values for SWMU 16 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]
Cadmium	5E-4[c]	H	5.7E-5[d]	—	—	6.3E+0[c]	B1
Mercury	3E-4[e]	—	8.6E-5[c]	M	—	—	D
Selenium	5E-3[c]	H	—	—	—	—	D
Silver	5E-3[c]	L	—	—	—	—	D
Methylene chloride	6E-2[c]	M	8.6E-1[e]	—	7.5E-3[c]	1.7E-3[c]	B2

[a]Confidence associated with IRIS (EPA 1998a) database values. Confidence—L = low, M = medium, H = high.

[b]EPA weight-of-evidence classification system for carcinogenicity (EPA 1989) taken from IRIS (EPA 1998a):

- B1 = Probable human carcinogen. Limited human data are available.
- 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 1998a).

[d]Toxicological parameter values from EPA Region 9 electronic database (EPA 1996)

[e]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 7
Radiological Toxicological Parameter Values for SWMU 16 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]
Th-232	3.30E-11	1.90E-08	2.00E-11	A
U-235	4.70E-11	1.30E-08	2.70E-07	A
U-238	6.20E-11	1.20E-08	6.60E-08	A

[a]From Yu et al. (1993).
[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.

- DCFs for ingestion and inhalation were taken from EPA (1988).
- DCFs for surface contamination (contamination on the surface of the site) were taken from DOE/EH-0070 DOE (1988).
- DCFs for volume contamination (exposure to contamination deeper than the immediate surface of the site) were calculated using the methods discussed in Kocher (1983) and in ANL/EAIS-8 (Yu et al. 1993).

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 were 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 were based upon the RAGS (EPA 1989). Parameters were 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 were used to estimate the incremental TEDE and cancer risk for individual exposure pathways. Further discussion of this process is provided in Yu et al. (1993).

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

An HI of 0.00 was calculated for the SWMU 16 nonradiological COCs, and the excess cancer risk was 4E-11 for the designated recreational land-use scenario (Table 8). These numbers included exposure from soil ingestion and dust and volatile inhalation for nonradiological COCs. All background constituents had nonquantified background concentrations (Table 9), thus risk associated with background could not be calculated.

For the radiological COCs, the risk assessment included the contribution from the direct gamma exposure pathway. 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 9.0E-2 millirem (mrem)/year (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 was used for the probable land-use scenario (recreational in this case); the calculated dose value for SWMU 16 for the recreational land use was well below this guideline. The estimated excess cancer risk was 1.5E-6.

For the residential land-use scenario nonradioactive COCs, the HI is 2, and the excess cancer risk is 9E-9 (Table 8). 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 was 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 were not considered (see Appendix 1). Table 9 shows that all background constituents had nonquantified background concentrations, thus risk associated with background could not be calculated.

For the radiological COCs, the incremental TEDE for the residential land-use scenario is 1.5 mrem/yr. The guideline 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 16 for the residential land-use scenario is well below this guideline. Consequently, SWMU 16 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

Table 8
Risk Assessment Values for SWMU 16 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
Cadmium	1.22 J	0.00	3E-11	1.00	7E-10
Mercury	0.0137 J	0.00	—	0.02	—
Selenium	2.75[b] J	0.00	—	0.97	—
Silver	0.15[b] J	0.00	—	0.01	—
Methylene chloride	0.0011 J	0.00	5E-12	0.00	8E-9
Total		**0.00**	**4E-11**	**2**	**9E-9**

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

Table 9
Risk Assessment Values for SWMU 16 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
Cadmium	<1	—	—	—	—
Mercury	<0.25	—	—	—	—
Selenium	<1	—	—	—	—
Silver	<1	—	—	—	—
Total		—	—	—	—

[a]From Dinwiddie (September 1997), Tijeras Supergroup.
[b]From EPA (1989).
COC = Constituent of concern.
EPA = U.S. Environmental Protection Agency.
SWMU = Solid Waste Management Unit.
-- = Information not available.

on-site receptor. The estimated excess cancer risk is 2.0E-5. 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 calculated HI is 0.00 (less than the numerical guideline of 1 suggested in the RAGS [EPA 1989]). Excess cancer risk is estimated at 4E-11. 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). The excess cancer risk is driven by cadmium and methylene chloride. Cadmium is a Class B1 carcinogen. Methylene chloride 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. Table 9 shows that all background constituents had nonquantified background concentrations, thus risk associated with background could not be calculated. 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. For conservatism, since all background constituents had nonquantified background concentrations, the background HI and excess cancer risk was considered to be zero. Incremental HI is 0.00, and incremental cancer risk is 3.5E-11 for the recreational land-use scenario. These incremental risk calculations indicated insignificant risk to human health from nonradiological COCs considering the recreational land-use scenario.

For radiological COCs of the recreational land-use scenario, incremental TEDE is 9.0E-2 mrem/yr, which is significantly less than EPA's numerical guideline of 15 mrem/yr. Incremental estimated excess cancer risk is 1.5E-6.

The calculated HI for the residential land-use scenario nonradiological COCs is 2, which is above the numerical guidance. Excess cancer risk is estimated at 9E-9. Excess cancer risk is driven by cadmium and methylene chloride. Cadmium is a Class B1 carcinogen. Methylene chloride is a Class B2 carcinogen. Therefore, the excess cancer risk for this site was below the suggested acceptable risk value (1E-6). Table 9 shows that all background constituents had nonquantified background concentrations, thus risk associated with background could not be calculated. The incremental HI is 2.00, and the incremental cancer risk is 8.7E-9 for the residential land-use scenario. The incremental HI calculation indicated a risk to human health above the proposed guideline considering the residential land-use scenario.

The incremental TEDE for a residential land-use scenario from the radiological components is 1.5 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 2.0E-5.

VI.8 Step 7. Uncertainty Discussion

The determination of the nature, rate, and extent of contamination at SWMU 16 was based upon the results of site inspections and investigations as well as VCM activities and was validated with confirmatory sampling conducted at the site. The confirmatory sampling was implemented in accordance with discussions and agreements reached between SNL/NM and NMED technical personnel involved in activities at the site. The data collected, based upon sample location, density, and depth, are considered to be representative of the site as a whole. Data quality was validated in accordance with SNL/NM procedures (SNL/NM July 1994, SNL/NM July 1996). Therefore, there is essentially no uncertainty associated with the data used to perform the risk screening assessment at SWMU 16.

Because of the location, history of the site, and future land use (DOE and USAF January 1996), 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 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 were conservative and that calculated intakes were probably overestimates. Maximum measured values of COC concentrations were used to provide conservative results.

Table 6 shows the uncertainties (confidence) in nonradiological toxicological parameter values. Some of the values are estimated and others are from the IRIS (EPA 1998), HEAST (EPA 1997a), and EPA Region 9 (EPA 1996) electronic databases. Where values are not provided, information is not available from the HEAST (EPA 1997a), IRIS (EPA 1998), or the EPA regions (EPA 1996, 1997c). Because of the conservative nature of the RME approach, uncertainties in toxicological values were not expected to change the conclusion from the risk assessment analysis.

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

For radiological COCs, the risk assessment concluded 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

COCs associated with SWMU 16 consisted 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 and volatile 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 showed that for the recreational land-use scenario the HI (0.00) was significantly less than the accepted numerical guidance from the EPA. Excess cancer risk (4E-11) was also below the acceptable risk value provided by the NMED for a recreational land use scenario (NMED March 1998).

Incremental TEDE and corresponding estimated cancer risk from radiological COCs were much less than EPA guidance values; the estimated TEDE was 9.0E-2 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 was 1.5E-6 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 1.5E+0 mrem/yr with an associated risk of 2.0E-5. The guideline for this scenario is 75 mrem/yr (SNL/NM February 1998). Therefore, SWMU 16 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 COPECs in soils at SWMU 16. 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 Sections II through V 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 potential contaminants associated with site activities. Included in this section are an evaluation of existing data and a comparison of maximum detected concentrations to background concentrations, an 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 3 and 4), the following inorganic constituents in soil within the 0- to 0.5-foot depth interval exceeded background concentrations:

- Cadmium
- Selenium
- Th-232
- U-235
- U-238.

In addition, mercury and silver do not have quantified background screening values and, therefore, could not be rejected as potential COPECs for this site based upon screening against background. Methylene chloride was the only organic analyte detected in the soil at this site.

VII.2.2 Bioaccumulation

Among the COPECs listed in Section VII.2.1, the following were considered to have bioaccumulation potential in aquatic environments (Section IV, Tables 3 and 4):

- Cadmium
- Mercury
- Selenium
- U-235
- U-238.

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 5 (Section V), wind and surface water could be of moderate significance as transport mechanisms for COPECs at this site, while food-chain uptake is expected to be of low significance. Migration to groundwater is not anticipated. Degradation/transformation for the inorganic COPECs (including the radionuclides) is expected to be of low significance. Methylene chloride could be lost through volatilization and/or transformation processes.

VII.2.4 Scoping Risk Management Decision

Based upon information gathered through the scoping assessment, it was concluded that complete ecological pathways may be associated with this SWMU and that COPECs also existed 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 involved 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 was conservative to ensure that ecological risks not be underpredicted.

Components within the screening assessment included 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 IT (July 1998) and are not duplicated here.

VII.3.1.1 Ecological Pathways and Setting

SWMU 16 is approximately 28 acres in size. The site is located along Arroyo del Coyote and is dominated by riparian scrubland habitat, flanked on either side by grassland habitat. A sensitive species survey of the site was conducted on April 18, 1994 (IT February 1995), and no sensitive species were found. The habitat at this site, however, has been highly disturbed by VCM activities and was subsequently recontoured and reseeded. Although wildlife use is not expected to be significant at the current time, it is expected to increase as the vegetation becomes reestablished.

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; exposure of plants to wind-blown soil was assumed to be minor. For the wildlife receptors, exposure modeling for nonradiological COPECs was limited to the food and soil ingestion pathways. Because surface water at this site is highly ephemeral and the potential for partitioning of the COPECs from soil to water are generally low, 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 was not expected to be affected by COPECs at this site. Dose calculations for radiological COPECs included internal dose from the ingestion of food and soil and the inhalation of dust and external dose from the surrounding soil medium.

VII.3.1.2 COPECs

In order to provide conservatism in this ecological risk assessment, the assessment was based upon the maximum soil concentrations of the COPECs measured at this site or, in the cases of selenium and silver, one-half the detection limit of the element. These values are reported in Tables 3 and 4 (Section IV). Both radiological and nonradiological COPECs were evaluated. The nonradiological COPECs included both inorganic and organic analytes. All organic analytes detected were considered to be COPECs. 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 and those for which a definitive screening level could not be determined were considered to be COPECs. Nonradiological inorganics that are essential nutrients such as iron, magnesium, calcium, potassium, and sodium were not included in this risk assessment as set forth by the EPA (1989).

VII.3.1.3 Ecological Receptors

As described in detail in IT (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 the mammalian herbivore, omnivore, and insectivore. The burrowing owl was selected to represent the top predator at this site. The burrowing owl occurs in the grassland habitats 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

For nonradiological COPECs, 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 surface water is very temporary 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). The exposure in the burrowing owl from a diet consisting of equal parts of herbivorous, omnivorous, and insectivorous mice is the same as the exposure resulting from a diet consisting of only omnivorous mice. For this reason, 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 10 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, implying 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 COPEC 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

Table 10
Exposure Factors for Ecological Receptors at SWMU 16

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 kilograms wet weight.
[b]Food intake rates are estimated from the allometric equations presented in Nagy (1987). Units are kilograms dry weight per day.
[c]Dietary compositions are generalized for modeling purposes. Default soil intake value of 2 percent 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.

both internally and externally from Th-232, U-235, and U-238. Internal and external dose rates to the deer mouse and burrowing owl were approximated using modified dose rate models from 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 caused by exposure to each of the radionuclides, and these are summed to calculate the total dose to the receptor.

Table 11 presents the transfer factors used in modeling the concentrations of COPECs through the food chain. Table 12 presents maximum concentrations in soil and derived concentrations in tissues of the various food-chain elements that were 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 13. For plants, the benchmark soil concentration is based upon the lowest-observed-adverse-effect level. 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 NOAEL for silver for the burrowing owl.

The benchmark used for exposure of terrestrial receptors to radiation was 0.1 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 16.

VII.3.4 Risk Characterization

Maximum concentrations in soil and estimated dietary exposures were compared to plant and wildlife benchmark values, respectively. Results of these comparisons are presented in Table 14. HQs are used to quantify the comparison with benchmarks for plants and wildlife exposure. Only selenium (evaluated at one half its maximum detection limit) produced HQs greater than unity. This was the case for both plants and the insectivorous deer mouse.

Table 11
Transfer Factors Used in Exposure Models for Constituents of Potential Ecological Concern at SWMU 16

Constituent of Potential Ecological Concern	Soil-to-Plant Transfer Factor	Soil-to-Invertebrate Transfer Factor	Food-to-Muscle Transfer Factor
Inorganics			
Cadmium	5.5E-1[a]	6.0E-1[b]	5.5E-4[a]
Mercury	1.0E+0[c]	1.0E+0[d]	2.5E-1[a]
Selenium	5.0E-1[c]	1.0E+0[d]	1.0E-1[c]
Silver	1.0E+0[c]	2.5E-1[b]	5.0E-3[c]
Organics			
Methylene chloride	7.3E+0[e]	1.5E+1[f]	3.6E-7[e]

[a]From Baes et al. (1984).
[b]From Stafford et al. (1991).
[c]From NCRP (January 1989).
[d]Default value.
[e]Soil-to-plant and food-to-muscle transfer factors from equations developed in Travis and Arms (1988) based upon relationship of the transfer factor to the log K_{ow} value of compound.
[f]Soil-to-invertebrate transfer factors from equations developed in Connell and Markwell (1990) based upon relationship of the transfer factor to the K_{ow} value of compound.
K_{ow} = The octanol-water partition coefficient.
NCRP = National Council for Radiation Protection and Measurements.
SWMU = Solid Waste Management Unit.

Table 12
Media Concentrations[a] for Constituents of Potential Ecological Concern at SWMU 16

Constituent of Potential Ecological Concern	Soil (maximum)[a]	Plant Foliage[b]	Soil Invertebrate[b]	Deer Mouse Tissues[c]
Inorganics				
Cadmium	1.2E+0	6.7E-1	7.3E-1	1.3E-3
Mercury	1.4E-2	1.4E-2	1.4E-2	1.1E-2
Selenium	2.8E+0[d]	1.4E+0	2.8E+0	6.6E-1
Silver	1.5E-1[d]	1.5E-1	3.8E-2	1.5E-3
Organics				
Methylene chloride	1.1E-3	8.1E-3	1.7E-2	1.4E-8

[a]In milligrams 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 was not detected. Soil concentration value represents one-half the detection limit.
EPA = U.S. Environmental Protection Agency.
SWMU = Solid Waste Management Unit.

Table 13
Toxicity Benchmarks for Ecological Receptors at SWMU 16

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[d]	Test Species NOAEL[d,e]	Burrowing Owl NOAEL[e,g]
Inorganics							
Cadmium	3	Rat[h]	1.0	1.9	Mallard	1.45	1.45
Mercury (inorganic)	0.3	Mouse	13.2	14.0	Japanese quail	0.45	0.45
Mercury (organic)	0.3	Rat	0.032	0.063	Mallard	0.0064	0.0064
Selenium	1	Rat	0.20	0.39	Screech owl	0.44	0.44
Silver	2	Rat	17.8[i]	34.8	—	—	—
Organics							
Methylene chloride	—	Rat	5.85	11.4	—	—	—

[a]In milligram(s) per kilogram soil.
[b]From Efroymson et al. (1997).
[c]Body weights (in kilogram[s]) for the no-observed-adverse-effect level (NOAEL) conversion are as follows: lab mouse, 0.030; lab rat, 0.350 (except where noted).
[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 NOAEL conversion methodology presented in Sample et al. (1996). The avian scaling factor of 0.0 was used, making the NOAEL independent of body weight.
[h]Body weight: 0.303 kilogram.
[i]Based upon a rat lowest-observed-adverse-effect-level of 89 mg/kg/-d (EPA 1998a) and an uncertainty factor of 0.2.

EPA = U.S. Environmental Protection Agency.
mg/kg-d = Milligram(s) per kilogram day.
NOAEL = No-observed-adverse-effect level.
SWMU = Solid Waste Management Unit.
— = Insufficient toxicity data.

Table 14
Hazard Quotients for Ecological Receptors at SWMU 16

Constituent of Potential Ecological Concern	Plant HQ	Deer Mouse HQ (Herbivorous)	Deer Mouse HQ (Omnivorous)	Deer Mouse HQ (Insectivorous)	Burrowing Owl HQ
Inorganics					
Cadmium	4.1E-1	5.7E-2	6.0E-2	6.2E-2	2.0E-3
Mercury (inorganic)	4.6E-2	1.6E-4	1.6E-4	1.6E-4	2.8E-3
Mercury (organic)	4.6E-2	3.5E-2	3.5E-2	3.5E-2	2.0E-1
Selenium	**2.8E+0**[a]	5.7E-1	8.4E-1	**1.1E+0**[a]	1.8E-1
Silver	7.5E-2	6.8E-4	4.3E-4	1.8E-4	—
Organics					
Methylene chloride	—	1.1E-4	1.7E-4	2.3E-4	—
HI[b]	**3.3E+0**[a]	6.6E-1	9.3E-1	**1.2E+0**[a]	3.8E-1

[a]**Bold** text indicates HQ or HI exceeds unity.
[b]The HI is the sum of individual HQs using the value for organic mercury as a conservative estimate of the HI.
HI = Hazard index.
HQ = Hazard quotient.
SWMU = Solid Waste Management Unit.
— = Insufficient toxicity data available for risk estimation purposes.

As directed by the NMED, HIs were calculated for each of the receptors (the HI is the sum of chemical-specific HQs for all pathways for a given receptor). Only the HI values for plants and the insectivorous deer mouse exceeded unity. The maximum HI was 3.3 (in plants).

Tables 15 and 16 summarize the internal and external dose-rate-model results for Th-232, U-235, and U-238. The total radiation dose rate to the deer mouse was predicted to be 3.5E-4 rad/day. Total dose rate to the burrowing owl was predicted to be 2.9E-4 rad/day. In both cases, the external dose rate accounted for the majority of the total dose rate. The dose rates for the deer mouse and the burrowing owl were 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 16. These uncertainties result from assumptions used in calculating risk that could overestimate or underestimate true risk presented at a site. For this risk assessment, assumptions were made that were more likely to overestimate exposures and risk rather than to underestimate them. These conservative assumptions were used to provide more protection to the ecological resources potentially affected by the site. Conservatisms incorporated into this risk assessment included the use of maximum measured analyte concentrations in soil or one-half the detection limit value 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 Environmental Restoration Program (IT July 1998).

Uncertainties associated with the estimation of risk to ecological receptors following exposure to Th-232, U-235, and U-238 were primarily related to those inherent in the radionuclide-specific data. Radionuclide-dependent data are measured values that have their associated errors, which are typically negligible. The dose rate models used for these calculations were based upon conservative estimates on receptor shape, radiation absorption by body tissues, and intake parameters. The goal was to provide a realistic but conservative estimate of a receptor's internal and external exposure to radionuclides in soil.

Selenium was the only COPEC to produce HQs greater than unity (2.8 for plants and 1.1 for insectivorous deer mice). The greatest source of uncertainty associated with these findings is that selenium was not detected in the soil samples from this site; therefore, risks were evaluated using one-half the highest detection limit. This overestimates the actual mean concentration of selenium in the soils at this site because the MDL for Se in the confirmatory samples was approximately 1/40th of the highest detection limit. Because of the use of this conservative exposure point concentration and the incorporation of the other conservative assumptions described above, coupled with the low levels of risk indicated by the HQs, the potential for ecological risks actually to exist at SWMU 16 is very low.

Table 15
Internal and External Dose Rates for
Deer Mice Exposed to Radionuclides at SWMU 16

Radionuclide	Maximum Concentration (pCi/g)	Internal Dose Rate (rad/day)	External Dose Rate (rad/day)	Total Dose Rate (rad/day)
Th-232	1.2E+0	4.8E-7	2.3E-4	2.3E-4
U-235	2.7E-1	2.9E-6	4.4E-6	7.3E-6
U-238	8.9E+0	9.0E-5	1.8E-5	1.1E-4
Total	—	9.3E-5	2.6E-4	3.5E-4

pCi/g = Picocurie(s) per gram.
SWMU = Solid Waste Management Unit.

Table 16
Internal and External Dose Rates for
Burrowing Owls Exposed to Radionuclides at SWMU 16

Radionuclide	Maximum Concentration (pCi/g)	Internal Dose Rate (rad/day)	External Dose Rate (rad/day)	Total Dose Rate (rad/day)
Th-232	1.2E+0	7.0E-7	2.3E-4	2.3E-4
U-235	2.7E-1	1.2E-6	4.4E-6	5.6E-6
U-238	8.9E+0	3.6E-5	1.8E-5	5.4E-5
Total	—	3.8E-5	2.5E-4	2.9E-4

pCi/g = Picocurie(s) per gram.
SWMU = Solid Waste Management Unit.

VII.3.6 Risk Interpretation

Ecological risks associated with SWMU 16 were conservatively estimated through a screening assessment that incorporated site-specific information when available. For all detected COPECs, the maximum concentrations or radionuclide activities were below the plant screening benchmarks and no risks were predicted for wildlife receptors. For selenium, which was not detected but was evaluated at one-half its highest detection limit, low levels of potential risk to plants and the insectivorous deer mouse were indicated. However, based upon the conservative assumptions associated with these predictions, the potential for ecological risks to exist because of COPECs associated with SWMU 16 is expected to be very low.

VII.3.7 Screening Assessment Scientific/Management Decision Point

After potential ecological risks associated with the site have been assessed, a decision is made as to whether the site should be recommended for NFA or whether additional data should be collected to provide more thorough assessment of actual ecological risk at the site. With respect to this site, the potential for ecological risks to exist was predicted to be very low. The scientific/management decision is to recommend this site for NFA.

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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.

<u>Equations and Default Parameter Values for Identified Exposure Routes</u>

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).

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